Special Report 1030

July 2001

Research in the Klamath Basin 2000 Annual Report

in cooperation with Klamath County

OREGON STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION

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Agricultural Experiment Station
Oregon State University
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Note from the Superintendent

The new decade brought major staffing changes to the Klamath Experiment Station (KES). In April, Dr. Donald Clark joined our staff as an Assistant Professor and Research Agronomist responsible for forage and cereal research programs. Don completed his doctorate program at Texas Tech University in late 1999. In May, Greg Chilcote resigned his 18-year position as a Research Technician on our Klamath County funding to pursue new challenges as the Oregon State University computer support person for Eastern Oregon. Greg will service all county extension offices and branch experiment stations east of the Cascade Mountains out of his Bend, Oregon office.

In August, Gail Quick retired from the Office Specialist position to join her husband, Dick, in his retirement from a long and distinguished career with the Oregon Air National Guard (42 years). On November 31, Jim Rainey III retired after 21 years of service to KES as our Biological Sciences Research Technician III supporting forage research projects. We wish Gail, Jim, and Greg success as they move on to new challenges and pursuits, and we thank them for their many contributions to KES.

We have been fortunate to replenish our staff and make adjustments in several positions to accommodate changing programs and activities. Jimmie Goodrich joined us in a newly established 9-month, county-funded Farm Worker position in May. Jewel Haskins assumed the duties of Office Specialist in August. Jim Smith joined us in the new Faculty Research Assistant position created as a result of legislative support for the statewide cereals research and extension programs. The future of the position Jim Rainey held is still uncertain and will depend on support for statewide research programs during the 2001-2002 legislative session.

With staffing changes, cereal and forage research activities were scaled down in the past 2 years. A shift in emphasis to explore water quality in the basin also reduced row crop research emphasis. Finally, two 2000 sugarbeet research projects were abandoned after severe spring frosts killed original plantings and mid-May replantings. KES experience with frost damage to sugarbeet crops mirrored commercial experience, in which over 8,000 acres planted in 2000 were reduced to less than 4,000 acres harvested.

The net result of these factors is a downsizing of our annual research report for 2000. However, we have published a summary of our water quality investigations in a separate volume as Special Report 1023. Interested parties can obtain a copy of the report, "Nutrient Loading of Surface Waters in the Upper Klamath Basin: Agricultural and Natural Sources" by calling, writing, or contacting us by e-mail at **kenneth.rykbost@orst.edu**. The report is also posted on our Internet web page at **http://www.orst.edu/dept/kes**.

We take this opportunity to extend our appreciation to our many colleagues who cooperate in research activities, industry and organizations who provide financial support for research projects, members of our station Advisory Board for their counsel, and to Klamath County for continuing support for staffing, facilities, and equipment. Where appropriate, cooperators and financial support are acknowledged in project reports. Finally, I thank all KES staff for their efforts during this time of transition.

As this report goes to press in early June, the future of the agricultural industry in the Klamath Basin is very tenuous. On April 6, the Bureau of Reclamation announced an operations plan for the Klamath Irrigation Project that did not include any diversion of water from Klamath Lake or Klamath River for irrigation. This decision was based on Biological Opinions from the U.S. Fish and Wildlife Service requiring maintenance of high lake elevations to protect endangered sucker species in Klamath Lake and from the National Marine Fisheries Service requiring high flows to lower Klamath River to protect threatened Coho Salmon.

This decision has eliminated surface water irrigation supply for about 170,000 acres of cropland in the Klamath Irrigation Project. Immediate consequences have included forced sales of livestock because of loss of irrigated pasture, a doubling of local rental rates for pastures with irrigation capability, and a doubling of hay prices in the local area. Contracts for processing onions and chipping potatoes have been significantly reduced. Local potato seed producers were forced to sell much of their 2000 seed crop through fresh market channels at less than 20 percent of the value for seed. Potato acreage, planted in fields with well water supplies, is about 30 percent of the 2000 acreage.

Long-term consequences of changing management of the Klamath Irrigation Project remain to be seen. However, the stability and sustainability of the local industry and outlying communities it has supported for decades are at severe risk. Agricultural land values have plummeted, as the security of irrigation supply has been lost. Our 2001 research programs at KES will be very limited. We have secured a field with well water supply for maintaining limited cooperative variety-development projects for cereals and potatoes. With no well at KES, newly established forage research projects are at risk. This year will present unprecedented challenges for the region.

Kenneth A. Rykbost

Kenneth A. Rykbost
Superintendent
Klamath Experiment Station

Major Cooperators in KES Research Programs

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Mr. Mylen Bohle, *Crook County Cooperative Extension Service*
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Dr. Dan Hane, *Hermiston Agricultural Research and Extension Center*
Dr. Patrick Hayes, *Department of Crop and Soil Science*
Dr. Russell Ingham, *Department of Botany and Plant Pathology*
Mr. Steve James, *Central Oregon Agricultural Research Center*
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Dr. Kerry Locke, *Klamath County Cooperative Extension Service*
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Dr. James Petersen, *Department of Crop and Soil Science*
Dr. Clinton Shock, *Malheur Experiment Station*
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University of California

Dr. Harry Carlson, *Intermountain Research and Extension Center*
Mr. Donald Kirby, *Intermountain Research and Extension Center*
Mr. Herb Philips, *Department of Vegetable Crops*
Dr. Ron Voss, *Department of Vegetable Crops*
Dr. Lee Jackson, *Department of Agronomy and Range Science*

Others

Dr. Chuck Brown, *USDA-Agricultural Research Service, Prosser, Washington*
Dr. Dennis Corsini, *USDA-Agricultural Research Service, Aberdeen, Idaho*
Dr. Steve Fransen, *Washington State University*
Dr. David Holm, *Colorado State University*
Dr. Stephen Love, *University of Idaho*
Dr. J. Creighton Miller, Jr., *Texas A&M University*
Dr. Richard Novy, *USDA-Agricultural Research Service, Aberdeen, Idaho*
Dr. Robert Thornton, *Washington State University*
Dr. Darrell Wesenberg, *USDA-Agricultural Research Service, Aberdeen, Idaho*

We deeply appreciate their involvement and contributions to KES research efforts.

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Dr. Donald R. Clark, *Assistant Professor of Crop and Soil Science*
Mr. George E. Carter, *Associate Professor, Emeritus*
Mr. Brian A. Charlton, *Faculty Research Assistant*
Mr. Jimmie Goodrich, *Farm Worker (Klamath County)*
Mrs. Jewel Haskins, *Office Specialist II*
Mr. Lawrence Johnson, *Facility Maintenance Leadworker (Klamath County)*
Mr. Jim E. Smith, *Faculty Research Assistant*

Contents

Klamath Basin Crop Trends

Jim E. Smith and Kenneth A. Rykbost[1]

The Klamath Basin, including portions of Modoc and Siskiyou counties, California, and Klamath and Lake counties, Oregon, comprises a large geographical area with differences in elevation and growing season duration, and a wide variety of climatic conditions. Included within Modoc, Siskiyou, and Klamath counties are Bureau of Reclamation (BOR) Klamath Irrigation Project (Project) lands (Fig. 1). Typical of most western states, significant portions of land are owned and controlled by federal and state agencies including the Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (USFWS), the U.S. Forest Service (USFS), and their state counterparts. This report summarizes data on crop acreage within the Project. Although a large acreage of hay and cereal grains is grown outside the Project, most of the high-value crops are grown within the Project. Trends in cropping patterns are similar for land in and outside of the Project.

In this report, onion production refers to dehydrated onions, not fresh market onions, even though a few acres of fresh market onions are produced in the Klamath Basin. Potatoes include fresh market, process (chippers), seed, and culls, sold as either cow feed or to potato flake processors. Other hay includes all hay other than alfalfa, such as grass/meadow hay, grain hay, and legume/grain hay.

Bureau of Reclamation (BOR) Acreage Trends

Project lands are located in south central Oregon (62 percent) and north central California (38 percent). The Project provides irrigation water to approximately 240,000 acres, including two national wildlife refuges. Water distribution to the Project is controlled by BOR (Fig.1). There are 18 water districts within the Project. Their respective growers, who benefit from the delivery system and support the purchase and operational costs of the districts through assessed acreage charges, own the districts. Acreage data for the Project are fairly accurate due to the requirement of each district to provide BOR with an annual report, including total acres irrigated and crops grown.

Total Project crop acreage has varied slightly over the past decade, ranging from 203,475 acres in 1990 to 190,866 acres in 2000 (Table 1). Within the four-county region, pastures comprise more total acres than all other crops combined, and provide a major component of gross agricultural economic activity in the region. Within the Project, irrigated pastures accounted for 49,246 acres in 1990 and 41,721 acres in 2000. Total pasture acreage in the four-county region includes several hundred thousand acres of unimproved irrigated pasture, unirrigated pasture, and rangeland.

Total grain and total hay crop acreages are the largest acreage in the Project, with total grain at 56,856 acres, and total hay at 67,330 acres in 2000. Total hay

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[1] Faculty Research Assistant and Superintendent/Professor, respectively, Klamath Experiment Station, Klamath Falls, OR.

acreage has increased by 30 percent since 1990, from 51,726 acres. Most of the increase (nearly 17,000 acres) was in alfalfa production.

Total grain acreage declined from 76,999 acres in 1990 to 56,856 acres in 2000, a reduction of 26 percent. Barley acreage is highest among cereal crops. However, barley acreage has declined 35 percent from 58,063 acres in 1990 to 37,872 acres in 2000. Wheat acreage increased during the decade by nearly 50 percent. The reverse is true for oats, which experienced a reduction from 9,838 acres in 1990 to 5,093 acres in 2000. Shifts in the acreage of cereal crops reflect changing market conditions and the introduction of barley stripe rust to the region.

Total potato acreage shows a downward trend from 21,367 acres in 1990 to 12,816 acres in 2000. Most of the decrease has occurred in the last 4 or 5 years, and is due to poor returns in fresh potato markets. There has been a slight increase in the acreage grown for chips. BOR data indicate a loss of about 2,000 acres/year for the past 5 years. This pattern may accelerate in 2001 because of extremely low fresh market prices for 2000 crops.

Onion production has increased from 1,823 acres in 1990 to 3,256 acres in 2000. However, onion acreage for 2001 has been severely curtailed, and the contract price to growers has declined significantly. These changes are due to consolidation of processing companies and to competition from Chinese imports of dehydrated food products.

Sugarbeets were introduced to the region in 1989. The crop acreage expanded from 906 acres in 1990 to a maximum of about 11,500 acres in 1995. After consolidation of two processing companies, the acreage remained constant at about 8,500 acres from 1996 through 1999. In 2000, severe frost damage reduced acreage from over 8,000 planted to around 3,900 harvested. Closure of the processing plant in Woodland, California in January 2000 signaled the end of sugarbeet production in the Klamath Basin.

Peppermint was reintroduced to the Klamath Basin in 1997. In 2000, this crop accounted for 2,385 acres in the Project. The future for this crop is also uncertain, as surpluses have resulted in lower prices and a lack of new contracts. Horseradish has remained a stable but small acreage crop at less than 1,000 acres annually.

Irrigation Costs in the Four-County Area

Water conveyance costs to irrigators for areas within and outside the Project are shown in Figure 2. Costs for each district are different based on maintenance and repair, operational, litigation, and wage costs. Irrigation district charges are due whether water is available or not, and property liens are attached to the parcel in the event of nonpayment.

Shasta View Irrigation District, at \$70.00/acre, has the highest charges. This district provides high-pressure water, requiring no pumps for irrigation. Fort Klamath irrigation costs are very low, at less than \$10.00/acre, because of the method of irrigation and lack of overhead costs.

Tulelake Irrigation District (TID) and Klamath Irrigation District (KID) control irrigation on the largest tracts of land, at over 120,000 combined acres. Costs on TID lands are \$29.00/acre and \$25.00/acre on KID lands. Several smaller irrigation districts were established with primary water rights, such as the Van Brimmer Ditch Co., which maintains lower irrigation costs of around \$12.50/acre. In comparison, the Butte Valley Irrigation District, outside of Project land, shows irrigation costs at approximately \$42.00/acre, with surcharges for use of over 2 acre-feet/year.

Summary

Acreage trends show major reductions in potatoes, irrigated pasture, and grain; the elimination of sugarbeets; and an increase in hay production in the Klamath Basin over the past decade. Acreage reductions occurred in 1992 for crops such as onions and potatoes because of drought conditions and a BOR decision early in the spring that there would be no water for irrigation. In fact, later in the spring the water availability outlook improved and irrigation supplies were allocated. The uncertainty forced many growers into revising plans and shifting crop acreage. Unfortunately, as of this writing, there is no assurance of Project water availability for irrigation in 2001, based on projected allocations for endangered species, including salmon, shortnose suckers, and Lost River suckers. How this will change Klamath Basin agriculture is uncertain. However, if Project irrigation supplies are not committed by late April, row crop production will be confined to fields with well-water supplies. The cropping trend changes of the past decade will accelerate unless stability of the irrigation supply is implemented. In an insecure irrigation scenario, crop production will be limited to pastures, hay, and cereals.

Table 1. Crop acreages within the Bureau of Reclamation Irrigation Project in 1990 and 2000 as reported by the Bureau of Reclamation, Klamath Falls, OR.

	1990 Production (Acres)			2000 Production (Acres)		
Crop	Oregon	California	total	Oregon	California	total
Barley	25,040	33,023	58,063	15,497	22,375	37,872
Oats	6,514	3,324	9,838	3,416	1,677	5,093
Wheat	3,740	5,309	9,049	3,421	10,067	13,488
Other cereals	49	0	49	264	139	403
Total cereals	35,343	41,656	76,999	22,598	34,258	56,856
Alfalfa	26,320	8,233	34,553	39,110	12,202	51,312
Other hay	16,383	790	17,173	14,997	1,021	16,018
Irrigated pasture	40,565	8,681	49,246	38,987	2,734	41,721
Other forage	0	0	0	1,183	0	1,183
Total forages	83,268	17,704	100,972	94,277	15,957	110,234
Potatoes	8,874	12,493	21,367	5,389	7,427	12,816
Sugarbeets	278	628	906	1,479	2,393	3,872
Onions	0	1,823	1,823	422	2,834	3,256
Peppermint	0	0	0	505	1,880	2,385
Horseradish	0	892	892	0	975	975
Pea seed	114	302	416	60	168	228
Other	100	0	100	244	0	244
Total other	9,366	16,138	25,504	8,099	15,677	23,776
Total crops	127,977	75,498	203,475	124,974	65,892	190,866

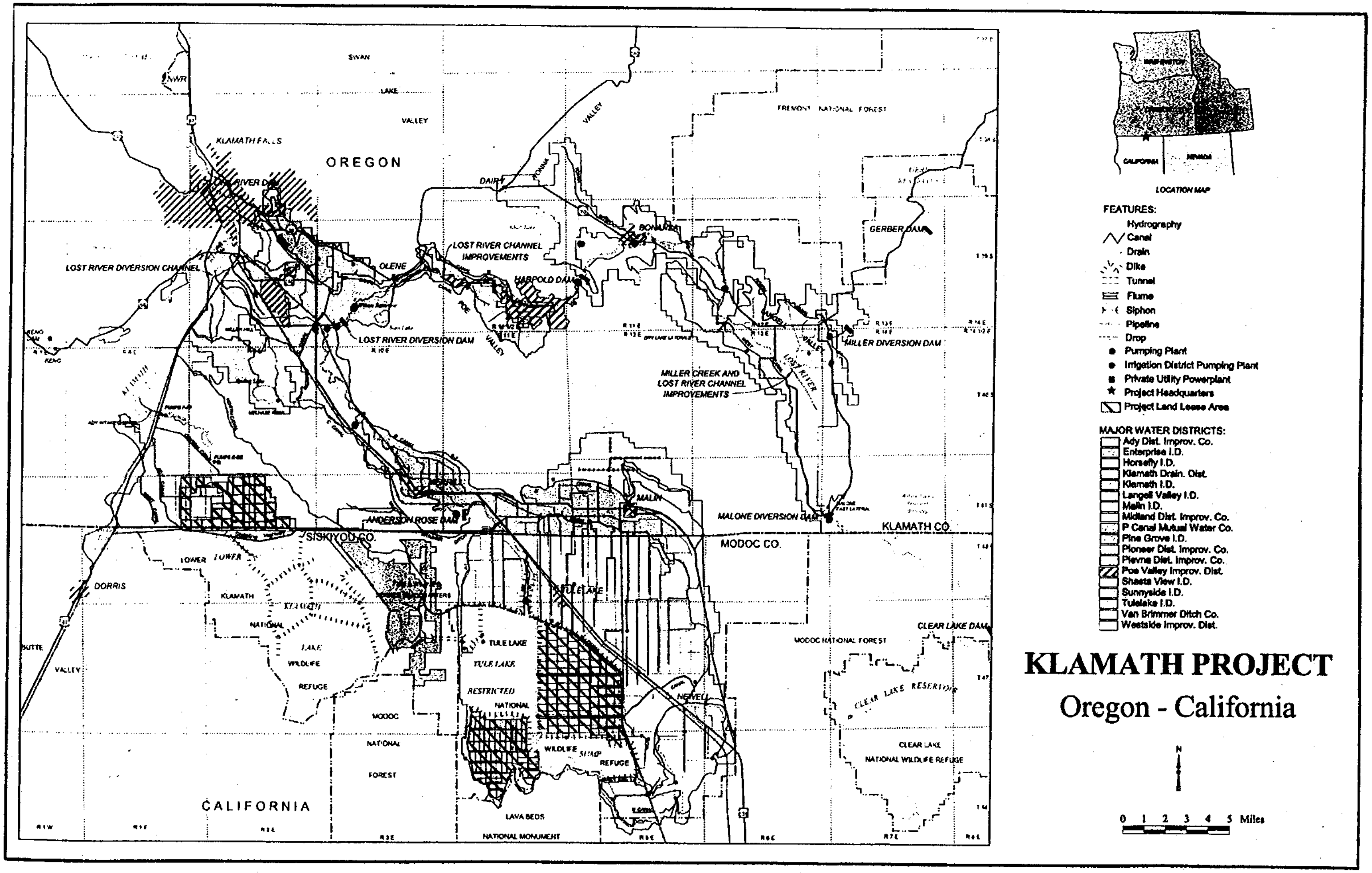

Figure 1. The Klamath Irrigation Project

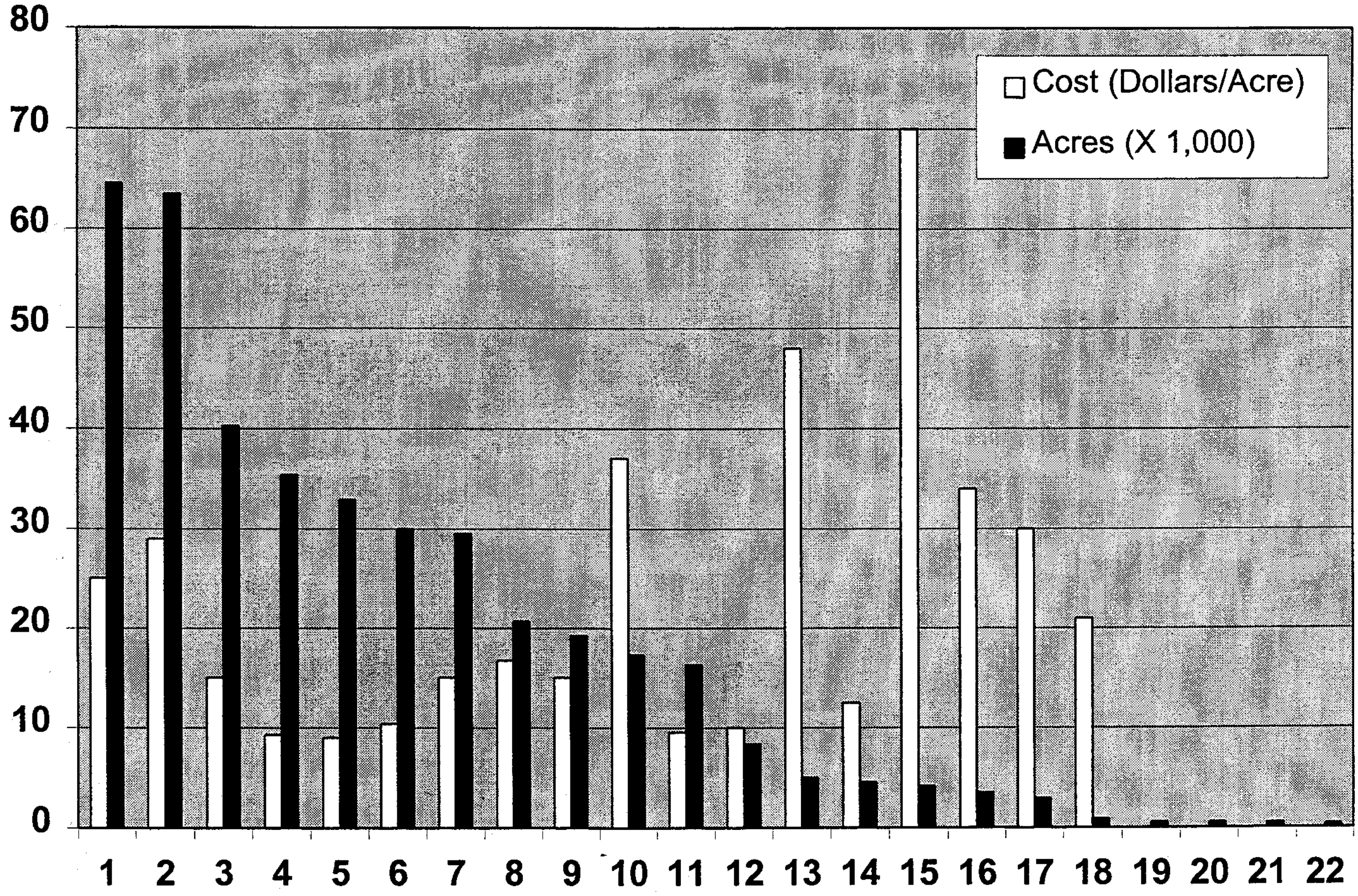

Figure 2. Water Cost Comparisons to Irrigators Inside and Outside the Klamath Irrigation Project.

1 = Klamath Irrigation District; 2 = Tulelake Irrigation District; 3 = Modoc Pt/Klamath Marsh; 4 = Fort Klamath Valley; 5 = North County; 6 = Sprague River Valley; 7 = WHwy97/Keno; 8 = Horsefly Irrigation District; 9 = Klamath Drainage District; 10 = Leaseland/Coop Land; 11 = Langell Valley Irrigation District; 12 = Swan Lake Valley; 13 = Butte Valley Irrigation District; 14 = Van Brimmer Ditch Co.; 15 = Shasta View Irrigation District; 16 = Malin Irrigation District; 17 = Enterprise Irrigation District; 18 = Pine Grove Irrigation District; 19 = Sunnyside Irrigation District; 20 = Midland District Improvement Co.; 21 = Plevna District Improvement Co.; 22 = Ady District Improvement Co.

Weather and Crop Summary, 2000

Kenneth A. Rykbost and Brian A. Charlton[1]

In a short-season, high-elevation climate, year-to-year weather variability can dramatically affect crop production. The Klamath Basin has a long-term average frost-free season of about 100 days, from around the first of June through early September. However, the region is susceptible to frost every day of the year. Three times in the 1990s, at least one frost event occurred at the Klamath Experiment Station (KES) in each month. Outlying areas south and southwest of Klamath Falls experience minimum temperatures several degrees lower than minimums recorded at the KES. Spring frosts had important consequences for Klamath Basin crops in 2000.

Lying in the rain shadow of the Cascade Mountains, the Klamath Basin experiences semi-arid conditions. The long-term average annual precipitation at Klamath Falls is about 13 in. Crop production in the region depends totally on irrigation.

The U.S. Water Bureau monitored precipitation at Klamath Falls and stream flows at several sites in the region from 1884 through 1948. Kingsley Field was selected as the site for a National Oceanic and Atmospheric Administration (NOAA) weather station established in 1949. Kingsley Field is located at 42°09' N latitude, 121°44' W longitude, and 4,092-ft elevation. The Kingsley Field NOAA station was closed in 1996. The KES weather station, located one-fourth mile west of Kingsley Field, has been in operation since 1984 and was designated as the official NOAA station for Klamath Falls in 1997.

The U.S. Bureau of Reclamation (BOR) office in Boise, Idaho has established additional weather stations in the region during the past 2 years as part of the Agricultural Meteorology (AgriMet) network. Instrumentation was installed adjacent to the KES weather station in April 1999. Sites added in April, 2000 included one at Lower Klamath Lake (LKL), approximately 15 miles southwest of Klamath Falls, and one at the northwest shore of Agency Lake at the pumping station for drainage of the Agency Lake Ranch (ALR). The AgriMet stations monitor soil temperature at 4- and 8-in depths, solar radiation, air temperature, relative humidity, wind speed and direction, and precipitation. The ALR station also monitors lake elevation. Readings taken at 15-minute intervals are stored and transmitted every 4 hours through a geostationary satellite to the BOR coordinating office in Boise, Idaho. These stations are intended to provide daily crop-specific water use estimates to assist in irrigation scheduling. Crop water use data are displayed on Internet web pages at the Klamath County Cooperative Extension Service and the KES homepage, or can be obtained from the BOR's regional Hydromet System at **http://www.pn.usbr.gov/agrimet**.

Several changes in monitoring of weather parameters at the KES station have occurred during the change to official NOAA status and establishment of the AgriMet station. NOAA station readings are based on 7:30 a.m. observations. AgriMet

[1] Superintendent/Professor and Faculty Research Assistant, respectively, Klamath Experiment Station, Klamath Falls, OR.

data are based on midnight-to-midnight reporting. This creates minor discrepancies in daily observations of temperatures, wind miles, and precipitation. Soil temperature sensors were replaced when the AgriMet station was installed. Soil temperature data since April 1999 show greater sensitivity to diurnal fluctuations, particularly at the 4-in depth. KES precipitation data is obtained with a standard 8-in rain gauge. The AgriMet station measures rainfall with a tipping-bucket electronic gauge.

Weather records dating back to 1884 have documented total rainfall ranging from a low of 6.72 in in 1959 to a high of 20.91 in in 1948 (Table 1). Extended periods of dry or wet cycles have been recorded over the past century. The three extended periods of lowest rainfall occurred in 1929 through 1932 (37.34 total in), 1965 through 1968 (41.01 total in), and 1973 through 1976 (41.58 total in). At the other extreme, the highest rainfall over consecutive 4-year periods was observed in 1884 through 1887 (65.42 total in) and 1995 through 1998 (72.40 total in) (KES data).

From 1984 through 1996, stations were maintained at both Kingsley Field and KES. From 1984 through 1989, total annual precipitation averaged 11.36 and 11.48 in for NOAA and KES stations, respectively. Rainfall data were quite varied from 1990 through 1996, averaging 15 percent more for the NOAA station. Although air temperature data are not shown, daily maximums were similar while daily minimums were frequently 2-3^{0}F lower at KES than at the NOAA site. This was probably the result of proximity to large buildings and extensive paved areas at Kingsley Field. An important point to note from the precipitation data is the return to 2 consecutive years of below normal rainfall in 1999 and 2000 following 4 years' annual precipitation that averaged 135 percent of normal, based on KES data, or nearly 150 percent of normal, based on Kingsley Field data.

A monthly summary of air temperatures and precipitation for 2000 and the 16-year period from 1984 through 1999 is presented in Table 2. All data are derived from the KES station. January through April 2000 experienced slightly higher temperatures and rainfall than the 16-year average. Rainfall during the remainder of 2000 was more than 4 in below the long-term mean. Mean air temperatures were similar in 2000 and over the 16-year period from May through August. Cooler temperatures were experienced in September through December 2000. Total precipitation for 2000 was 88 percent of the 16-year mean. However, if January rainfall is excluded, 2000 received only 67 percent of the long-term average.

Affects of weather on crop production are primarily limited to the period from April 1 through September. Data for these months, from 1970 through 2000, are presented in Table 3. Data for 1970 through 1983 are derived from the NOAA station at Kingsley Field, while the 1984 through 2000 data are from the KES station. This data set indicates that the 2000 growing season was quite typical for the region.

A more detailed review of growing season weather (Tables 4 and 5) compares weekly data for 2000 with a 20-year mean for 1979-1999. Critical data for 2000 crops in the region are the minimum air temperatures observed in late April and early and late May. At KES, minimum temperatures were 25^{0}F or lower on 6 days in April and on May 12 and 31. These frost events resulted in loss of stands in sugarbeet crops from early plantings and replantings. Sugarbeet acreage was reduced from about

8,500 acres initially, to approximately 3,700 acres. The May 31 frost also seriously affected alfalfa, mint, cereal, and onion crops in Lower Klamath Lake and Copic Bay areas. Several fields of potatoes experienced damage to unemerged sprouts during the May 31 event. Several grain fields in the Lower Klamath Lake area were replanted in June. The May 31 frost caused several million dollars in crop losses.

A second cause of potato crop loss was related to widely fluctuating air temperatures in late June and early July. Warm weather during late June was followed by cool days and a minor frost in the first week of July. Temperatures returned to more normal conditions in the second week of July. Several fields of potatoes experienced a high incidence of growth cracks and internal defects caused by the affects of alternating temperatures on tuber development.

Rainfall at KES during the growing season was only 1.87 in in April and less than 2 in during the remainder of the season through mid-October. A storm on September 4 produced only 0.28 inches at KES, but over 2.0 inches in southern regions of the Klamath Basin. The storm was a very important reprieve from a serious water shortage that threatened to suspend water deliveries to Lower Klamath and Tulelake national wildlife refuges and irrigators with junior water rights.

It is interesting to compare weather data from the KES NOAA station with data from the AgriMet stations at KES, LKL, and ALR. Monthly temperature, precipitation, and wind data for the KES stations are compared in Table 6. Sensors for these stations are located less than 15 ft apart. Data are generally in good agreement except that minimum air temperatures are commonly 3-4^{0}F lower at the NOAA station. The occurrence of frost on nearby vegetation supports the accuracy of data from the NOAA station. The NOAA station recorded slightly higher precipitation in all months except November and December. Wind data are very similar for both stations. As expected, evapotranspiration (ET) during May through September was about 10 percent less than evaporation from a free-water surface in an evaporation pan. The ET value reported is for actively growing alfalfa. Considerably lower values would be found for row crops and cereals.

Data from the AgriMet stations at LKL, ALR, and KES are compared in Table 7. Site-specific features influence the microclimate at LKL and ALR. Initially, the LKL station was placed on a dike adjacent to the Klamath Straits Drain channel. Temperature data were clearly affected by the gravel surface under the sensors and flowing water in the nearby channel. In June and July, minimum temperatures at this station were 2^{0}F lower than at the KES station. In August, the station was relocated into a grain field several hundred feet from the channel and dike. Minimum temperatures in August, September, and October were about 6^{0}F lower at LKL than at KES. This difference agrees with past experience with frosts at these locations.

The ALR station is located on a dike adjacent to Agency Lake. Temperatures are influenced by the proximity to the large water body within a few ft of sensors. Air temperatures at this site are about the same as at KES each month. As expected, precipitation varies between the sites, which are up to 40 miles apart. However, over 8 months, total rainfall was nearly identical at LKL and ALR, and about 0.5 in higher than at KES.

Daily weather records from the KES NOAA station for the past 3 years are available on the KES Internet home page at **http://www.orst.edu/dept/kes**. Current weather records are updated daily on weekdays.

Table 1. Annual precipitation at Klamath Falls, OR, recorded by the U.S. Water Bureau (1884-1948), National Weather Service (NOAA) (1949-2000), and Klamath Experiment Station (KES) (1984-2000).

Year	Precipitation in	Year	Precipitation in	Year	Precipitation in	Year	Precipitation in	
U.S. Water Bureau				NOAA				KES
1884	17.94	1921	11.94	1949	6.86	1979	14.10	
1885	18.71	1922	15.19	1950	13.56	1980	11.03	
1886	18.06	1923	9.85	1951	10.76	1981	15.57	
1887	10.71	1924	11.28	1952	10.97	1982	13.90	
1888	13.75	1925	14.26	1953	10.76	1983	18.56	
1889	10.40	1926	13.23	1954	8.57	1984	12.98	13.32
1890	IN	1927	15.47	1955	11.31	1985	9.17	10.15
1891-99	NA	1928	11.65	1956	12.52	1986	13.49	13.06
1900	NA	1929	8.56	1957	18.38	1987	10.11	10.13
		1930	9.44	1958	13.25	1988	10.32	10.15
				1959	6.72	1989	12.11	12.08
				1960	15.86	1990	13.33	12.46
1901	NA	1931	9.50	1961	13.21	1991	10.50	9.29
1902	11.26	1932	9.84	1962	16.92	1992	11.68	11.34
1903	IN	1933	11.01	1963	10.41	1993	16.78	14.96
1904	15.04	1934	10.47	1964	15.45	1994	9.84	7.72
1905	8.32	1935	11.25	1965	10.12	1995	22.66	19.06
1906	14.87	1936	13.44	1966	11.50	1996	23.91	19.54
1907	16.67	1937	19.41	1967	9.21	1997	14.29	14.29
1908	10.02	1938	13.05	1968	10.18	1998	19.51	19.51
1909	17.67	1939	11.99	1969	15.38	1999	11.54	11.54
1910	14.70	1940	17.12	1970	12.61	2000	11.51	11.51
1911	9.73	1941	19.71	1971	12.68			
1912	19.56	1942	14.09	1972	11.72			
1913	16.11	1943	13.82	1973	11.03			
1914	11.42	1944	12.42	1974	8.64			
1915	11.72	1945	16.52	1975	13.21			
1916	10.98	1946	11.46	1976	8.70			
1917	10.22	1947	11.32	1977	12.37			
1918	9.51	1948	20.91	1978	9.30			
1919	9.40							
1920	12.22							

Means	1884-1948	13.22
	1949-1983	12.51
NOAA	1984-1997	13.65
KES	1984-2000	12.95

IN: datum incomplete.
NA: datum unavailable.

Table 2. Mean monthly air temperatures and total monthly precipitation recorded at the Klamath Experiment Station, Klamath Falls, OR, in 2000 and for 1984-1999.

Month	Mean monthly temperature			Total precipitation
	max	min	mean	
	—	°F	—	in
		2000		
January	42	22	32	4.04
February	47	27	37	1.21
March	51	24	38	0.72
April	62	32	47	1.87
May	66	35	50	0.43
June	78	43	61	0.08
July	81	45	63	0.47
August	84	44	64	0.04
September	73	36	54	0.53
October	61	29	45	1.15
November	42	19	31	0.47
December	43	18	30	0.50
Mean	61	31	46	
Total				11.51
		1984-1999		
January	40	20	30	1.86
February	44	22	33	1.19
March	52	27	39	1.27
April	59	30	44	0.88
May	66	36	51	1.26
June	74	43	59	0.84
July	83	48	65	0.40
August	83	46	64	0.56
September	77	39	58	0.74
October	65	30	48	0.74
November	48	24	36	1.70
December	39	18	28	1.62
Mean	61	32	46	
Total				13.06

Table 3. Mean air temperatures for April through September, mean 4-in soil temperatures for May through October, and total precipitation for April through September and annually from 1970-2000 at Klamath Falls, OR.

Year	Air temperature Apr-Sept			4-in soil temperature May-Oct			Total precipitation	
	max	min	mean	max	min	mean	Apr-Sept	annual
	°F						in	
2000	72	39	56	70	56	63	4.20	11.51
1999	72	39	55	68	55	61	3.98	11.54
1998	73	41	57	59	57	58	6.95	19.51
1997	73	41	57	60	57	58	4.52	14.29
1996	72	39	56	61	59	60	5.50	19.54
1995	72	40	56	61	57	59	7.10	19.06
1994	76	40	58	63	59	61	3.42	7.72
1993	70	38	54	60	55	58	5.82	14.96
1992	77	42	60	66	58	62	3.41	11.34
1991	73	40	57	61	55	59	3.41	9.29
1990	74	41	58	61	55	58	5.66	12.46
1989	72	40	56	62	55	59	5.16	12.08
1988	75	41	58	64	56	60	3.13	10.15
1987	76	41	59	65	56	61	3.24	10.13
1986	73	42	58	70	59	64	3.87	13.06
1985	74	40	57	64	53	59	5.50	10.13
1984	71	41	56	70	57	64	4.36	13.32
1983	69	40	55	73	59	66	3.88	18.56
1982	70	40	55	71	57	64	4.18	13.90
1981	74	42	58	73	58	66	2.43	15.57
1980	71	41	56	74	59	67	2.75	11.03
1979	74	42	58				3.77	14.10
1978	70	40	55	71	58	65	4.57	9.30
1977	73	43	58	71	58	65	4.97	12.37
1976	69	41	55	72	57	65	4.94	8.70
1975	71	41	56				4.10	13.21
1974	74	42	58	70	56	63	1.82	8.64
1973	75	42	59	69	55	62	1.29	11.03
1972	73	41	57				1.87	11.72
1971	70	40	55				4.68	12.68
1970	74	39	57	70	57	64	1.25	12.61
Mean	73	41	57	67	57	62	4.06	12.69

Table 4. Weekly average maximum, minimum, and mean air temperatures for the 2000 growing season and 1979-1999 at Klamath Falls, OR.

Weekly period		2000 Weekly average			1979-1999 Weekly average		
		max	min	mean	max	min	mean
		°F					
April	1-7	70	31	51	54	28	41
	8-14	66	33	49	56	29	43
	15-21	52	36	44	60	33	46
	22-28	54	31	42	59	32	46
	29-5	64	30	47	62	34	48
May	6-12	56	32	44	63	35	49
	13-19	62	35	49	66	36	51
	20-26	79	41	60	69	39	54
	27-2	64	30	47	69	41	55
June	3-9	75	40	57	70	41	55
	10-16	72	41	57	73	43	58
	17-23	81	46	64	76	44	60
	24-30	86	51	69	78	46	62
July	1-7	71	39	55	79	46	62
	8-14	80	44	62	82	48	65
	15-21	84	51	68	83	49	66
	22-28	84	56	70	85	50	68
	29-4	91	53	72	85	48	67
August	5-11	87	48	68	86	49	67
	12-18	82	40	61	84	47	65
	19-25	80	42	61	81	46	63
	26-1	83	42	62	80	43	62
September	2-8	62	37	50	80	43	62
	9-15	79	40	59	77	40	58
	16-22	80	42	61	74	39	56
	23-29	72	29	50	73	38	56
	30-6	73	33	53	73	36	54
October	7-13	64	34	49	68	34	51
	14-20	65	27	46	63	29	46
	21-27	55	24	39	62	31	46
Mean		72	39	56	72	40	56

Table 5. Weekly minimum air temperatures, frost days, and precipitation for the 2000 growing season and 1979-1999 at Klamath Falls, OR.

Weekly period		Weekly min.		Frost days/week		Weekly precip.		Accum. precip.	
		2000	1979-99	2000	1979-99	2000	1979-99	2000	1979-99
		°F		%		in			
April	1-7	25	11	57	76	0.00	0.16	0.00	0.16
	8-14	24	15	43	67	0.32	0.16	0.32	0.32
	15-21	32	17	14	52	1.55	0.21	1.87	0.53
	22-28	22	20	57	52	0.00	0.25	1.87	0.78
	29-5	20	19	57	35	0.05	0.28	1.92	1.06
May	6-12	23	18	43	44	0.19	0.21	2.11	1.27
	13-19	30	19	28	33	0.19	0.27	2.30	1.54
	20-26	36	24	0	19	0.00	0.24	2.30	1.78
	27-2	24	27	28	17	0.00	0.33	2.30	2.11
June	3-9	36	26	0	10	0.08	0.27	2.38	2.38
	10-16	31	27	14	7	0.00	0.16	2.38	2.54
	17-23	39	30	0	4	0.00	0.08	2.38	2.62
	24-30	49	31	0	0	0.00	0.14	2.38	2.76
July	1-7	32	31	14	1	0.47	0.06	2.85	2.82
	8-14	41	34	0	0	0.00	0.04	2.85	2.86
	15-21	48	32	0	1	0.00	0.12	2.85	2.98
	22-28	44	35	0	0	0.00	0.04	2.85	3.02
	29-4	49	36	0	0	0.00	0.08	2.85	3.10
August	5-11	40	34	0	0	0.04	0.13	2.89	3.23
	12-18	37	29	0	2	0.00	0.11	2.89	3.34
	19-25	38	30	0	3	0.00	0.16	2.89	3.50
	26-1	41	29	0	2	0.00	0.19	2.89	3.69
September	2-8	32	29	14	4	0.53	0.07	3.42	3.76
	9-15	31	24	28	10	0.00	0.14	3.42	3.90
	16-22	38	24	0	13	0.00	0.20	3.42	4.10
	23-29	24	24	86	20	0.00	0.14	3.42	4.24
	30-6	27	20	57	23	0.00	0.07	3.42	4.31
October	7-13	29	18	28	41	0.45	0.16	3.87	4.47
	14-20	25	18	100	70	0.00	0.12	3.87	4.59
	21-27	22	15	100	65	0.33	0.32	4.20	4.91

Table 6. A comparison of monthly mean air temperatures and wind miles, total precipitation, and pan evaporation (EVAP), versus evapotranspiration (ET) for NOAA and AgriMet (AGM) weather stations at Klamath Experiment Station, OR, 2000.

	Air temperature											
	Maximum		Minimum		Mean		Precipitation		Wind		EVAP	ET
Month	NOAA	AGM	NOAA	AGM	NOAA	AGM	NOAA	AGM	NOAA	AGM	NOAA	AGM
	°F						in		miles/day		in	
January	42	41	22	26	32	34	4.04	3.98	94	89	---	0.58
February	47	46	27	30	37	38	1.21	1.16	121	109	---	1.24
March	51	51	24	27	38	40	0.72	0.71	103	100	---	2.57
April	62	61	32	34	47	47	1.87	1.44	103	99	---	4.10
May	66	64	35	38	50	51	0.43	0.36	114	111	6.47	6.12
June	78	77	43	46	61	62	0.08	0.03	110	110	9.24	8.80
July	81	80	45	48	63	64	0.47	0.40	77	78	8.48	8.22
August	84	82	44	48	64	65	0.04	0.01	75	76	8.78	7.89
September	73	72	36	40	54	56	0.53	0.46	73	70	5.51	4.69
October	61	60	29	33	45	46	1.15	1.01	80	81	---	2.82
November	42	42	19	22	31	32	0.47	0.47	50	57	---	0.92
December	43	43	18	22	30	33	0.50	0.59	47	52	---	0.67
Mean	61	60	31	35	46	47			87	86		
Total							11.51	10.62			38.48	35.72[1]

[1] Total from May 1 through September 30.

Table 7. A comparison of monthly mean air temperatures and total monthly precipitation from May through December 2000 at AgriMet weather stations located at the Klamath Experiment Station (KES), Lower Klamath Lake (LKL), and Agency Lake Ranch (ALR), OR.

	Air temperature											
	Maximum			Minimum			Mean			Precipitation		
Month	KES	LKL	ALR	KES	LKL	ALR	KES	LKL	ALR	KES	LKL	ALR
	°F									in		
May	64	63	60	38	38	43	51	51	52	0.36	0.38	0.25
June	77	77	75	46	44	50	62	60	62	0.03	0.16	0.17
July	80	80	78	48	46	50	64	63	64	0.40	0.48	0.22
August	82	83	80	48	42	47	65	63	64	0.01	0.01	0.17
September	72	72	71	40	35	40	56	53	56	0.46	0.80	0.28
October	60	61	59	33	27	32	46	44	45	1.01	0.86	1.11
November	42	43	41	22	19	21	32	31	31	0.47	0.40	0.68
December	43	44	40	22	20	22	33	32	31	0.59	0.84	1.08
Mean	65	65	63	37	34	38	51	50	51			
Total										3.33	3.93	3.96

Potato Variety Screening

Kenneth A. Rykbost and Brian A. Charlton[1]

Abstract

The Oregon potato variety development program released three new varieties in 2000. Klamath Russet is a late maturing, high-yielding, long russet with resistance to *verticillium* wilt and excellent culinary quality for fresh market use. Mazama is an early maturing, bright-red-skinned variety with moderate yields but a high percentage of small tubers suitable for B size and creamer markets. Winema is also early maturing with bright-red skin color. It produces higher yields than Mazama with larger tuber size. Both red-skinned clones retain color in storage, have shallow eyes, and produce few internal or external defects.

Additional clones have been identified for probable release in 2001 or 2002. A dual-purpose long russet selection tested as AO87277-6 is planned for release as Wallowa Russet in 2001. This high-yielding selection has excellent processing quality for French fry production. Willamette is an oval white-skinned chipping selection with excellent chip color out of cool storage. Tested as AO91812-1, this medium-late maturing clone produces high yields of medium-size tubers with low susceptibility to early blight and net necrosis caused by potato leafroll virus. The red-skinned selection, NDO4300-1R is planned for release by 2002 as Modoc. This early-maturing, bright-colored selection produces intermediate yields with relatively small tuber size and few internal or external defects.

The Klamath Experiment Station (KES) participates in the variety development program as a trial site for screening after the second year of field production. In 2000, KES trials included 82 entries in the preliminary yield trial, 24 entries in the statewide trial, 16 selections in the western regional trial, and 9 regional chipping trial entries. Weather conditions in the Klamath Basin in 2000 promoted high yields but contributed to external and internal defects in susceptible selections. This provided an opportunity to detect and eliminate clones with environmental stress susceptibility.

Introduction

The Oregon Potato Variety Development Program produces approximately 65,000 seedling tubers annually in greenhouses from true botanical seed provided by the USDA-Agricultural Research Service potato-breeding program at Aberdeen, Idaho. Additional breeding material included in the program has come from North Dakota, Colorado, and most recently, the Crop and Soil Science

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Department at Oregon State University, Corvallis.

First-generation field screening conducted at the Central Oregon Agricultural Research Center (COARC) typically results in selection of several hundred clones for further evaluation. Second-year screening includes evaluation of these clones in 4-hill plots at the Hermiston Agricultural Research and Extension Center (HAREC) and 12-hill plots at COARC, which also serve to increase seed for further testing. Clones selected at this stage are advanced to third-year screening in preliminary yield trials at Malheur Experiment Station (MES), KES, HAREC, and COARC. Selections advanced from this stage are evaluated up to 3 years in Oregon statewide trials conducted at the above sites.

Promising selections are advanced to tri-state and western regional trials, where evaluations are expanded to include more detailed analysis of culinary quality, disease reactions, chemical composition, and response to storage management. The total screening process requires approximately 10 years from the breeding cross to graduation from regional trials. Naming and release of superior clones is usually delayed 2 or 3 years after regional evaluations are completed to gain commercial experience and build seed supplies.

Extensive evaluation procedures followed through the development process lead to characterization of over 50 attributes describing plants, tubers, yield, quality, disease and pest reactions, and physiological responses to stress. Selections completing the process are exposed to a wide range of soil, weather, and environmental conditions at about 20 locations in 7 western states.

This report summarizes the performance of entries in preliminary yield, statewide, regional chipping, and western regional russet trials conducted at KES in 2000. Greater details on performance of advanced lines are available through the fully interactive database maintained at COARC's web page at **www.css.orst.edu/coarc/database.htm.**

Procedures

All trials at KES were conducted on Poe fine sandy loam soil. Previous crops at the site were spring grain in 1999 and annual ryegrass in 1998. Soil samples collected in October, 1999 indicated modest populations of root-knot nematodes (*Meloidogyne chitwoodi*) and low populations of stubby-root nematodes (*Paratrichodorus allius*). The field was fumigated with Telone II^{TM} (dichloropropene, Dow Chemical Co.) shanked in at 24-in spacing and 18-in depth at 25 gal/acre (gpa) on April 3. Field preparations included moldboard plowing on May 5 and harrowing on May 9.

All seed was hand-cut to approximately 1.5-2.5 oz/seedpiece, treated with Tops MZ (thiophanate methyl-mancozeb, Gustafson) at 1.0 lb/cwt, and suberized at 55^0F and 95 percent relative humidity for 10 days before planting. Potatoes were planted at 8.7-in seed spacing in 32-in rows with an assisted-feed, 2-row planter on May 17 and 18. The insecticide DiSyston® (disulfoton, Bayer) was applied in the seed furrow at 3.0 lb active ingredient (ai)/acre. Fertilizer was banded on both sides of rows at planting at 160 lb N/acre, 80 lb P_2O_5/acre, 80 lb K_2O/acre, and 140 lb S/acre. Irrigation was applied with solid-set sprinklers arranged on a 40- by 48-ft spacing. Total crop water, including irrigation and rainfall, was approximately 20 in.

Weeds were controlled with Dual® (metolachlor, Novartis) and Prowl® (pendimethalin, Cyanamid) applied with a conventional ground sprayer at recommended rates on May 31. The fungicides Bravo® (chlorothalonil, Syngenta), Dithane® (mancozeb, Rohm and Haas), and Ridomil® (metalaxyl, Syngenta) were applied at recommended rates aerially at approximately 2-week intervals from late June through late August. Monitor® (methamidaphos, Bayer) was applied aerially at 0.75 lb ai/acre on August 2. Vines were desiccated with Diquat (diquat dibromide, Seneca) applied with a ground sprayer at 1.0 pt/acre on September 15. NuCop (copper dioxide) was applied at the labeled rate in combination with Diquat. Vines were shredded with a rotobeater 1 day before harvest.

The preliminary yield trial included 5 standard varieties and 77 numbered selections in 20-hill plots with 2 replications. Entries in the statewide trial included 5 standard varieties, 15 Oregon selections, and 2 lines submitted by a private breeder. Three standard varieties and 13 numbered selections were evaluated in the regional russet trial. Statewide and regional trials included 30-hill plots with 4 replications.

Potatoes were harvested with a one-row, digger-bagger on September 28 (preliminary yield trial), September 29 (regional russet trial), and September 30 (statewide trial). All tubers from each plot were stored at 55^0F and 95 percent relative humidity until tubers were graded in mid-October.

External tuber characteristics were noted for each replication during grading. Ten large tubers (mostly >12 oz) from each plot were cut lengthwise and inspected for internal defects. A sample of approximately 10 lb of 8- to 12-oz U.S. No. 1s from each plot was used to determine specific gravity by the weight-in-air, weight-in-water method. USDA grade standards were used to separate B size (<4 oz), U.S. No. 1s (4-12 oz and >12 oz), U.S. No. 2s, and culls. U.S. No. 1 yields were not adjusted for external blemishes such as rhizoctonia or scab, or internal defects such as hollow heart, brown center, or corky ringspot. Samples of 6-10 No. 1 tubers from the 8- to 12-oz size category were saved from 1 replication of each selection in all trials for processing quality evaluation.

Data from the preliminary yield trial were not analyzed statistically because the trial only included two replications. Yield, specific gravity, and internal defect data from statewide and regional trials were analyzed using MSU STAT software. Least significant differences (LSD) are based on Student's *t* at the 5 percent probability level, unless otherwise stated. Only a portion of the data collected is reported here. Data from trials at all locations were compiled and reviewed by all cooperators as the basis for disposition decisions.

Results and Discussion

Early season crop development experienced erratic weather conditions. Frosts were recorded at KES on May 31, June 1, June 11, and July 4. Plant emergence was about 50 percent on June 10. Solid-set sprinklers used for frost protection on June 11 and July 4 prevented foliar damage. Two weeks of above-average temperatures in late June resulted in rapid early canopy development. Cool weather from July 3 to 10 was followed by hot weather with daily maximum air temperatures reaching or exceeding 80^0F at KES for 40 consecutive days. The first killing frost occurred on

September 23. Fluctuating temperatures in late June and early July caused both internal and external defects in susceptible varieties. Second growth, growth cracks, hollow heart, and brown center were observed in numerous selections in KES trials, and severe growth cracks occurred in at least one commercial field in the region. The season favored late maturing varieties. Exceptionally high yields were observed in many selections in KES variety trials and were reported for commercial crops in the region.

Weather conditions were generally favorable for avoidance of fungal diseases. Rhizoctonia, *verticillium* wilt, white mold, and early blight infections were minor or absent, and late blight was not reported in the region in 2000. Several selections in variety trials exhibited corky ringspot (CRS), caused by tobacco rattle virus and vectored by stubby-root nematodes. As in previous years, no CRS were observed in Russet Norkotah or any strains of Russet Norkotah included in the trials.

Preliminary Yield Trial

Based on data from 4 locations, 12 numbered selections from this trial were advanced for further evaluation. Yield and specific gravity data from KES are presented for standard varieties and the selections retained (Table 1). All retained selections exceeded U.S. No. 1 yields of the standard russet varieties at KES. Across all locations, U.S. No. 1 yields of standard varieties ranked 82nd (Russet Burbank), 52nd (Ranger Russet), 64th (Shepody), 46th (Russet Norkotah), and 34th (Atlantic) out of 82 entries in the trial. Ranking of U.S. No. 1 yields for selections retained ranged from first to 38th, with 7 of 12 selections ranking in the top 10. All advancing selections exhibited superior quality in terms of freedom from external and internal defects compared to Russet Burbank and Ranger Russet. All selections retained are russet-skinned with fresh or dual-purpose market potential. These selections will be included in the 2001 statewide yield trial.

Statewide Trial

All entries achieved high emergence percentage (Table 2). Fumigation failed to control stubby-root nematodes and CRS infection. CRS was observed in all entries except Russet Norkotah, AO94117-201, and AO95115-6. Hollow heart and brown center incidence was highest in Russet Burbank. Several selections were free of internal defects. Zolushka and Catalina are privately owned hybrid families propagated from true potato seed. Relatively large differences in plant type, size, and maturity were noted in both families.

Yields were lower in this trial than in the preliminary yield trial (Table 3). High yields of No. 2s and culls were observed for several clones and the standard varieties Russet Burbank and Ranger Russet. In most cases, growth cracks accounted for the majority of off-grade yields. After reviewing data from all locations, most clones in this trial were discarded. AO87277-6 has graduated from the evaluation process and will be released in 2001 as Wallowa Russet. The chipping selection, AO91812-1 has completed evaluation in the regional chipping trial and is planned for release as the variety Willamette. AO92017-6 was advanced to the 2001 regional trial. Purple pigmentation has been observed in the flesh of this clone at KES and Powell Butte, but not at long-season trial sites. Zolushka produced the highest yield at KES. Tubers of Zolushka and Catalina were fairly uniform in shape and appearance.

Disposition of these lines will be decided by the owner.

While most clones are being discarded, results from across locations demonstrate the progress that has been achieved to date in Oregon and regional variety development programs. The standard varieties Russet Burbank, Ranger Russet, Shepody, and Russet Norkotah ranked 21st, 20th, 18th, and 13th, respectively, in total yield of No. 1s out of 21 entries. Russet Burbank had the highest incidence of internal defects at KES and Ranger Russet the highest percentage of No. 2s and culls. Several clones were superior to the standards in fry color and/or dry matter content. AO87277-6 is a good example of the progress. This selection combines high yield potential with excellent fry color, high dry matter content, and freedom from internal defects.

Western Regional Trial

Performance of material in the regional trial was similar to results observed in the statewide trial. Russet Norkotah and the Texas strains of Norkotah were earliest in vine maturity (Table 4). Russet Burbank had the highest incidence of internal defects. CRS was less common than in the statewide trial; it was not observed in standard Norkotah or the Texas strains. As has been observed in previous trials, Norkotah strains had a higher incidence of hollow heart than standard Norkotah at KES. Although they were not formal entries in the regional trial, Klamath Russet and AO87277-6 were included in this trial at KES. Both selections were relatively free of internal defects.

As in the statewide and preliminary yield trials, Russet Burbank and Ranger Russet had high yields of No. 2s and culls (Table 5). A90586-11 produced very high yields at KES and other trial locations. It was also among the highest selections in off-grade yields at KES. Klamath Russet and AO87277-6 produced relatively high yields of No. 1s and low yields of off-grade tubers. Both Texas Norkotah strains produced higher yields of No. 1s than the standard Norkotah at KES and over all regional trial locations. A8792-1 completed 3 years of evaluation in the regional trial. Idaho is waiting for commercial evaluations to determine the fate of this selection. All other formal entries in the late trial will be continued in 2001 comparisons.

Summary

Stressful growing conditions in 2000 at KES and other potato trial locations resulted in a high frequency of internal and external defects in standard varieties and advanced selections in the Oregon variety development program. This resulted in a relatively high rate of rejection of clones from the program. Only 11 of 77 entries in the preliminary yield trial and 1 of 14 statewide entries will be retained for further evaluation. However, good performance was confirmed in KES trials for recently released Klamath Russet and the planned releases AO87277-6 and AO91812-1. Additional information on performance of material in the Oregon program can be obtained from the interactive database maintained at **www.css.orst.edu/coarc/database.htm.**

Table 1. Tuber yield and specific gravity of potato entries selected from the Preliminary Yield Trial for further evaluation, Klamath Falls, OR, 2000.

Variety or selection	Yield U.S. No. 1s			Yield				Specific gravity
	4-12 oz	>12 oz	total	Bs	No. 2s	culls	total	
	cwt/acre							
Russet Burbank	253	81	334	63	84	117	597	1.079
Ranger Russet	236	281	517	17	120	179	833	1.087
Shepody	230	249	479	21	95	53	648	1.079
Russet Norkotah	325	173	498	34	30	1	563	1.068
Atlantic	301	263	564	56	39	27	686	1.088
AO92019-4	420	137	557	47	36	20	660	1.074
AO94004-3	448	142	590	80	8	0	678	1.084
AO96060-1	297	346	643	18	20	6	686	1.076
AO96065-7	340	209	549	36	20	34	639	1.090
AO96160-3	502	164	666	40	23	0	729	1.090
AO96164-1	496	192	688	40	26	8	762	1.082
AO96165-2	553	81	634	47	18	4	703	1.091
AO96165-9	507	101	608	100	14	4	726	1.082
AO96176-3	367	283	650	28	9	0	687	1.081
AO96177-6	238	368	606	18	60	0	684	1.084
AO96262-1	477	207	684	47	65	52	847	1.093
AO96272-1	485	167	652	68	32	20	771	1.090
Mean[1]	381	203	583	45	41	31	700	1.083

[1]Mean for standard varieties and selected clones only.

Table 2. Characteristics of potato entries in the Oregon Statewide Trial, Klamath Falls, OR, 2000.

Variety or selection	Percent stand	Vine maturity[1]	Specific gravity	Hollow heart[2]	Brown center[2]	CRS[3]
					%	
Russet Burbank	100	3.0	1.081	33	33	18
Ranger Russet	99	4.3	1.084	0	0	20
Shepody	98	2.5	1.076	0	0	18
Russet Norkotah	98	1.8	1.067	3	0	0
Atlantic	93	2.5	1.084	15	3	18
AO87277-6	99	3.3	1.084	3	0	3
AO89128-4.1	97	2.8	1.086	5	0	10
AO89128-4.2	100	4.0	1.095	0	0	8
AO91812-1	96	3.5	1.084	0	0	8
AO92007-2	100	3.0	1.078	3	3	18
AO92017-6	98	4.5	1.084	0	0	25
CO093031-3	99	2.5	1.073	8	0	8
AO92252-1	100	3.8	1.080	0	0	18
AO94110-203	100	4.3	1.091	13	0	30
AO94117-201	99	3.3	1.085	0	0	0
AO94171-2	99	4.0	1.086	3	0	25
AO95115-3	97	3.0	1.093	13	10	23
AO95115-6	98	3.8	1.069	3	0	0
AO95135-5	96	3.3	1.080	3	0	38
Zolushka	95	4.0	1.085	8	0	5
Catalina	92	4.0	1.080	8	5	5
Mean	98	3.4	1.082	6	3	14
CV (%)	-	-	0.3	142	236	146
LSD (0.05)	-	-	0.004	12	9	NS

[1]Vine maturity: 1 for early to 5 for late.

[2]Hollow heart and brown center in 10 large tubers/sample.

[3]CRS: corky ringspot infection in 10 large tubers/sample.

Table 3. Tuber yield by grade for potato entries in the Oregon Statewide Trial, Klamath Falls, OR, 2000.

Variety or selection	Yield U.S. No. 1s 4-12 oz	Yield U.S. No. 1s >12 oz	Yield U.S. No. 1s total	Yield Bs	Yield No. 2s	Yield culls	Yield total
	cwt/acre						
Russet Burbank	283	99	382	37	68	52	539
Ranger Russet	215	183	398	14	106	106	623
Shepody	224	185	409	15	59	26	509
Russet Norkotah	253	135	388	26	27	12	453
Atlantic	204	211	415	38	13	9	475
AO87277-6	276	209	485	27	60	23	595
AO89128-4.1	293	75	368	30	86	37	521
AO89128-4.2	389	66	455	42	20	12	529
AO91812-1	353	76	430	71	18	10	529
AO92007-2	301	73	374	54	7	6	441
AO92017-6	303	129	432	35	51	73	591
COO93031-3	237	258	495	24	44	21	584
AO92252-1	213	170	383	16	123	45	566
AO94110-203	352	112	464	57	12	6	539
AO94117-201	350	123	473	33	55	28	588
AO94171-2	292	163	454	17	40	9	520
AO95115-3	312	59	371	53	20	13	456
AO95115-6	274	254	527	28	18	0	573
AO95135-5	290	135	425	27	91	42	585
Zolushka	408	156	564	66	24	12	666
Catalina	329	146	474	64	29	9	576
Mean	293	144	436	37	46	26	546
CV (%)	16	34	17	33	53	107	11
LSD (.05)	67	70	104	17	34	40	84

Table 4. Characteristics of potato entries in the Western Regional Trial, Klamath Falls, OR, 2000.

Variety or selection	Percent stand	Vine maturity[1]	Specific gravity	Hollow heart[2]	Brown center[2]	CRS[3]
				%		
Russet Burbank	98	3.5	1.085	25	40	0
Ranger Russet	100	3.8	1.085	0	0	13
Russet Norkotah	100	1.5	1.066	3	0	0
A8792-1	99	3.8	1.093	8	0	8
A8893-1	100	2.8	1.086	0	0	3
A9014-2	99	3.8	1.083	0	0	10
A9045-7	99	3.8	1.085	5	0	15
AC87079-3	98	2.8	1.086	13	0	3
A90586-11	100	4.5	1.092	0	0	0
AC87138-4	100	3.8	1.079	18	0	3
AC89536-5	100	3.3	1.084	3	0	0
ATX9202-3RU	100	3.5	1.081	3	0	5
TXNS102	100	1.3	1.069	10	0	0
TXNS296	98	1.5	1.067	20	0	0
Klamath Russet	98	3.0	1.080	3	3	0
AO87277-6	97	2.8	1.083	0	0	0
Mean	99	3.1	1.082	7	3	4
CV (%)	-	-	0.3	144	210	277
LSD (.05)	-	-	0.005	14	8	NS

[1]Vine maturity: 1 for early to 5 for late.

[2]Hollow heart and brown center in 10 large tubers/sample.

[3]CRS: corky ringspot infection in 10 large tubers/sample.

Table 5. Tuber yield by grade for potato entries in the Western Regional Trial, Klamath Falls, OR, 2000.

Variety or selection	Yield U.S. No. 1s			Yield			
	4-12 oz	>12 oz	total	Bs	No. 2s	culls	total
	cwt/acre						
Russet Burbank	301	76	377	54	65	67	564
Ranger Russet	243	138	381	15	91	81	569
Russet Norkotah	284	118	402	29	17	12	459
A8792-1	271	63	334	23	59	132	547
A8893-1	343	153	496	27	56	8	586
A9014-2	232	205	437	18	46	5	506
A9045-7	212	205	417	11	56	130	614
AC87079-3	294	79	373	57	15	2	447
A90586-11	358	175	533	42	82	78	735
AC87138-4	289	103	392	34	55	29	510
AC89536-5	352	83	435	48	30	16	529
ATX9202-3RU	335	143	478	17	83	45	622
TXNS102	264	183	447	32	36	8	523
TXNS296	254	222	476	15	41	6	538
Klamath Russet	301	159	460	24	25	7	515
AO87277-6	332	133	465	29	32	3	529
Mean	292	140	431	30	49	39	550
CV (%)	14	29	13	36	41	68	9
LSD (.05)	59	58	80	15	29	38	69

Red-skinned and Chipping Potato Variety Development

Kenneth A. Rykbost and Brian A. Charlton[1]

Abstract

A red-skinned potato variety screening program was initiated at the Klamath Experiment Station (KES) in 1988 in a concerted effort to identify superior red clones for the Pacific Northwest. Breeding material was initially provided by the North Dakota State University potato-breeding program. Subsequently, Colorado State University and the Aberdeen, Idaho USDA-Agricultural Research Service (ARS) breeding programs provided material for evaluation. Single-hill, first-generation field screening at KES resulted in selection of NDO2686-6R and NDO2438-6R in 1989. These clones were released in 2000 as Mazama and Winema, respectively. A third clone, NDO4300-1R, will be released as Modoc in the near future. Each of these selections produces bright skin color that does not fade in storage. Mazama and Modoc produce many small tubers suitable for the high-value B and creamer markets. All three selections have smooth, shallow-eyed tubers, and they mature early.

The Oregon red-skinned variety selection program is being phased out. Single-hill screening ceased following the 1998 season. The Central Oregon Agricultural Research Center (COARC) retains several clones selected from single-hills in 1998 and prior years. These Oregon red-skinned selections will continue through the evaluation process. However, cooperators in the program have decided to discontinue further efforts with red-skinned selections because of difficulties in seed production related to susceptibility to powdery scab and potato virus Y in many of the clones.

The Oregon program has also identified a clone with superior chipping quality. AO91812-1 completed 3 years of evaluation in the regional chip trial in 2000 and is planned for release as Willamette. This selection has excellent chip color out of 45^{0}F storage. In 2000, KES conducted preliminary and advanced red-skinned trials and the regional chipping trial. Results of these trials are included in this report.

Introduction

California, Texas, Colorado, and the Skagit Valley in Washington are major production areas for red-skinned potato varieties. Red LaSoda and Dark Red Norland are currently the dominant varieties. Although both produce high yields, neither produces smooth, shallow-eyed, bright-colored tubers that retain good color in storage. The Oregon program initiated in 1988 has emphasized early maturity, bright skin color that does not fade in storage, shallow eyes, and production of high yields of small tubers suitable for high-value B size

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and creamer markets. These objectives have been largely achieved in the new varieties Mazama, Winema, and the soon-to-be-released, Modoc.

Production of potatoes for chips has increased in the Klamath Basin in recent years. In 2000, over 3,000 acres of chip potatoes were grown in the basin. KES has participated in the regional chip trial since 1998. This report summarizes results from red-skinned and chipping trials conducted at KES in 2000 and provides a long-term summary of performance for NDO4300-1R at KES and in regional trials.

Procedures

Red-skinned and chipping trials were conducted on Poe fine sandy loam soil at KES. Preceding crops at the site were spring cereals in 1999 and annual ryegrass in 1998. A preliminary yield trial for third-generation red-skinned clones included 16 selections planted in 20-hill plots with 2 replications. An advanced red-skinned trial included Dark Red Norland, Red LaSoda, and Yukon Gold as standards, 9 numbered red-skinned selections, a yellow-fleshed russet selection from Texas, the yellow-fleshed variety Yagana, and Winema and Mazama. Plots were 30 hills with 4 replications. The regional chip trial included Atlantic and Chipeta as standards and 7 numbered selections in 30-hill plots with 4 replications. The chip trial was planted on May 17 and both red-skinned trials were planted on May 18.

Seed for all trials was hand-cut to 1.5-2.5 oz/seedpiece on May 2, treated with Tops MZ (thiophanate-methyl, mancozeb, Gustafson), and stored at approximately 55^{0}F and 95 percent relative humidity until planting. Seed was planted with an assisted-feed, 2-row planter at 8.7-in spacing in 32-in rows. Cultural practices were as described for other variety trials on pages 19-20. Vines were desiccated with Diquat (diquat-dibromide, Seneca) applied with a ground sprayer at 1.0 pt/acre on September 9 (red-skinned trials) and September 15 (chip trial). Potatoes were harvested on September 26 (red-skinned trials) and September 29 (chip trial) with a one-row, digger-bagger. All tubers from each plot were stored at 55^{0}F and 95 percent relative humidity until grading in mid-October.

External tuber characteristics were noted for all samples at grading. Ten large tubers from each plot were cut and inspected for internal defects. A sample of approximately 10 lb of U.S. No. 1 tubers was used to determine specific gravity by the weight-in-air, weight-in-water method. USDA grade standards were used to separate B size (<4 oz), U.S. No. 1s (4-6 oz, 6-10 oz, and >10 oz for red-skinned selections; 4-12 oz and >12 oz for chipping selections), and culls. Subsamples from each replication of the chip trial were evaluated for chip color at Corvallis.

Data from the preliminary trial were not analyzed statistically because the trial only included two replications. Yield, specific gravity, and internal defect data from advanced red and chip trials were analyzed using MSU STAT software. Least significant differences (LSD) are based on Student's *t* at the 5 percent probability level.

Results and Discussion

Sixteen red-skinned selections were grown in preliminary yield trials at KES and COARC. Ten of these were also evaluated in observational trials at the Intermountain Research and Extension Center (IREC) at Tulelake, California. Based on performance at all locations, six clones were selected for further evaluation (Table 1). Yields of all retained clones were high at KES (Table 2).

Based on marketable yield, skin color, and attractive tuber appearance, AO93487-2R ranked first. It was rated worthy of retention at all locations. At KES, skinning was noted as the only deficiency. This clone resulted from a cross at Aberdeen, Idaho using Mazama as the male parent.

An advanced yield trial at KES included Dark Red Norland, Red LaSoda, and five formal entries in the regional red-skinned trial, three yellow-fleshed selections, and six additional red-skinned selections from the Oregon program (Tables 3 and 4). CO89097-2, NDO4300-1R, and NDO4588-5R have completed 3 years of evaluation in the regional trial. Colorado will continue evaluation and pursue release of CO89097-2. Oregon also intends to continue development of NDO4300-1R and has tentative plans to release this selection as Modoc. It has consistently produced moderately high yields with bright skin color and good tuber size distribution for markets favoring small tubers. The third selection graduating from the regional trial, NDO4588-5R, will be discarded from the Oregon program. NDO4323-2R and A92657-1R will be retained for further evaluation in the regional trial.

Yellow-fleshed entries in the trial included the standard and most commonly grown yellow-fleshed variety in North America, Yukon Gold; Yagana, a specialty variety from South America; and the russet-skinned Texas selection TX1523-1RU/Y. Yagana achieved the highest yield of all entries in the trial. Texas intends to continue evaluation of TX1523-1RU/Y.

Newly released varieties Winema and Mazama and four additional Oregon red-skinned selections were included in this trial. Mazama was second only to Yagana, and significantly higher than all other selections in yield of marketable-size tubers. As in previous trials, Winema produced a relatively high yield, but many tubers were in the over-10-oz size range. The four numbered selections in this group are being discarded.

Performance of NDO4300-1R over 3 years in regional trials is summarized in Table 5. Although total yields were less than yields of Dark Red Norland and Red LaSoda, yield of tubers in the preferred size range (<4 oz to <10 oz) was higher than for either standard variety. A comparison of long-term performance of the standard varieties and NDO4300-1R at two Oregon and two California locations is presented in Table 6. Averaged over 20 location-years, the marketable yield of NDO4300-1R was 111 and 144 percent of yields of Dark Red Norland and Red LaSoda, respectively. NDO4300-1R was not superior to the standards in yields at Bakersfield, California.

Yields of varieties and selections in the 2000 regional chip trial were high (Table 7). Chipeta was among the highest in total No. 1 and total yield and specific gravity. Chip colors were determined on samples delivered to Corvallis. Exposure to cool temperatures in transit resulted in dark chips in all selections. The Oregon selection AO91812-1 completed 3 years in the regional trial. It is being considered for release as Willamette. It generally produces good chip color out of 45^0F storage. A90467-14 will probably be discarded by Idaho. AC87340-2 has also completed 3 years in the trial and will continue to be evaluated in Colorado. AC89653-3 will be discarded. The remaining selections will continue in the regional trial in 2001.

Summary

Under conditions that resulted in very high yields, three Oregon red-skinned selections continued to demonstrate high yields, excellent appearance, and superior internal and external quality compared to industry standards in 2000 trials at KES. Mazama and Winema were formally released in 2000 and their seed is being increased in commercial production. A third selection from the Oregon program is planned for release as Modoc within the next year. Seed of Modoc is being increased in the Oregon Foundation Seed Potato Program.

Two chipping varieties that originated in the Oregon variety development program are planned for release in the near future. NDO1496-1 completed evaluation in the regional chip trial several years ago. Oregon decided not to pursue release of this selection because of susceptibility to shatter bruise. Commercial interest in this selection in Idaho has resulted in a decision by the Idaho potato variety development program to release the selection as Ivory Crisp. Oregon plans to release NDO91812-1 as Willamette. Both selections produce good chip color out of cool storage.

Table 1. Parentage and tuber characteristics of red-skinned potato clones selected from 2000 preliminary yield trials, Oregon.

Selection	Female parent	Male parent	Tuber shape	Shape uniformity	Tuber size	Eye depth	Skin color
AO91854-1R	NDTX1068-11R	ND2224-5R	Round/Oblong	Good	Medium	Shallow	Red/Purple
AO93487-2R	NDO3503-5R	Mazama	Round/Oblong	Good	Medium	Shallow	Red
AO96747-2R	A90601-2RDY	A83350-9R	Round/Oblong	Fair	Medium	Medium	Purple
AO96751-1R	A91848-1R	CO86218-2R	Round/Oblong	Good	Medium	Shallow	Red/Purple
NDO7119-1R	ND4945-11R	Winema	Round/Oblong	Good	Medium	Shallow	Red
NDO7130-1R	ND5002-3R	ND5256-7R	Round/Oblong	Fair	Small	Shallow	Red/Purple

Table 2. Yield, tuber size distribution, and grade of red-skinned potato clones selected from the preliminary yield trail, Klamath Falls, OR, 2000.

Selection	Yield U.S. No. 1s					Yield		
	<4 oz	4-6 oz	6-10 oz	>10 oz	total	marketable[1]	culls	total
	cwt/acre							
AO91854-1R	67	166	206	235	674	439	70	744
AO93487-2R	128	221	192	122	663	541	7	670
AO96747-2R	161	192	203	94	650	556	8	658
AO96751-1R	71	151	235	162	619	457	14	633
NDO7119-1R	100	155	161	125	541	416	14	555
NDO7130-1R	196	206	158	29	589	560	2	591

[1]Marketable: <4 oz to 10 oz U.S. No. 1s.

Table 3. Plant and tuber characteristics of advanced red-skinned and yellow-fleshed potato selections grown at Klamath Falls, OR, 2000.

Variety or selection	Percent stand	Vine vigor[1]	Vine maturity[2]	Tuber characteristics[3]			
				color	eyes	shape	skinning
Dk. Red Norland	99	4.0	2.8	3.0	3.5	2.0	4.1
Red LaSoda	98	2.5	3.0	3.0	2.0	3.0	3.3
Yukon Gold	93	3.0	2.8	Yellow	4.3	3.0	5.0
CO89097-2	96	2.3	3.0	4.8	5.0	2.0	4.3
NDO4300-1R	92	1.8	3.0	5.0	5.0	2.0	4.3
NDO4588-5R	94	3.3	2.8	5.0	4.0	2.0	2.5
NDO4323-2R	100	3.0	4.0	4.5	3.0	2.0	3.8
A92657-1R	88	2.0	3.0	4.3	4.0	2.0	3.0
TX1523-1RU/Y	97	5.0	2.5	Lt. Russ	4.0	2.0	4.5
NDO5108-1R	99	3.5	3.3	5.0	4.0	2.0	1.5
NDO6183-1R	97	4.0	2.3	4.8	4.0	1.0	2.5
NDO6184-1R	97	2.8	3.0	5.0	3.5	1.0	3.5
A092657-3R	99	3.5	2.3	5.0	3.5	1.0	3.3
Winema	97	2.3	2.0	4.5	3.8	2.0	4.0
Mazama	97	3.3	2.3	5.0	5.0	1.0	4.1
Yagana	98	4.8	4.5	Yellow	4.0	2.5	4.3
Mean	96	3.2	2.9	4.5	3.5	2.1	3.9

[1]Vine vigor rating: 1 is small, weak, to 5 for large, robust.

[2]Vine maturity: 1 is early, to 5 for a late maturing plant.

[3]Color: 1 is pale to pink, to 5 for bright red.
Eye depth: 1 is deep, to 5 for shallow.
Shape: 1 is round, 2 for oval, 3 for oblong.
Skinning: 1 is severe, to 5 for none.

Table 4. Yield, grade, tuber size distribution, and specific gravity of advanced red-skinned and yellow-fleshed potato selections grown at Klamath Falls, OR, 2000.

Variety or selection	Yield U.S. No. 1s					Yield			Specific gravity
	<4 oz	4-6 oz	6-10 oz	>10 oz	total	marketable[1]	culls	total	
	cwt/acre								
Dk. Red Norland	36	93	216	319	664	345	42	707	1.069
Red LaSoda	35	49	137	248	469	221	122	591	1.067
Yukon Gold	17	37	121	410	585	175	26	610	1.085
CO89097-2	48	115	223	228	614	386	37	651	1.075
NDO4300-1R	73	149	203	115	540	425	25	564	1.064
NDO4588-5R	31	73	187	245	536	291	61	596	1.063
NDO4323-2R	53	130	214	142	539	397	190	728	1.078
A92657-1R	26	90	232	229	577	348	56	633	1.072
TX1523-1RU/Y	13	53	166	449	681	232	8	688	1.077
NDO5108-1R	60	142	218	117	537	420	123	659	1.068
NDO6183-1R	41	113	214	186	554	368	55	609	1.065
NDO6184-1R	88	130	152	81	451	370	10	462	1.082
A092657-3R	41	103	215	314	673	359	22	694	1.064
Winema	36	83	163	227	509	282	48	557	1.055
Mazama	105	180	220	67	572	505	12	582	1.069
Yagana	148	215	203	129	695	566	39	733	1.078
Mean	53	110	193	219	575	356	55	629	1.071
CV (%)	24	22	15	11	10	11	37	9	0.3
LSD (.05)	18	34	41	70	82	53	28	81	0.004

[1]Marketable: <4 oz to 10 oz U.S. No. 1s.

Table 5. Yield, grade, tuber size distribution, and specific gravity of NDO4300-1R, Dark Red Norland, and Red LaSoda potato varieties in Western Region Trials, 1998-2000[1].

Entry	Yield U.S. No. 1s				Yield			Specific gravity
	<4 oz	4-10 oz	>10 oz	total	marketable[2]	culls	total	
	cwt/acre							
NDO4300-1R	66	235	61	362	301	24	386	1.067
Dark Red Norland	43	230	126	399	273	40	439	1.068
Red LaSoda	28	169	135	332	197	77	409	1.069

[1]Locations: California, Idaho, Oregon, Texas, Washington.

[2]Marketable yield: U.S. No. 1s <4 oz to 10 oz.

Table 6. Yield, grade, tuber size distribution, and specific gravity of NDO4300-1R, Dark Red Norland, and Red LaSoda potato varieties in trials at Corvallis and Klamath Falls, Oregon and Tulelake and Bakersfield, California, 1995-2000.

Entry	Location	Years tested	Yield U.S. No. 1s <4 oz	4-10 oz	>10 oz	total	Yield marketable[1]	culls	total	Specific gravity
			cwt/acre							
NDO4300-1R	Corvallis	6	64	271	81	416	335	48	464	1.068
	Klamath Falls	6	88	295	96	479	383	22	501	1.063
	Bakersfield	4	21	251	62	334	272	26	360	1.074
	Tulelake	4	30	306	62	398	336	17	415	1.068
	Average		51	281	75	407	332	28	435	1.068
Dark Red Norland	Corvallis	6	43	251	113	407	294	105	512	1.074
	Klamath Falls	6	49	235	166	450	284	57	507	1.067
	Bakersfield	4	11	331	111	453	342	42	495	1.075
	Tulelake	4	22	257	119	398	279	51	449	1.066
	Average		31	269	127	427	300	64	491	1.071
Red LaSoda	Corvallis	6	32	201	154	387	233	115	502	1.075
	Klamath Falls	6	35	190	212	437	225	97	534	1.069
	Bakersfield	4	11	260	127	398	271	65	463	1.077
	Tulelake	4	14	176	163	353	190	121	474	1.065
	Average		23	207	164	394	230	100	494	1.072

[1]Marketable yield: U.S. No. 1s <4 oz to 10 oz.

Table 7. Yield, grade, tuber size distribution, specific gravity, and chip color of potato entries in the Western Regional Chip Trial grown at Klamath Falls, OR, 2000.

Variety or selection	Yield U.S. No. 1s				Yield			Specific	Chip
	4-8 oz	8-12 oz	>12 oz	total	Bs	culls	total	gravity	color[1]
	cwt/acre								
Atlantic	120	154	271	545	40	22	607	1.088	3.0
Chipeta	112	267	207	586	31	62	679	1.093	2.8
A90467-14	123	195	193	511	43	28	582	1.095	2.8
A90490-1	147	271	167	585	64	13	662	1.089	3.0
A91790-13	258	164	76	498	162	0	660	1.090	1.8
AC87340-2	184	181	94	459	60	5	523	1.072	2.0
AC89653-3	237	193	58	487	104	10	601	1.083	3.0
AO91812-1	188	211	114	512	68	18	598	1.090	2.3
NDTX4930-5W	163	223	178	564	38	40	641	1.091	2.8
Mean	170	206	151	527	68	22	617	1.088	3.3
CV (%)	18	16	27	10	22	46	8	0.3	----
LSD (.05)	45	49	60	77	22	15	71	0.004	----

[1]Color using Snack Food Association chip color standards (1 is light to 5 for dark).

Potato Variety Response to Nitrogen Fertilizer Rate

Kenneth A. Rykbost and Brian A. Charlton[1]

Abstract

Research on potatoes in other regions has indicated lower nitrogen fertilizer requirements for Texas and Colorado strains of Russet Norkotah, compared with the standard Russet Norkotah. Standard Russet Norkotah and the Texas strain, TXNS 112 were compared at 120, 160, 200, and 240 lb N/acre at Klamath Experiment Station (KES) in 2000. Both clones produced economically optimum yields at 160 lb N/acre. Averaged over both selections, the difference in total No. 1 yield between 120 lb N/acre and higher N rates was statistically significant. The response was similar for Russet Norkotah and TXNS 112. Failure to observe a yield response to nitrogen rates above 160 lb N/acre in a year with high yields is consistent with previous research at KES with standard Russet Norkotah.

A second experiment at KES evaluated effects of the same nitrogen rates on late maturing Russet Burbank, Klamath Russet, Gem Russet, and AO87277-6. Total yield of No. 1s was significantly lower for Russet Burbank than the other selections. Although numerically higher No. 1 yields were observed at the highest N rate for each selection, differences were not statistically significant. Averaged over four selections, No. 1 yields were nearly identical for the three lower rates and about 30 cwt/acre higher for the 240 lb N/acre rate. Significant differences were found among varieties for all yield parameters except total yield. Significance was not found for any yield parameter for N rates. The interaction between variety and nitrogen rate was not statistically significant for any parameter.

Introduction

New potato varieties and several strains of Russet Norkotah from Colorado and Texas are offering growers alternatives to the standards, Russet Norkotah and Russet Burbank, for fresh market crops in the Klamath Basin. Experience in other regions suggests that less nitrogen fertilizer is required for the Norkotah strains than for the standard variety. The new selections Klamath Russet, Gem Russet, and AO87277-6 are similar in maturity to Russet Burbank. Response to nitrogen rates under local conditions has not been evaluated for these selections. However, previous experience with Klamath Russet and Gem Russet has shown both varieties are slow to emerge and both maintain vigorous vines late in the season. Reduced nitrogen rates may hasten maturity for these clones, which would be advantageous in the short growing season experienced locally.

Fertilizer efficiency has become more important in cropping systems for environmental as well as economic reasons. While extensive research has failed to document economic potato yield responses

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to N rates above about 180 lb N/acre on mineral soils at KES or 150 lb N/acre on organic lakebed soils at Tulelake, California, many crops in the Klamath Basin are fertilized at rates well above 250 lb N/acre. The recent emphasis on agricultural practices in development of local management plans to protect water quality provides justification for reevaluation of fertilizer requirements for standard and new varieties. Fertilizer costs are expected to rise significantly in the near term. Studies were conducted at KES in 2000 to compare nitrogen fertilizer response for the new varieties with standard fresh market varieties.

Procedures

Separate experiments were conducted for early maturing Russet Norkotah and TXNS 112 and late maturing Russet Burbank, Klamath Russet, Gem Russet, and AO87277-6. Both experiments were split-plot designs with variety as the main plot and N rate as the split-plot. Individual plots were two 43-ft-long rows with 3 replications for early varieties and 4 replications for late maturing varieties.

All seed was hand-cut to 1.5-2.5 oz/seedpiece and treated with Tops MZ (thiophanate-methyl, mancozeb, Gustafson) 10 days before planting. Seed was suberized at approximately 55^{0}F and 95 percent relative humidity. Seed was planted in 32-in rows with a 2-row, assisted-feed planter on May 18. In-row seed spacing was 12 in for Russet Burbank and Gem Russet and 8.7 in for the other varieties. All plots received 120 lb N, 60 lb P_2O_5, 60 lb K_2O, and 140 lb S/acre banded on both sides of rows at planting. Additional N fertilizer was applied as Solution 32 with a conventional ground sprayer and incorporated with a rolling cultivator on May 31. Cultural practices for weed, insect, and disease control are described on pages 19-20. Irrigation was applied with solid-set sprinklers arranged in a diamond pattern at 40- by 48-ft spacing. Total water applied during the growing season including rainfall was approximately 20 in. Vines were desiccated with Diquat (diquat-dibromide, Seneca) applied at 1.0 pt/acre on September 9 for early-maturing varieties and September 15 for late-maturing varieties.

Before harvest, 3-ft borders were hand-dug between plots to eliminate N-rate border overlap affects. Tubers were harvested with a one-row, digger-bagger on September 25 for early varieties and October 4 for late varieties. In the early-maturing trial, all tubers from both rows were weighed in the field. Approximately 120-lb samples were stored and graded in mid-October. In the late-maturing trial, all tubers from one row were stored and graded.

Ten large tubers (usually >16 oz) from each sample were cut lengthwise and inspected for internal defects. USDA grade standards were used to separate B size (<4 oz), U.S. No. 1s (4-8 oz, 8-12 oz, and >12 oz), U.S. No. 2s, and culls. A 10-lb sample of No.1s in the 8- to 12-oz size fraction was used to determine specific gravity by the weight-in-air, weight-in-water method. No. 1 yields were not adjusted to account for external blemishes such as rhizoctonia or internal defects such as hollow heart or corky ringspot. All yield and specific gravity data were analyzed statistically using MSU STAT software. Least significant differences (LSD) are based on Student's *t* at the 5 percent probability level.

Results and Discussion

Excellent stands were achieved in all selections although emergence timing was different in the late-maturing varieties.

Klamath Russet and Gem Russet were about 10 days later than Russet Burbank in achieving full emergence. Plant canopies were more vigorous at high nitrogen rates in all varieties. Vines were senescing rapidly at the time of vine desiccation for Russet Norkotah and TXNS 112, but were quite vigorous in late-maturing selections at vine desiccation.

TXNS 112 produced a slightly higher average yield of No. 1s than standard Norkotah. Both varieties achieved optimum yield at 160 lb N/acre (Table 1). Contrary to reports from other regions suggesting Norkotah strains require less N than standard Norkotah, the yield response to increasing the N rate from 120 to 160 lb N/acre was substantially greater for TXNS 112. Averaged for both varieties, the increases in total yield and total No. 1 yield from 120 to 160 lb N/acre were statistically significant. Differences among the three highest rates were not significant. Nitrogen rates did not affect individual yield components significantly. The incidence of hollow heart was slightly higher in TXNS 112 (8 percent) than in standard Norkotah (2 percent) (data not shown). Minor affects of N rate on specific gravity were not significant.

Nitrogen response was quite similar for all late maturing varieties (Table 2). Averaged over varieties, total No. 1 yields were nearly identical for the three lowest rates. The increase of about 30 cwt/acre for the highest rate occurred in each variety. A trend for larger tuber size at higher N rates, evident in yield of tubers >12 oz, is consistent with previous experience with other varieties at KES. The only significant affect of N rate in this experiment was the reduction in specific gravity for high N rates.

Yield differences among varieties were also consistent with past experience at KES. Russet Burbank had significantly lower No. 1 yields and higher cull yields than all other varieties. No. 1 yields were intermediate for Gem Russet and highest for Klamath Russet and AO87277-6. Klamath Russet tubers had significantly lower specific gravity than the other varieties, as expected. Hollow heart incidence was significantly higher in Russet Burbank (31 percent) and Klamath Russet (18 percent) than in Gem Russet (3 percent) or AO87277-6 (0 percent) (data not shown). The potential for hollow heart in large tubers has been commonly recognized for Russet Burbank and Klamath Russet. Brown center was also a serious problem in Russet Burbank (40 percent) but it was not observed in any of the other varieties. N rate did not affect the incidence of either hollow heart or brown center.

Summary

The failure of any potato variety to produce large yield responses to the N rates evaluated in a year of very high yields indicates modest nitrogen rates are sufficient in the short-season conditions experienced in the Klamath Basin. A 3-year study with Russet Burbank and numerous studies with new varieties and advanced selections have reached the same conclusions in previous years. In recognition of increased nitrogen fertilizer costs, and a growing concern for the potential affects of excess fertilizer use on water quality, reduced nitrogen use in potato production makes economic and environmental sense.

Table 1. Effect of nitrogen rate on yield, grade, and tuber size distribution of potato varieties Russet Norkotah and Russet Norkotah Strain TXNS 112 grown at Klamath Falls, OR, 2000.

Variety	Trt.[1]	Yield U.S. No. 1s				Yield				Specific
		4-8 oz	8-12 oz	>12 oz	total	<4 oz	No. 2s	culls	total	Gravity
		cwt/acre								
Russet Norkotah	1	141	135	101	378	21	16	4	420	1.075
	2	160	124	122	406	27	25	3	460	1.073
	3	113	127	144	384	27	22	8	441	1.070
	4	153	145	112	409	37	2	14	463	1.070
TXNS 112	1	174	97	78	349	53	26	3	430	1.075
	2	186	140	116	441	50	16	1	508	1.074
	3	151	134	125	410	37	32	2	482	1.075
	4	161	145	123	429	43	25	0	497	1.074
Variety main effect:										
Russet Norkotah		142	133	120	394	28	16	7	446	1.072
TXNS 112		168	129	111	408	46	25	1	479	1.074
CV (%)		44	8	32	10	6	109	25	8	0.9
LSD (.05)		NS	NS	NS	NS	4	NS	2	NS	NS
Fertilizer main effect:										
1		158	116	90	364	37	21	3	425	1.075
2		173	132	119	423	39	20	2	484	1.074
3		132	131	135	397	32	27	5	462	1.072
4		157	145	118	419	40	13	7	480	1.072
CV (%)		18	14	23	7	24	48	126	5	0.5
LSD (.05)		NS	NS	NS	38	NS	NS	NS	28	NS

[1]Treatment: 1 = 120-60-60, 2 = 160-60-60, 3 = 200-60-60, 4 = 240-60-60.

Table 2. Effect of nitrogen rates on yield, grade, and tuber size distribution of Russet Burbank, Gem Russet, Klamath Russet, and AO87277-6 potato varieties grown at Klamath Falls, OR, 2000.

Variety	Trt.[1]	Yield U.S. No. 1s 4-8 oz	Yield U.S. No. 1s 8-12 oz	Yield U.S. No. 1s >12 oz	Yield U.S. No. 1s total	Yield < 4 oz	Yield No. 2s	Yield culls	Yield Total	Specific Gravity
		cwt/acre								
Russet Burbank	1	238	120	57	415	80	50	66	610	1.088
	2	225	147	47	420	75	32	44	570	1.086
	3	257	102	48	407	85	41	86	619	1.082
	4	242	148	67	457	75	36	43	611	1.081
Gem Russet	1	158	169	175	501	20	23	11	555	1.087
	2	164	171	173	509	20	23	6	558	1.086
	3	135	145	229	508	14	43	5	571	1.085
	4	150	177	216	542	20	27	13	602	1.084
Klamath Russet	1	219	156	169	545	46	29	5	624	1.081
	2	198	162	186	546	39	24	7	615	1.081
	3	157	167	206	530	40	25	7	602	1.079
	4	161	160	254	574	43	29	2	648	1.1
AO87277-6	1	252	181	122	554	48	20	9	631	1.092
	2	222	177	142	541	45	27	4	616	1.089
	3	266	180	111	557	55	19	9	638	1.087
	4	252	185	134	571	59	20	5	656	1.084
Variety main effect:										
Russet Burbank		241	129	55	425	79	40	60	603	1.084
Gem Russet		152	165	198	515	18	29	9	571	1.086
Klamath Russet		184	161	204	549	42	27	5	622	1.08
AO87277-6		248	181	127	555	51	22	7	635	1.088
CV (%)		30	22	60	14	61	66	69	12	1
LSD (.05)		49	28	70	56	23	15	11	NS	0.003
Fertilizer main effect:										
1		216	156	131	503	48	31	23	605	1.087
2		202	164	137	504	45	27	15	590	1.086
3		204	149	148	501	48	32	27	607	1.083
4		201	167	168	536	49	28	16	629	1.082
CV (%)		13	15	28	9	19	47	79	8	1
LSD (.05)		NS	NS	NS	NS	NS	NS	NS	NS	0.002

[1]Treatment: 1 = 120-60-60, 2 = 160-60-60, 3 = 200-60-60, 4 = 240-60-60.

Potato Seed Conditioning

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Abstract

The newly released potato varieties Klamath Russet and Gem Russet have appearance and culinary quality characteristics that make them good candidates for production as fresh market varieties for the Klamath Basin. However, both varieties are moderately late in vine maturity and experience delayed emergence compared to Russet Burbank. Duplicate experiments were conducted at the Klamath Experiment Station (KES) and the Intermountain Research and Extension Center (IREC) at Tulelake, California in 2000 to investigate seed conditioning regimes to hasten emergence and enhance performance of these two promising varieties and Russet Burbank.

Seed lots were stored at 40°F, 50°F, or 60°F for 2 weeks before planting. The lot stored at 40°F was transferred to 50°F storage for 2 days before cutting, and held at that temperature for 2 more days until planting. Seed lots stored at higher temperatures were cut 2 days after placement in the higher temperature regime or 2 days before planting. Storage temperature and time of cutting were not effective in hastening emergence for any variety at either location. At KES, Russet Burbank achieved 95 percent emergence on June 12, 25 days after planting. At that date, emergence was 8 percent for Gem Russet and 29 percent for Klamath Russet. Both varieties reached 95 percent emergence 9 days later. At IREC, full stands were achieved at 19, 26, and 23 days after planting for Russet Burbank, Gem Russet, and Klamath Russet, respectively. Slightly higher stem numbers were observed at both locations for seed stored at 60°F and cut 10 days before planting.

Seed conditioning treatments did not significantly affect yield performance for any variety at either location. Russet Burbank produced significantly lower total U.S. No. 1 yields than either Klamath Russet or Gem Russet at KES. Gem Russet achieved the highest yield of No. 1s at IREC, with Russet Burbank ranked second and Klamath Russet significantly lower than Gem Russet in No. 1 yield.

Introduction

Changing buyer preferences have resulted in reduced demand for Klamath Basin Russet Burbank crops. Currently, Russet Norkotah is the preferred variety for most customers for local crops. Russet Norkotah performance is inconsistent because of susceptibility to fungal diseases, including *verticillium* wilt, early blight, and silver scurf. Klamath Russet and Gem Russet, recent releases from Oregon and Idaho potato breeding programs, respectively, have performed well in trials at

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KES and IREC over several years. These varieties have acceptable appearance and are superior to Russet Norkotah in culinary quality. However, both varieties emerge several days later than Russet Burbank and are later in vine maturity. Management practices that would hasten maturity could make these varieties even more attractive as alternatives to Russet Norkotah for Klamath Basin growers. Preconditioning seed by warming should hasten sprout development and may result in earlier emergence and enhanced early season growth and development. Joint studies were established at KES and IREC in 2000 to evaluate the potential for seed conditioning to improve the adaptability of Klamath Russet and Gem Russet to the short-season environment of the Klamath Basin.

Procedures

Seed lots of Russet Burbank, Klamath Russet, and Gem Russet were transferred from 40^0F storage at KES to multi-bin controlled environment storage units at IREC on May 3. Quantities of each variety were immediately placed in units at 40^0F, 50^0F, or 60^0F. On May 5, portions of seed lots in 50^0F and 60^0F units were removed from storage, hand-cut to 1.5-2.0 oz/seedpiece, treated with Tops MZ (thiophanate-methyl, mancozeb, Gustafson), and returned to the 50^0F or 60^0F storage units. On May 13, temperature in the 40^0F storage unit was increased to 50^0F. On May 15, remaining seed lots were removed from storage units, hand-cut, treated with Tops MZ , and returned to their respective storage conditions. Relative humidity was maintained at approximately 98 percent in all storage units through the 2-week period. Temperature and relative humidity were monitored at 15-minute intervals during the entire conditioning period.

Seed was planted with two-row assisted-feed planters at KES and IREC on May 17 in split-plot design experiments with variety as the main plot and seed conditioning treatments as the split-plot. Russet Burbank and Gem Russet seed spacing was 12 in in 32-in rows at KES and 10.5 in in 36-in rows at IREC. Klamath Russet was spaced at 8.7 in at KES and 8 in at IREC. Individual plots were two rows with 30 hills/row for Russet Burbank and Gem Russet and 42 hills/row for Klamath Russet. Standard fertilizer, disease and weed control, and irrigation practices were followed at each site.

Vines were desiccated with Diquat (diquat-dibromide, Seneca) applied at 1.0 pt/acre on September 15 and shredded with a rotobeater the day before harvest at KES. Vines were burned on September 15 at IREC with a propane burner. Potatoes were harvested with one-row digger-baggers at both sites on October 5. At IREC, all tubers from each plot were graded to USDA standards immediately after harvest. At KES, all tubers were weighed in the field at harvest and approximately 120-lb samples from each plot were saved and graded to USDA standards in mid-October. Specific gravity was determined on 10-lb samples of U.S. No. 1s in the 8- to 12-oz size fraction with the weight-in-air, weight-in-water method at KES. Internal defects were monitored by cutting 10 tubers/plot at IREC and 20 tubers/plot at KES from the over 12-oz size fraction. Yields of No. 1s were not adjusted for internal defects. KES yields were adjusted for tare loss between field and graded weights.

Results and Discussion

At KES, Russet Burbank achieved 95 percent emergence 26 days after planting (Table 1). At that time, average emergence was 8 percent for Gem Russet and 29 percent for Klamath Russet. Warming seed hastened emergence significantly for both varieties, but emergence did not reach 95 percent in either variety until 9 days later than Russet Burbank. At IREC, full emergence was achieved 19, 23, and 26 days after planting for Russet Burbank, Klamath Russet, and Gem Russet, respectively (Table 2). Warming to 60^0F reduced time to emergence by 4 days for Gem Russet but did not affect emergence in Russet Burbank or Klamath Russet. At both locations, a slight increase in stem numbers was observed for early cutting in the 60^0F conditioning treatment. Seed conditioning did not affect specific gravity at KES or the incidence of hollow heart at either location. Interestingly, hollow heart incidence was highest in Russet Burbank and Klamath Russet at KES and nearly absent in Gem Russet, while at IREC, more hollow heart occurred in Gem Russet than in the other varieties. This may be accounted for by the fact that tuber size was much larger for Gem Russet than for Russet Burbank and Klamath Russet at IREC. Large tubers are more susceptible to hollow heart in these varieties.

Yield performance varied by location. At KES, total yield of U.S. No. 1s was significantly higher for Klamath Russet and Gem Russet than Russet Burbank (Table 3). Tuber size was much smaller in Russet Burbank while yields of No. 2s and culls were significantly higher for Russet Burbank. Total yields were similar for all varieties. Seed conditioning treatments did not affect any yield parameters except the 4- to 8-oz No. 1s, whose yield was higher for the early cut, 60^0F conditioning treatment. This was apparently related to the slight increase in stem numbers observed for this treatment.

At IREC, Gem Russet had a significantly higher total yield of No. 1s than Klamath Russet (Table 4). In contrast to results at KES, Klamath Russet produced the lowest yield of No. 1s and a relatively high yield of culls. Gem Russet had the highest yield of large tubers and significantly fewer B size (<4 oz) tubers than Russet Burbank or Klamath Russet. Seed conditioning affects were limited to minor differences in the yield of small tubers. Early cutting and conditioning at 60^0F resulted in significantly higher yield of 4- to 8-oz No. 1s than all other treatments. As at KES, this was apparently related to the slight increase in stem numbers.

Averaged over location, Russet Burbank produced significantly lower total yield of No. 1s than Gem Russet or Klamath Russet (Table 5). The interaction between variety and location was significant for all yield parameters. A minor reduction in tuber size was found for early cutting and conditioning seed at 60^0F.

Summary

Seed conditioning did not effectively enhance early development or yield performance of Klamath Russet or Gem Russet at KES or IREC. It has been suggested that longer conditioning time may be required to produce significant hastening of sprout development. Exposure of the 40^0F treatment to 50^0F for 4 days may have masked minor effects that otherwise would have been observed. However, Klamath Russet and Gem Russet are notably slow to emerge compared to Russet Burbank. With late maturity, these varieties should be planted early in the Klamath Basin to take full advantage of the limited season available. The results of this study suggest that Klamath Russet may be better adapted to mineral soils while Gem Russet may perform best on high organic matter soils.

Table 1. Effect of seed conditioning on emergence, stem counts, and tuber quality of Russet Burbank, Gem Russet, and Klamath Russet potatoes grown at Klamath Falls, OR, 2000.

Variety	Trt.[1]	Emergence % 6/12	Emergence % 6/21	Stem number 7/13	Spec. grav.	% Hollow heart
Russet Burbank	1	94	98	2.3	1.083	14
	2	96	100	2.5	1.082	16
	3	96	100	2.2	1.086	41
	4	96	99	2.8	1.084	31
	5	95	98	2.5	1.083	28
Gem Russet	1	5	94	1.8	1.087	1
	2	4	95	1.8	1.086	1
	3	8	91	1.7	1.083	3
	4	9	98	2.0	1.083	1
	5	14	98	2.0	1.089	0
Klamath Russet	1	18	93	2.1	1.082	23
	2	21	96	2.2	1.079	21
	3	33	96	2.1	1.078	16
	4	37	97	2.4	1.080	19
	5	37	96	2.2	1.078	26
Variety main effect:						
Russet Burbank		95	99	2.4	1.084	26
Gem Russet		8	95	1.8	1.086	1
Klamath Russet		29	96	2.2	1.079	21
CV (%)		19	9	12	0.8	89
LSD (.05)		7	1.4	0.2	0.002	11
Seed conditioning main effect:						
1		39	95	2.0	1.084	13
2		40	97	2.2	1.082	13
3		46	96	2.0	1.082	20
4		47	98	2.4	1.082	17
5		48	97	2.2	1.083	18
CV (%)		14	2	13	0.8	57
LSD (.05)		5	NS	0.3	NS	NS

[1]Treatments: 1 = 2 days at 50°F, cut, 2 days at 50°F, plant.
2 = 2 days at 50°F, cut, 12 days at 50°F, plant.
3 = 12 days at 50°F, cut, 2 days at 50°F, plant.
4 = 2 days at 60°F, cut, 12 days at 60°F, plant.
5 = 12 days at 60°F, cut, 2 days at 60°F, plant.

Table 2. Effect of seed conditioning on emergence, stem counts, and tuber quality of Russet Burbank, Gem Russet, and Klamath Russet potatoes grown at Tulelake, CA, 2000.

Variety	Trt.[1]	Emergence DAP	Stem number 7/13	% Hollow heart
Russet Burbank	1	18	2.4	5
	2	19	2.5	8
	3	18	2.6	3
	4	20	2.7	3
	5	19	2.8	3
Gem Russet	1	28	1.6	13
	2	27	1.4	13
	3	26	2.0	8
	4	24	1.8	10
	5	24	1.9	8
Klamath Russet	1	23	2.2	3
	2	25	2.4	10
	3	22	2.0	0
	4	22	2.9	8
	5	23	2.3	8
Variety main effect:				
Russet Burbank		19	2.6	4
Gem Russet		26	1.7	10
Klamath Russet		23	2.4	6
CV (%)		3	11	150
LSD (.05)		1	0.2	NS
Seed conditioning main effect:				
1		23	2.1	7
2		24	2.1	10
3		22	2.2	3
4		22	2.5	7
5		22	2.3	6
CV (%)		3	12	125
LSD (.05)		1	0.3	NS

[1]Treatments: 1 = 2 days at 50^0F, cut, 2 days at 50^0F, plant.
2 = 2 days at 50^0F, cut, 12 days at 50^0F, plant.
3 = 12 days at 50^0F, cut, 2 days at 50^0F, plant.
4 = 2 days at 60^0F, cut, 12 days at 60^0F, plant.
5 = 12 days at 60^0F, cut, 2 days at 60^0F, plant.

Table 3. Effect of seed conditioning on yield, grade, and tuber size distribution of Russet Burbank, Gem Russet, and Klamath Russet potatoes grown at Klamath Falls, OR, 2000.

Variety	Trt.[1]	Yield U.S. No. 1s				Yield			
		4-8 oz	8-12 oz	>12 oz	total	<4 oz	No. 2s	culls	Total
		cwt/acre							
Russet Burbank	1	195	117	73	385	57	55	58	553
	2	218	116	49	383	66	46	48	542
	3	188	106	80	374	59	48	57	537
	4	213	105	45	362	77	45	49	533
	5	194	114	66	375	58	73	52	557
Gem Russet	1	109	137	189	434	26	32	14	505
	2	107	138	188	432	22	43	7	504
	3	119	122	195	437	20	20	16	492
	4	153	142	180	475	21	39	9	544
	5	130	149	190	469	17	35	8	528
Klamath Russet	1	186	155	132	473	47	13	9	541
	2	209	142	143	493	50	22	3	568
	3	186	164	124	473	43	24	4	544
	4	200	133	126	459	51	17	3	530
	5	196	148	151	495	41	26	5	566
Variety main effect:									
Russet Burbank		202	111	63	376	63	53	53	544
Gem Russet		123	138	188	449	21	34	11	515
Klamath Russet		196	148	135	479	46	20	5	550
CV (%)		20	16	32	16	45	67	73	10
LSD (.05)		27	16	32	53	15	18	13	NS
Seed conditioning main effect:									
1		163	136	131	430	43	33	27	533
2		178	132	126	436	46	37	19	538
3		164	131	133	428	40	31	25	524
4		189	126	117	432	49	34	20	535
5		174	137	136	446	38	44	21	550
CV (%)		13	17	28	9	25	56	67	6
LSD (.05)		18	NS	NS	NS	NS	NS	NS	NS

[1]Treatments: 1 = 2 days at 50 ^{0}F, cut, 2 days at 50 ^{0} F, plant.
2 = 2 days at 50 ^{0}F, cut, 12 days at 50 ^{0}F, plant.
3 = 12 days at 50 ^{0}F, cut, 2 days at 50 ^{0}F, plant.
4 = 2 days at 60 ^{0}F, cut, 12 days at 60 ^{0}F, plant.
5 = 12 days at 60 ^{0}F, cut, 2 days at 60 ^{0}F, plant.

Table 4. Effect of seed conditioning on yield, grade, and tuber size distribution of Russet Burbank, Gem Russet and Klamath Russet potatoes grown at Tulelake, CA 2000.

Variety	Trt.[1]	Yield U.S. No. 1s				Yield			
		4-8 oz	8-12 oz	>12 oz	total	<4 oz	No. 2s	culls	Total
		cwt/acre							
Russet Burbank	1	120	181	76	376	117	27	61	581
	2	133	186	78	397	167	20	53	636
	3	120	175	76	371	128	29	59	587
	4	144	182	74	401	150	18	51	619
	5	122	169	74	366	119	27	49	560
Gem Russet	1	82	173	153	408	67	13	47	535
	2	89	163	176	428	69	16	36	548
	3	101	168	152	421	73	11	36	541
	4	103	168	166	437	79	14	33	562
	5	94	169	154	416	75	21	45	557
Klamath Russet	1	111	155	101	366	123	20	58	567
	2	89	159	88	337	132	22	55	546
	3	79	156	96	331	109	15	89	544
	4	127	165	65	356	120	16	59	551
	5	88	168	130	386	129	17	55	587
Variety main effect:									
Russet Burbank		128	178	76	382	136	24	55	596
Gem Russet		94	168	160	422	72	15	39	549
Klamath Russet		99	161	96	355	123	18	63	559
CV (%)		24	21	18	14	45	63	58	13
LSD (.05)		20	NS	16	42	39	NS	NS	NS
Seed conditioning main effect:									
1		104	170	110	383	102	20	55	561
2		104	169	114	387	122	19	48	577
3		100	166	108	374	103	18	61	557
4		124	172	102	398	116	16	48	577
5		101	169	120	389	108	21	50	568
CV (%)		16	10	21	7	16	41	34	5
LSD (.05)		14	NS	NS	NS	15	NS	NS	NS

[1]Treatments: 1 = 2 days at 50°F, cut, 2 days at 50°F, plant.
2 = 2 days at 50°F, cut, 12 days at 50°F, plant.
3 = 12 days at 50°F, cut, 2 days at 50°F, plant.
4 = 2 days at 60°F, cut, 12 days at 60°F, plant.
5 = 12 days at 60°F, cut, 2 days at 60°F, plant.

Table 5. Effect of seed conditioning on yield, grade, and tuber size distribution of Russet Burbank, Gem Russet, and Klamath Russet potatoes grown at Klamath Falls, OR and Tulelake, CA, 2000.

Variety	Yield U.S. No. 1s				Yield			
	4-8 oz	8-12 oz	>12 oz	total	<4 oz	No. 2s	culls	Total
	cwt/acre							
Location main effect:								
KES	174	132	129	435	43	36	23	536
IREC	107	169	111	386	110	19	52	568
CV (%)	39	18	57	25	71	43	16	17
LSD (.05)	32	16	NS	NS	32	7	3	NS
Variety main effect:								
Russet Burbank	165	145	69	379	100	39	54	570
Gem Russet	109	153	174	436	47	24	25	532
Klamath Russet	147	154	115	417	84	19	34	554
CV (%)	22	19	27	15	49	70	66	12
LSD (.05)	15	NS	16	30	18	9	12	32
Seed conditioning main effect[1]:								
1	134	153	120	407	73	26	41	547
2	141	151	120	412	84	28	34	557
3	132	148	120	401	72	25	43	541
4	157	149	109	415	83	25	34	556
5	137	153	128	418	73	33	36	559
CV (%)	14	13	25	8	19	56	44	6
LSD (.05)	14	NS	NS	NS	10	NS	NS	NS

[1]Treatments: 1 = 2 days at 50°F, cut, 2 days at 50°F, plant.
2 = 2 days at 50°F, cut, 12 days at 50°F, plant.
3 = 12 days at 50°F, cut, 2 days at 50°F, plant.
4 = 2 days at 60°F, cut, 12 days at 60°F, plant.
5 = 12 days at 60°F, cut, 2 days at 60°F, plant.

Dry Bean Performance

Brian A. Charlton[1]

Abstract

Several market classes of dry beans (*Phaseolus vulgaris*) were planted in an observational trial at the Klamath Experiment Station (KES) in 2000 to determine whether this crop could be grown to maturity in the cool, short-season climate of the Klamath Basin. Black, Red Mexican, Pinto, Great Northern, and Pink market classes were evaluated. Yields varied widely across replications due to border affects in the small plot area. Maximum yields of approximately 3,500 lb/acre are comparable to yields from commercial fields in Idaho.

Introduction

Crop options for the Klamath Basin are limited by climatic conditions, a lack of processing facilities, and distance to markets. Low commodity prices for several crops that are grown in the region and the loss of sugarbeet acreage because of closure of processing facilities in Northern California have heightened interest in finding alternative crops that offer profit potential. The Central Oregon region has evaluated dry beans in recent years, leading to small-scale commercial production in 2000. Dry beans were chosen for evaluation in the Klamath Basin because market outlets are readily accessible and variable production costs are much lower than for row crops currently grown in the region.

Procedures

Eight dry bean varieties were planted on Poe fine sandy loam soil fallowed the previous 2 years. The soil has an organic matter content of about 1.0 percent in the plow layer and a pH of about 6.5. Field preparation occurred in May. A Kincaid (Kincaid Equipment Manufacturing) plot planter was used to apply 50 lb/acre of N, P_2O_5, and K_2O and to open seed furrows on May 22. Seed was hand-planted at a depth of 0.5 in at 4 seeds/ft in 24-in rows on May 23. Individual plots were 3 rows, 15 ft long. Plots were arranged in a randomized complete block design with four replications.

Weeds were controlled by hand cultivation on June 7, June 19, and June 26. White mold, a common fungal pathogen in dry bean production, was not observed. No fungicides or insecticides were applied. Irrigation, totaling 13 in for the season, was applied with solid-set sprinklers arranged in a 40- by 48-ft pattern. Bean foliage was protected from frost damage on June 11 and July 4 with sprinkler irrigation. Irrigation ceased on August 15 to provide adequate time for seed drying.

All plants in the center row of each plot were harvested by hand on September 8 and stored in burlap bags until the beans were threshed on October 3. Seed was cleaned using a bench-top seed cleaner. Seed weight was recorded and moisture content was determined on a subsample. Moisture content was less than 6 percent for all varieties. Yield data were not adjusted for moisture content or broken or cracked seed. All data were statistically analyzed using MSU STAT software.

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Results and Discussion

Poor growth uniformity occurred because of shading from a nearby windbreak. Plants at the southern end of the trial had good emergence and vigor throughout the season. Emergence and vigor declined steadily to the shaded north end of the experimental area. Plants at the northern end were stressed throughout the season, which led to early flowering and maturity and low yield.

Yields did not significantly differ between varieties (Table 1). Averaged across replications, yields were very low. Yield differences between replications were significant for each variety. A three-fold difference in yield between high and low-yielding replications was observed in several varieties. Using data from single replications in the southern portion of the trial, yields averaged approximately 3,500 lb/acre. Yields in this range are common for commercial dry bean crops in the Pacific Northwest. The best performance was observed for the pink variety, 85312 and the black variety, Black Shadow. Another pink variety, UI537, and the Great Northern variety, 658 produced the lowest yields averaged over replications. The red varieties, Ember and Garnett, matured about 10 days earlier than Black Shadow.

Summary

The main objective of the study was to determine if dry beans could reach physiological maturity in the cool, short-season climate of the Klamath Basin. All varieties reached maturity within 100 days after planting. Under optimum growing conditions, early-maturing varieties could be grown in the Klamath Basin. Frequent frosts during the growing season are common occurrences. Frost protection in this trial was satisfactory at minimum temperatures of 31^0F on June 11 and 32^0F on July 4. Duration of both frosts was short and little water was applied. Under more severe frost conditions, bean stems may not withstand the weight of ice build-up over extended time periods. Additional research is needed to determine economic potential and plant response to frost protection with sprinklers.

Table 1. Yield of eight dry bean varieties planted May 23, 2000 at KES, Klamath Falls, OR.

Variety or selection	Type	% stand	Population plants/acre	Physiological Maturity (DAP)[1]	Harvest (DAP)[1]	Yield	Best rep yield
						------ lb/acre	------
Black Shadow	Black	83	72,300	98	108	920	3,600
658	G. North	73	63,600	92	108	470	3,860
UI 537	Pink	83	72,300	90	108	480	2,090
85312	Pink	85	74,100	94	108	910	4,320
Winchester	Pinto	68	59,200	90	108	780	3,680
Agassiz	Pinto	79	68,800	92	108	800	3,240
Ember	Red	90	78,400	87	108	640	3,960
Garnett	Red	87	75,800	89	108	710	3,400
Mean		81	70,600	92	108	710	3,520
CV (%)		----	----	----	----	50	----
LSD (.05)		----	----	----	----	NS	----

[1]DAP = days after planting.

Hybrid Poplar Performance

Scott Leavengood[1], Brian A. Charlton[2], and Jim Dahm[3]

Abstract

Reduced availability of timber supplies from Pacific Northwest public lands and declining harvest from private lands has encouraged several companies in the wood products industry to search for alternative timber supply sources. Hybrid poplar has generated much interest and is currently grown on tens of thousands of acres in the northwest. Initially, hybrid poplar was considered primarily as a source of pulp. Changing economics for pulp has heightened interest in evaluating the potential for production of other wood products. Most northwest commercial hybrid poplar production is concentrated in the long growing season environment of the Columbia Basin.

A study was established at the Klamath Experiment Station (KES) in 1996 to evaluate the performance of eight hybrid clones in a short-season environment. Severe winter mortality was experienced in all but one clone and the study was abandoned in 1997. A second study was established in two KES fields in June 1999 to further investigate performance of the OP-367 clone, which experienced the best survival in the winter of 1996-1997. Soil differences between and within sites affected tree performance. Average tree height at the most productive sites was about 4 ft in September 1999 and nearly 12 ft in October 2000. On March 22, 2001, vandals destroyed all trees at one of the sites.

Introduction

Poplar is a generic term used to refer to trees in the genus *Populus*. Aspen, lombardy poplar, black cottonwood, and eastern cottonwood are all members of this genus. Several hybrid (products of cross-fertilizing plants of different species) clones have been developed and constitute most of the commercial acreage. In the Pacific Northwest, hybrid poplar trees have grown to 70 ft in height and 15 in in diameter in just 7 years in the long-season environment of the Columbia Basin.

The availability of timber supplies for pulp and wood products in the Klamath Basin has been severely curtailed by loss of access to timber on public lands. Several mills in the area have closed in the past decade and supply to remaining mills from private land is rapidly being depleted. Wood product companies in the area are interested in determining if hybrid poplar is an economic alternative for the short-season environment of the Klamath Basin.

Procedures

1996

Eight clones were planted at KES in June on a 7-ft spacing in 10-ft rows. Seven clones were derived from parent stock

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involving crossing of *Populus trichocarpa* (black cottonwood) and *P. deltoides* (eastern cottonwood). The other clone, (OP-367) was derived from a cross between *P. nigra* (European black poplar) and *P. deltoides*. Irrigation was continued well into the fall and tree buds did not have adequate time to "harden off" before the onset of winter. Severe mortality occurred in all clones except OP-367. All Op-367 trees survived the winter and had achieved an average height of about 4 ft during the first year (Leavengood, *et al.* 1997). The experiment was abandoned in the spring of 1997.

1999

Hybrid poplar clone OP-367 was planted on two observational blocks at KES on June 15. The northern block is a Poe fine sandy loam soil with pH about 7.0. The southern block is a Fordney fine sandy loam soil with pH ranging from 7.5 to 8.5 in a west-to-east direction. Both fields were ripped to a depth of 18 in with shanks spaced 18 in apart. Fields were moldboard plowed and a broadcast application of 500 lb/acre of 16-16-16 fertilizer was incorporated to a depth of 6 in. Poplar cuttings ("sticks") were planted at 7-ft spacing in 14-ft rows on June 15. Irrigation was provided with solid-set sprinklers arranged on a 40- by 40-ft spacing equipped to apply 0.123 in/hour. The total water applied for the 1999 season was approximately 24 in, including rainfall. Irrigation was stopped in early September to allow tree buds to harden off. Weed control was achieved by cultivating between rows with a tractor-drawn harrow and within rows with an ATV-drawn harrow.

2000

The total irrigation plus rainfall for the season was approximately 24 in, as in 1999. To prevent root pruning, mechanical cultivation was not used for weed control in 2000. As an alternative, winter wheat was planted on May 2 as a cover crop to suppress weed competition. The cover crop and weeds were periodically flail-mowed during the summer. Foliar analysis performed in August of 1999 indicated elevated nutrient concentrations in both observational blocks. Therefore, no additional fertilizer was applied in 2000. Foliar analysis performed in August of 2000 indicated all major elements were at or well above recommended levels. Calcium and a few minor elements tested low, but deficiency symptoms were not identified.

Results and Discussion

1999

All trees in the northern block appeared healthy throughout the growing season. Trees in the center and eastern portion of the southern block began to show stress within 4 weeks of planting while trees in the western portion appeared healthy throughout the season. Poor performance in affected areas of the southern block was likely related to the high soil pH and the affect of this on minor nutrients. Growth data were collected on September 8. Height varied significantly in the southern block. Average height was 58, 32, and 21 in for trees in the western, center, and eastern sections, respectively (Fig. 1). Height was somewhat varied in the northern block. Shading effects from nearby trees reduced growth in poplars nearest the trees. Average height for trees in the northern block was approximately 49 in. Weed control with the cover crop and mowing was adequate.

2000

Winter mortality of trees in the southern block was 100, 40, and 1.8 percent

2000

Winter mortality of trees in the southern block was 100, 40, and 1.8 percent for eastern, center, and western portions, respectively. Mortality of trees in the northern block was 7.1 percent. High soil pH and related nutrient availability stressed trees in the eastern and center portions of the southern block and trees went dormant under less than optimum conditions, resulting in high mortality. It appears that an application of liquid sulfuric acid or similar compound needs to be applied through the irrigation system periodically through the growing season if trees are to survive in high soil pH conditions. The winter wheat cover crop required minimal mowing and effectively reduced weed competition. Ceasing irrigation in the first week of September allowed adequate time for buds to "harden off" and appears to have prevented further winter mortality.

Growth data were collected in October. Trees in the northern block averaged 143 in tall with 94 in of new growth during 2000 (Fig. 2). Trees in the healthy western portion of the southern block averaged 139 in tall with 81 in of new growth achieved during 2000. In the center portion, trees averaged 111 in tall, having gained 78 in during 2000. All trees in the eastern section of the southern block were dead.

Future Direction

All trees were pruned in February 2001 to remove multiple leaders and limbs below 1 ft. The stand was thinned by removing alternate trees, leaving stand of 14- by 14-ft or approximately 220 trees/acre. Future pruning will occur annually to promote knot-free trunk wood. Height and diameter data will be collected annually.

Vandals cut down all trees in the southern block on March 23, 2001. The action was part of a protest by a radical environmental group opposed to genetically modified organism (GMO) research. While some research is being conducted on genetically altered hybrid poplars, none of the trees at KES were genetically modified. Experimental plantings of hybrid poplars, including some GMO material, at other research sites in the Corvallis, Oregon area were also destroyed on the same date.

Summary

Providing that remaining trees are not vandalized, the observational study will be continued for several more years to determine performance of hybrid poplars under the limiting climatic conditions in the region. Preliminary observations indicated growth rates during the first 2 years were significantly less than rates observed in the long season areas of the Columbia Basin and the Treasure Valley in eastern Oregon.

References

Leavengood, S., J. Dahm, and K.A. Rykbost. 1997. Hybrid poplar research. Pages 84-88 *in Crop Research in the Klamath Basin, 1996 Annual Report. Special Report 981, Agricultural Experiment Station, Oregon State University, Corvallis, OR.*

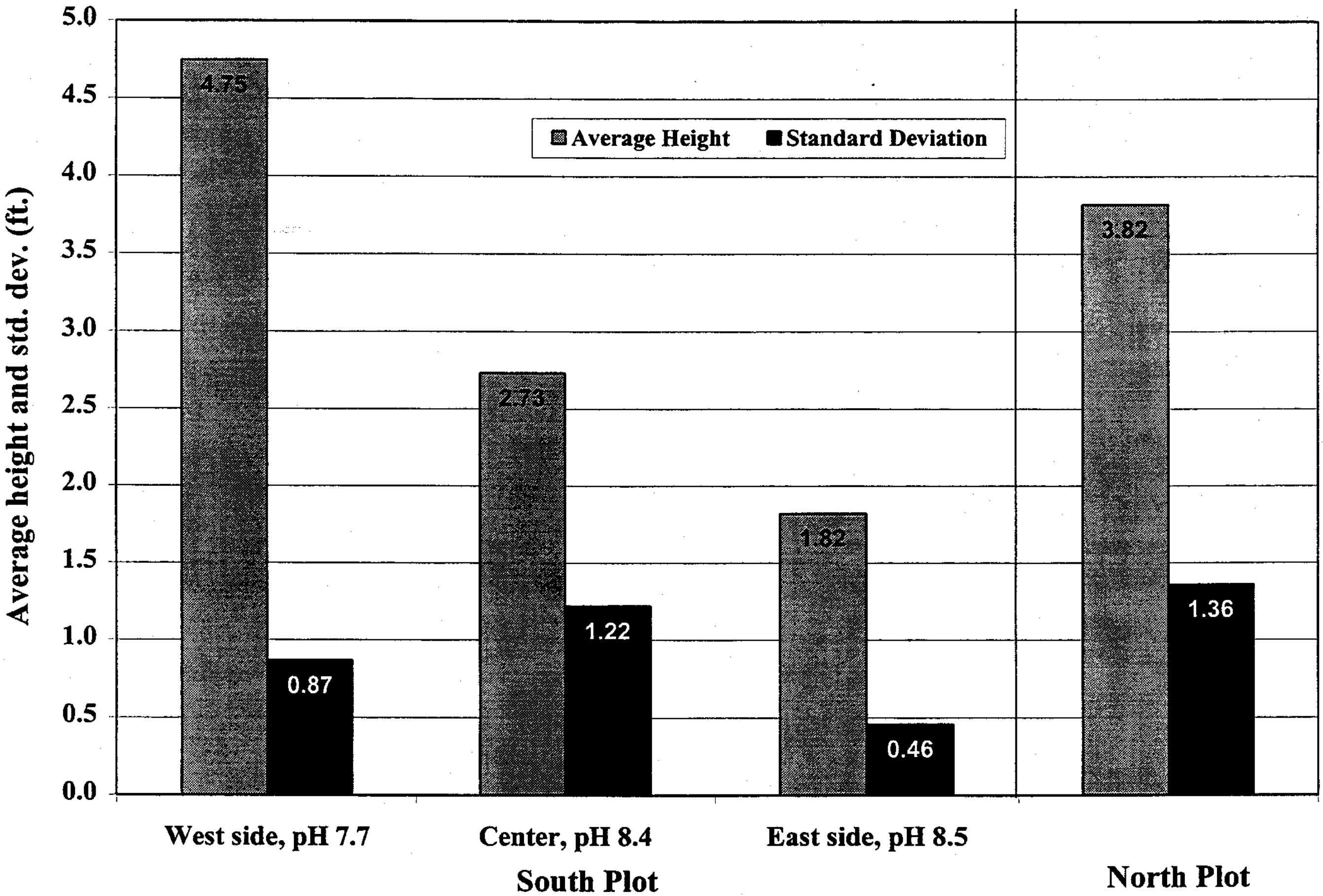

Figure 1. Average height and standard deviation in September 1999 for hybrid poplar clone OP-367 planted on June 15, 1999 at Klamath Falls, OR.

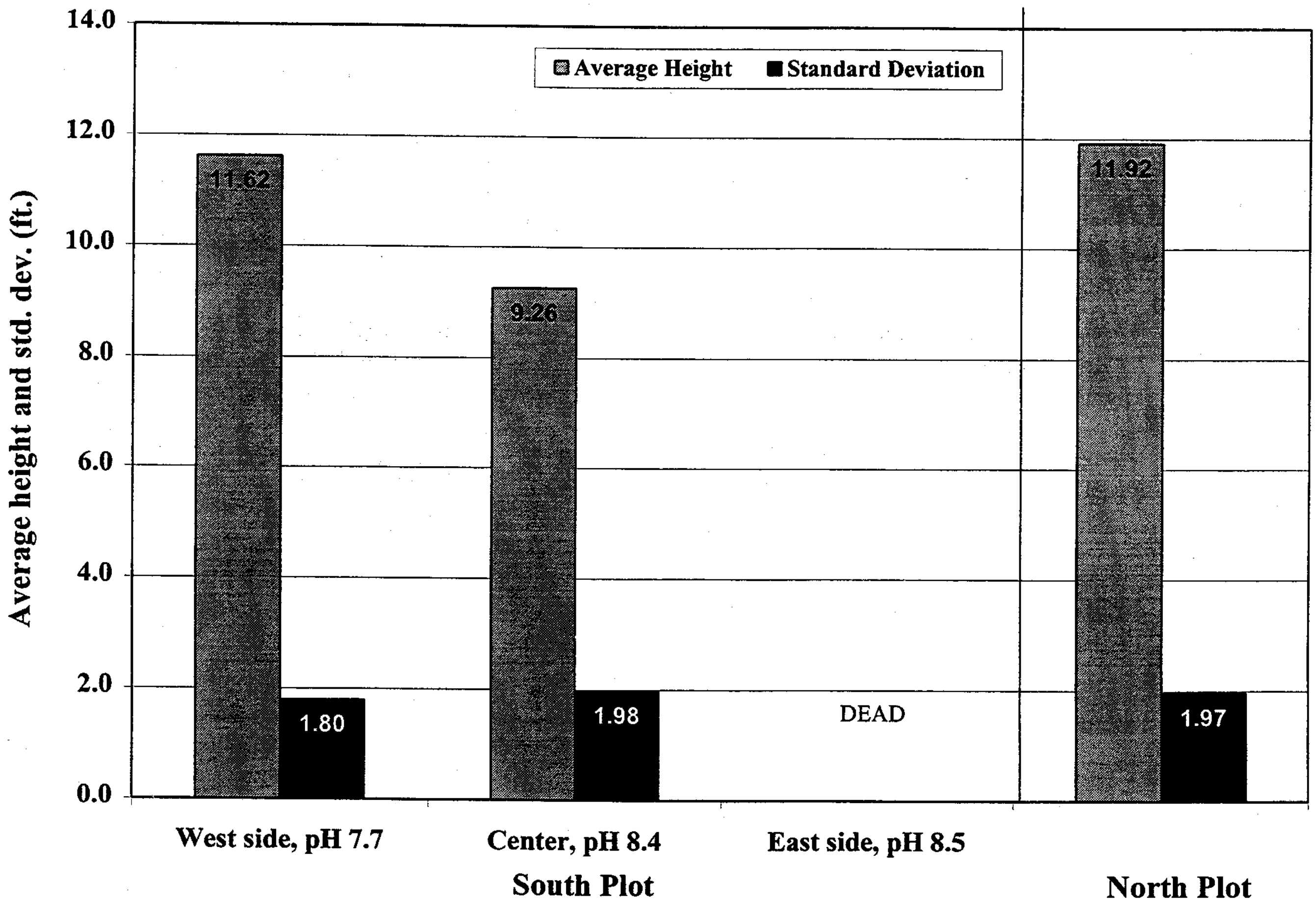

Figure 2. Average height and standard deviation in October 2000 for hybrid poplar clone OP-367 planted on June 15, 1999 at Klamath Falls, OR.

Alfalfa Variety Trial, 1996-2000

Donald R. Clark, Jim E. Smith, Randy L. Dovel, and James Rainey[1]

Abstract

A trial including 28 released and experimental alfalfa varieties was established at the Klamath Experiment Station (KES) in 1996. Varieties were arranged in a randomized complete block design with four replications. Individual plots were 4.5 by 20 ft. Harvested area of the plots were 3 by 15.5 ft or 46.5 ft^2. The crop was sprinkler-irrigated with a solid-set system to meet crop needs. Plants were allowed to grow through the 1996 season without cutting. From 1997 through 2000 plants were harvested under a three-cutting management with harvests scheduled when plants reached bud stage.

In 1998 and 1999, small but significant forage yield differences were observed in the third cutting. In 1999, significant differences of at least 0.56 ton/acre in total yield for three cuttings were found among varieties with a range from 5.53 to 6.63 ton/acre. In all other comparisons, no differences were noted for forage yield. Mean total yields were 6.22, 7.39, 6.07, and 6.44 ton/acre in 1997, 1998, 1999, and 2000, respectively.

Forage quality, as measured by crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients (TDN), and relative feed value (RFV), was determined from samples of the second cutting in each year. In addition, determinations of these quality parameters were completed on the first and third cuttings in 2000. No significant differences were observed in any of the second-cutting quality parameters monitored in any year. However, alfalfa varieties differed in CP, NDF, and RFV in the first cutting. In the third cutting, in addition to these three quality parameters, differences were seen for ADF and TDN. Alfalfa varieties WL 252 HQ, DK127, Accord, Oneida VR, and Magnum III all ranked in the top 10 for RFV in both the first and third cuttings. Stand persistence was acceptable for all varieties over 4 years.

Introduction

Alfalfa accounts for more than 51,000 acres within Klamath Irrigation Project lands, and close to 40,000 acres is produced in Klamath County. Major markets include dairies, cattle ranches, and horse farms in Oregon and California. As with other forages grown for hay, alfalfa yield increases with time. However, this yield increase is accompanied by a decrease in forage quality, caused by increases in fibers, ADF and NDF, and declines in CP.

In the Oregon hay market, alfalfa classes are based on RFV. Though these values cannot be used in ration development, it does provide a system that can rank forages in regard to animal

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nutritive value. RFVs are calculated using determined values for ADF, as a measure of digestibility, and NDF, as a measure of forage intake. Equation 1 is used in this RFV calculation where concentrations of ADF and NDF are based on 100 percent dry matter (DM).

$$\text{Equation 1: } RFV = \{ [120 / NDF] * [88.90 - (0.779 * ADF)] \} / 1.29$$

In the California hay market, alfalfa classes are assigned through concentrations of ADF or TDN. This classification scheme is important to Klamath Basin producers since much of their hay is sold in California. TDN is a calculated value derived from ADF levels and is reported on 90 percent DM basis. Equation 2 is used in this TDN calculation where ADF values are based on 100 percent DM.

$$\text{Equation 2: } TDN = [82.38 - (0.7515 * ADF)] * 0.9$$

A new quality class has recently been added in alfalfa market classifications. This "Supreme" class of alfalfa must have a RFV greater than 180, ADF less than 27 percent, TDN greater than 55.9 percent and CP greater than or equal to 22 percent. This is in contrast to the standard "Premium" alfalfa class where RFV is between 150 and 180, ADF is between 27 and 29 percent, TDN is between 54.5 and 55.9 percent, and CP is between 20 and 22 percent. The "Good" alfalfa class requires RFV to be between 125 and 150, ADF to be between 29 and 32 percent, TDN to be between 52.5 and 54.5 percent, and CP to be between 18 and 20 percent.

For producers to meet this Supreme grade of alfalfa, strict management practices must be followed. Harvesting needs to be done at early growth stages (pre-bud), and more attention must be given to weed control. Producers will have to determine if it will be economical to follow these practices considering potential effects to yield and stand persistence.

Alfalfa breeding programs are striving for improved quality and are marketing varieties reported to have superior quality factors. These advances are due to increased leafiness and finer stem material. In the KES trial, differences were shown in forage quality between the varieties tested.

A frost in late May, with temperatures dipping down to 20^0F, resulted in considerable damage to the first cutting of alfalfa for the 2000 growing season. In the basin, this injury was most severe in the Poe, Swan Lake, Yonna, and Langell valleys. Many producers harvested their alfalfa immediately after this frost in order to ensure proper regrowth due to meristematic injury.

The alfalfa weevil (*Hyper postica*) also affected the first cutting in the 2000 season. Chemical control measures are effective for this pest but require at least a 7-day period between treatment and harvest. Delaying harvest following treatment causes a decline in alfalfa forage quality. Harvesting alfalfa as soon as the weevil surpasses economic threshold levels can lessen damage; however, if weevil populations are high early, this results in reduced yields for that cutting.

The production of high yields of high-quality alfalfa is hindered by the extreme weather patterns experienced in the Klamath Basin. Though an aid in allowing slow growth and thus increasing potential quality of locally grown alfalfa, mild days and cool night-time temperatures reduce yield potential. Cold winter temperature stresses stands, resulting in reduced stand persistence. These and other factors justify local variety trials for the area. Trials at KES attempt to differentiate superior varieties of alfalfa for this region. This report summarizes an alfalfa variety test conducted at KES from 1996 to 2000.

Procedures

A trial was established on a Poe fine sandy loam soil at KES in August 1996 to evaluate 28 released and experimental alfalfa varieties. Varieties were arranged in a randomized complete block design with four replications. Fertilizer was applied preplant according to recommendations based on analysis of soil samples from the field. Seed was drilled to a depth of one-fourth in at a rate of 20 lb/acre using a modified Kincaid (Kincaid Equipment Manufacturing) planter. Individual plots were 4.5 by 20 ft, with 3 by 15.5 ft harvested. Sprinkler irrigation was applied with a solid-set system according to crop needs.

Plants were allowed to grow through the fall of 1996 without cutting. Alfalfa was harvested in a three-cutting management schedule in subsequent years with harvest timing scheduled to coincide with bud stage. The crop was harvested with a Carter (Carter MFG Co. Inc.) self-propelled flail harvester with a 3-ft-wide header. Random samples of about 1.0 lb from each plot were oven dried to determine dry matter yield. Dried samples from the second cutting in each year were ground to 2-mm-sieve size in a Wiley Mill (Arthur H. Thomas Co.) and to 1-mm-sieve size in a Udy Mill (UDY Corporation) before being analyzed in a near infrared spectrophotometer (NIRS) (NIRSystems) to determine forage quality. Samples of the first and third cuttings were also handled as above for the 2000 season.

Forage yield and quality data were analyzed statistically using SAS software. Single cutting data were analyzed using a randomized complete block design. Seasonal data were analyzed using a split-plot design with cutting as the main plot and variety as the subplot. Multi-year data were analyzed using a split-plot design with year as the main plot and variety as the subplot. Least significant differences (LSD) are based on student's t at the 5 percent probability level.

Results and Discussion

For the 2000 season, forage yields for each cutting, total yield for three cuttings, and total yield rank are presented in Table 1. No significant differences among varieties were noted in this year. Table 2 includes the data averaged across varieties for each of the three cuttings. These data indicate that the first-cutting yield was greater than that for the second cutting, and both were greater than the harvested alfalfa yield for the third cutting. This decline through the growing season would be expected even though a hard frost of 24^0F occurred 2 weeks before the first cutting.

The total yields for each of the 4 years of the alfalfa trial, the total of all 4 years, and the ranking from the total yields are included in Table 3. No differences were noted in total yield through the seasons except in 1999, when 13 alfalfa varieties yielded significantly less than the top variety.

Across years, average yields for the three cuttings, total yield, and the ranking according to total yield for the varieties are included in Table 4. Within the alfalfa varieties, only the first cutting showed differences. Thirteen varieties fell within the top yield range. Higher yields in the first cutting could be related to low fall dormancy ratings (FDR) and superior over-wintering ability. However, within the 13 varieties in the top yielding group, FDR values ranged from 2 to 5.

Following split-plot statistical analysis on total yearly yields across cuttings, differences were shown between years but not among varieties. The results for the different year yields are included in Table 5. Total yields across varieties were 18 percent higher for 1998 compared with the low yield year of 1999. Cool growing conditions in the summer of 1999 would explain some of this difference.

Alfalfa forage quality determined by CP, ADF, NDF, TDN, and TDN, and sorted on RFV for the tested varieties for each of the three harvests in 2000 are included in Tables 6, 7, and 8. Differences were exhibited among the varieties in the first and third cuttings. However, as was the case in the previous years, second-cutting forage quality did not vary due to variety. For the first cutting, concentrations of CP and NDF, and the calculated values for RFV varied among varieties. For CP, NDF, and RFV, differences of 5, 4, and 6 percent, respectively, would constitute a true difference. Sixteen, 16, and 17 varieties, respectively, differed from the highest-ranking variety in these three quality parameters. Considering RFV requirements in regard to alfalfa marketing classifications, all varieties meet requirements for "Good" classification.

For the third cutting, concentrations of CP, ADF, and NDF, and the calculated values for TDN and RFV varied among varieties. For the above factors, differences of 7, 9, 7, 4, and 8 percent, respectively, would constitute a true difference. With these five quality parameters 13, 16, 8, 17, and 11 varieties, respectively, differed from the highest-ranking variety. Considering RFV requirements in regard to alfalfa marketing classifications, 17 of the varieties would be graded "Premium" with the remaining falling into the "Good" classification. With California's TDN requirements for classifying alfalfa, 8 of the varieties would be graded "Premium" with the remaining classified "Good".

With cutting considered the main plot and varieties the subplot in a split-plot design, differences in yield among varieties were not noted. However, differences among varieties did occur for the five forage quality factors considered (Table 9). For CP, ADF, NDF, TDN, and RFV, differences of 4, 4, 3, 3, and 5 percent, respectively, would constitute a true difference. For these five quality parameters, 20, 17, 11, 8, and 17 alfalfa varieties, respectively, were different from the highest-ranking variety.

When considering forage quality differences due to cutting, included in Table 10, the second cutting produced the lowest-quality forage in regard to ADF, NDF, TDN, and CP. The highest forage quality was produced with the third cutting.

Data were compiled from company and breeder information or from the Certified Seed Council's "Fall Dormancy and Pest Resistance Rating for Alfalfa Varieties" concerning FDR or resistance to various pests. This information for the tested varieties is included in Table 11.

Table 1. 2000 forage yield of 28 alfalfa varieties planted at KES, Klamath Falls, OR, 1996.

Entry	Company	Cut 1	Cut 2	Cut 3	Total	Rank
		ton/acre				
Rushmore	Novartis Seeds	2.53	2.17	1.99	6.70	6
Aspen	Eureka Seeds	2.14	2.30	1.97	6.41	14
Innovator + Z	America's Alfalfa	2.72	2.04	1.97	6.73	5
Affinity + Z	America's Alfalfa	2.39	2.11	1.90	6.40	15
ABI 9352	America's Alfalfa	2.24	2.16	1.71	6.10	26
LM-331	Loshe Mill	2.34	2.21	1.88	6.43	11
H 154	Loshe Mill	2.31	2.04	1.89	6.24	23
LM 459	Loshe Mill	2.44	2.23	2.17	6.84	2
Accord	Union Seed/Chemgro	2.51	2.07	1.76	6.34	20
DK127	Dekalb Genetics Corp.	2.57	2.03	2.08	6.68	9
5396	Pioneer Hi-Breed Int.	2.66	2.24	2.00	6.90	1
5246	Pioneer Hi-Breed Int.	2.72	2.19	1.88	6.79	3
Extend	Grasslands West	2.18	2.29	1.78	6.25	22
Charger	Grasslands West	2.19	2.15	1.76	6.10	27
Webfoot MPR	Great Lakes Hybrids	2.70	2.04	1.95	6.69	7
Excalibur II	Allied Seed	2.40	2.02	1.96	6.38	17
Magnum III	Dairyland	2.41	2.06	1.95	6.42	12
Oneida VR	Public	2.12	2.15	1.68	5.95	28
Vernal	Public	2.84	1.94	1.91	6.68	8
Vernema	Public	2.44	2.03	1.92	6.39	16
W45	Public	2.52	1.94	1.99	6.45	10
HayGrazer	Great Plains Research	2.45	2.17	1.76	6.38	19
WL 252 HQ	WL Research Inc.	2.29	2.11	1.91	6.30	21
Blazer	Croplan Genetics	2.55	2.05	1.78	6.38	18
Blazer XL	Croplan Genetics	2.71	1.82	1.88	6.41	13
Baralfa 54	Barenbrug, USA	2.36	2.40	1.98	6.74	4
Baralfa 32 IQ	Barenbrug, USA	2.28	1.97	1.90	6.15	24
Ranger	Public	2.35	2.00	1.78	6.13	25
Mean		2.44	2.11	1.90	6.44	
CV (%)		13	10	13	8	
LSD (.05)		NS	NS	NS	NS	

Table 2. 2000 average total yield across 28 alfalfa varieties planted in 1996 at KES, Klamath Falls, OR.

Cutting	Yield
	ton/acre
1	2.44a[1]
2	2.10b
3	1.90c
Mean	2.15
CV (%)	23
LSD (.05)	0.16

[1]Values followed by the same letter are not significantly different at P = 0.05.

Table 3. Total forage yield of 28 alfalfa varieties planted in 1996 at KES, Klamath Falls, OR.

Entry	Company	1997	1998	1999	2000	Total	Rank
				ton/acre			
Rushmore	Novartis Seeds	6.10	7.39	5.84	6.70	26.03	17
Aspen	Eureka Seeds	6.06	7.20	5.75	6.41	25.42	26
Innovator + Z	America's Alfalfa	6.32	7.81	6.15	6.73	27.01	2
Affinity + Z	America's Alfalfa	6.09	7.55	6.57	6.40	26.61	4
ABI 9352	America's Alfalfa	5.98	7.02	6.08	6.10	25.18	27
LM-331	Loshe Mill	6.12	7.51	5.96	6.43	26.02	18
H 154	Loshe Mill	5.90	8.30	5.97	6.24	26.41	6
LM 459	Loshe Mill	6.14	7.11	6.17	6.84	26.26	10
Accord	Union Seed/Chemgro	6.33	7.65	5.94	6.34	26.26	11
DK127	Dekalb Genetics Corp.	6.25	7.75	5.53	6.68	26.21	12
5396	Pioneer Hi-Breed Int.	6.38	7.73	6.56	6.90	27.57	1
5246	Pioneer Hi-Breed Int.	5.70	7.26	6.33	6.79	26.08	16
Extend	Grasslands West	6.32	7.67	5.91	6.25	26.15	13
Charger	Grasslands West	6.22	7.07	6.28	6.10	25.67	24
Webfoot MPR	Great Lakes Hybrids	6.38	7.48	5.77	6.69	26.32	8
Excalibur II	Allied Seed	6.57	7.37	6.05	6.38	26.37	7
Magnum III	Dairyland	6.33	7.06	6.63	6.42	26.44	5
Oneida VR	Public	6.45	6.86	5.87	5.95	25.13	28
Vernal	Public	6.18	7.92	6.14	6.68	26.92	3
Vernema	Public	5.96	7.18	6.18	6.39	25.71	23
W45	Public	5.91	7.04	6.09	6.45	25.49	25
HayGrazer	Great Plains Research	6.33	7.26	6.15	6.38	26.12	14
WL 252 HQ	WL Research Inc.	6.44	7.33	5.83	6.30	25.90	20
Blazer	Croplan Genetics	6.41	7.45	5.71	6.38	25.95	19
Blazer XL	Croplan Genetics	6.07	7.27	6.07	6.41	25.82	22
Baralfa 54	Barenbrug, USA	6.35	7.17	6.04	6.74	26.30	9
Baralfa 32 IQ	Barenbrug, USA	6.37	7.14	6.18	6.15	25.84	21
Ranger	Public	6.38	7.50	6.10	6.13	26.11	15
Mean		6.22	7.39	6.07	6.44	26.12	
CV (%)		6	8	7	8	3	
LSD (.05)		NS	NS	0.56	NS	NS	

Table 4. Average 1997-2000 forage yield of 28 alfalfa varieties planted in 1996 at KES, Klamath Falls, OR.

Entry	Company	Cut 1	Cut 2	Cut 3	Total	Rank
		ton/acre				
Rushmore	Novartis Seeds	2.76	1.88	1.87	6.51	17
Aspen	Eureka Seeds	2.49	2.04	1.82	6.35	26
Innovator + Z	America's Alfalfa	2.92	2.05	1.78	6.75	2
Affinity + Z	America's Alfalfa	2.73	2.07	1.85	6.65	4
ABI 9352	America's Alfalfa	2.60	1.96	1.73	6.29	27
LM-331	Loshe Mill	2.72	2.01	1.78	6.51	18
H 154	Loshe Mill	2.80	2.02	1.78	6.60	6
LM 459	Loshe Mill	2.67	2.05	1.85	6.57	10
Accord	Union Seed/Chemgro	2.87	1.95	1.74	6.57	11
DK127	Dekalb Genetics Corp.	2.76	1.94	1.86	6.55	12
5396	Pioneer Hi-Breed Int.	3.02	2.00	1.87	6.89	1
5246	Pioneer Hi-Breed Int.	2.71	2.01	1.81	6.52	16
Extend	Grasslands West	2.64	2.07	1.83	6.53	13
Charger	Grasslands West	2.71	1.95	1.75	6.42	24
Webfoot MPR	Great Lakes Hybrids	2.81	1.97	1.80	6.58	8
Excalibur II	Allied Seed	2.76	1.99	1.84	6.59	7
Magnum III	Dairyland	2.87	1.96	1.78	6.61	5
Oneida VR	Public	2.55	2.04	1.70	6.28	28
Vernal	Public	2.97	1.96	1.80	6.73	3
Vernema	Public	2.68	1.99	1.76	6.43	23
W45	Public	2.66	1.88	1.84	6.38	25
HayGrazer	Great Plains Research	2.68	2.08	1.77	6.53	14
WL 252 HQ	WL Research Inc.	2.72	1.93	1.82	6.47	20
Blazer	Croplan Genetics	2.76	1.96	1.76	6.49	19
Blazer XL	Croplan Genetics	2.76	1.89	1.80	6.45	22
Baralfa 54	Barenbrug, USA	2.54	2.19	1.84	6.57	9
Baralfa 32 IQ	Barenbrug, USA	2.81	1.91	1.74	6.46	21
Ranger	Public	2.67	2.00	1.86	6.53	15
Mean		2.74	1.99	1.80	6.53	
CV (%)		7	6	5	3	
LSD (.05)		0.27	NS	NS	NS	

Table 5. 1997-2000 average total yield across 28 alfalfa varieties planted in 1996 at KES, Klamath Falls, OR.

Year	Yield
	ton/acre
1997	6.22bc[1]
1998	7.39a
1999	6.06c
2000	6.44b
Mean	6.53
CV (%)	17
LSD (.05)	0.33

[1]Values followed by the same letter are not significantly different at P = 0.05.

Table 6. 2000 first-cutting alfalfa forage quality as measured by crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients (TDN), and relative feed value (RFV) of 28 varieties planted in 1996 at KES, Klamath Falls, OR. Varieties are sorted by RFV.

Entry	Company	CP	ADF	NDF	TDN	RFV
		%				
DK127	Dekalb Genetics Corp.	23.2	32.4	41.4	52.2	143.1
Charger	Grasslands West	22.6	32.9	41.9	51.9	141.2
Ranger	Public	22.7	32.6	42.0	52.1	140.9
WL 252 HQ	WL Research Inc.	23.4	32.4	42.2	52.2	140.3
Baralfa 32 IQ	Barenbrug, USA	22.3	33.7	41.9	51.3	138.9
W45	Public	22.2	34.4	41.8	50.9	138.5
Aspen	Eureka Seeds	22.4	33.5	42.3	51.5	138.4
Accord	Union Seed/Chemgro	22.5	33.6	42.4	51.4	137.8
Magnum III	Dairyland	22.6	33.2	42.7	51.7	137.5
Oneida VR	Public	22.1	33.5	42.7	51.5	137.0
Affinity + Z	America's Alfalfa	22.4	33.8	42.8	51.3	136.1
Webfoot MPR	Great Lakes Hybrids	22.1	33.2	43.6	51.7	134.9
Rushmore	Novartis Seeds	22.3	34.3	42.9	50.9	134.8
Innovator + Z	America's Alfalfa	22.3	33.9	43.2	51.2	134.8
Excalibur II	Allied Seed	21.9	34.0	43.1	51.1	134.8
Extend	Grasslands West	22.4	33.3	43.6	51.6	134.5
HayGrazer	Great Plains Research	22.1	34.1	43.2	51.1	134.4
Blazer XL	Croplan Genetics	22.4	34.4	43.2	50.9	134.1
Vernema	Public	21.8	34.1	43.3	51.1	134.1
Baralfa 54	Barenbrug, USA	22.6	34.1	43.7	51.1	132.7
Blazer	Croplan Genetics	21.7	34.5	43.6	50.8	132.6
5396	Pioneer Hi-Breed Int.	21.4	34.9	43.5	50.5	132.3
LM-331	Loshe Mill	22.1	35.2	43.7	50.3	130.9
5246	Pioneer Hi-Breed Int.	21.6	35.5	43.6	50.1	130.6
LM 459	Loshe Mill	21.4	35.6	43.8	50.1	130.5
Vernal	Public	21.8	34.1	44.6	51.1	130.3
ABI 9352	America's Alfalfa	21.8	35.5	44.0	50.1	129.4
H 154	Loshe Mill	21.5	34.9	44.7	50.6	129.2
Mean		22.2	34.0	43.1	51.2	135.2
CV (%)		3	4	3	3	4
LSD (.05)		1.1	NS	1.7	NS	8.2

Table 7. 2000 second-cutting alfalfa forage quality as measured by crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients (TDN), and relative feed value (RFV) of 28 varieties planted in 1996 at KES, Klamath Falls, OR. Varieties are sorted by RFV.

Entry	Company	CP	ADF	NDF	TDN	RFV
		%				
Charger	Grasslands West	23.1	33.2	43.4	51.7	135.3
Affinity + Z	America's Alfalfa	22.7	33.3	44.1	51.6	133.3
WL 252 HQ	WL Research Inc.	22.4	33.6	44.6	51.4	131.4
Baralfa 32 IQ	Barenbrug, USA	22.6	34.2	44.2	51.0	131.1
HayGrazer	Great Plains Research	22.7	34.1	44.4	51.1	130.8
Excalibur II	Allied Seed	21.5	34.3	44.8	51.0	130.2
5396	Pioneer Hi-Breed Int.	22.0	34.4	44.6	50.9	129.7
H 154	Loshe Mill	22.2	33.7	45.1	51.4	129.6
DK127	Dekalb Genetics Corp.	22.2	34.3	44.9	50.9	128.8
Vernal	Public	22.3	34.5	45.0	50.8	128.5
Accord	Union Seed/Chemgro	22.0	34.7	44.9	50.7	128.4
Rushmore	Novartis Seeds	22.2	34.5	45.4	50.8	128.3
Oneida VR	Public	21.3	34.5	45.3	50.8	127.4
Innovator + Z	America's Alfalfa	22.1	35.2	45.2	50.4	127.1
Ranger	Public	21.1	35.6	44.9	50.0	127.0
Baralfa 54	Barenbrug, USA	21.1	35.0	45.5	50.5	126.3
Webfoot MPR	Great Lakes Hybrids	21.6	35.2	45.4	50.3	126.2
Blazer	Croplan Genetics	21.5	35.6	45.7	50.1	124.7
Blazer XL	Croplan Genetics	21.1	35.4	45.8	50.2	124.6
LM 459	Loshe Mill	21.3	35.6	45.8	50.0	124.6
LM-331	Loshe Mill	22.2	35.1	46.0	50.4	124.6
Magnum III	Dairyland	21.1	35.2	46.3	50.3	123.6
Aspen	Eureka Seeds	21.1	35.6	46.5	50.1	122.9
5246	Pioneer Hi-Breed Int.	21.2	36.8	45.8	49.2	122.6
ABI 9352	America's Alfalfa	21.7	35.2	46.9	50.3	122.2
Extend	Grasslands West	21.4	35.8	47.3	49.9	120.7
W45	Public	20.3	36.5	47.8	49.5	117.9
Vernema	Public	20.7	37.4	47.9	48.8	116.4
Mean		21.7	35.0	45.5	50.5	126.6
CV (%)		6	6	5	4	7
LSD (.05)		NS	NS	NS	NS	NS

Table 8. 2000 third-cutting alfalfa forage quality as measured by crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients (TDN), and relative feed value (RFV) of 28 varieties planted in 1996 at KES, Klamath Falls, OR. Varieties are sorted by RFV.

Entry	Company	CP	ADF	NDF	TDN	RFV
		%				
WL 252 HQ	WL Research Inc.	24.0	27.5	38.4	55.6	163.7
Excalibur II	Allied Seed	23.4	28.2	38.4	55.0	162.5
Vernal	Public	23.1	28.1	38.7	55.1	161.4
Accord	Union Seed/Chemgro	22.9	28.6	38.7	54.8	160.4
LM-331	Loshe Mill	23.6	28.3	38.9	55.0	159.9
HayGrazer	Great Plains Research	23.0	28.7	39.5	54.7	157.3
Oneida VR	Public	22.0	29.2	39.4	54.4	156.1
DK127	Dekalb Genetics Corp.	22.8	29.7	39.3	54.1	156.1
Affinity + Z	America's Alfalfa	22.7	29.6	39.4	54.1	155.4
Magnum III	Dairyland	22.3	29.1	40.1	54.5	153.8
Aspen	Eureka Seeds	22.6	29.4	40.1	54.2	153.8
Ranger	Public	22.1	29.0	40.2	54.5	153.4
Extend	Grasslands West	22.3	29.4	40.3	54.2	153.0
Rushmore	Novartis Seeds	22.6	30.0	40.3	53.8	152.9
5396	Pioneer Hi-Breed Int.	22.3	29.5	40.2	54.2	152.8
W45	Public	22.3	29.5	40.2	54.2	152.7
Charger	Grasslands West	22.4	29.6	40.2	54.1	152.3
Baralfa 32 IQ	Barenbrug, USA	21.4	30.3	40.7	53.7	149.6
Vernema	Public	21.7	30.2	40.9	53.7	149.5
Blazer	Croplan Genetics	22.0	30.0	40.8	53.9	149.4
Innovator + Z	America's Alfalfa	21.4	30.6	40.8	53.5	149.3
ABI 9352	America's Alfalfa	22.0	30.3	41.0	53.7	148.6
Webfoot MPR	Great Lakes Hybrids	21.7	30.3	41.1	53.7	147.7
Blazer XL	Croplan Genetics	21.7	30.9	41.1	53.3	146.9
H 154	Loshe Mill	21.4	30.7	41.4	53.4	146.0
5246	Pioneer Hi-Breed Int.	21.7	30.7	41.5	53.3	145.7
Baralfa 54	Barenbrug, USA	20.9	31.3	42.1	53.0	142.7
LM 459	Loshe Mill	20.1	32.8	43.4	52.0	136.0
Mean		22.2	29.7	40.3	54.1	152.5
CV (%)		6	6	4	3	6
LSD (.05)		1.7	2.4	2.5	2.0	13.0

Table 9. 2000 alfalfa total yield and average over three cuttings of forage quality as measured by crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients (TDN), and relative feed value (RFV) of 28 varieties planted in 1996 at KES, Klamath Falls, OR, 1996. Varieties are sorted by RFV.

Entry	Company	Yield	CP	ADF	NDF	TDN	RFV
		Ton/acre	%				
WL 252 HQ	WL Research Inc.	6.30	23.3	31.1	41.7	53.1	145.1
Charger	Grasslands West	6.10	22.7	31.9	41.8	52.6	142.9
DK127	Dekalb Genetics Corp.	6.68	22.8	32.1	41.9	52.4	142.7
Excalibur II	Allied Seed	6.38	22.3	32.2	42.1	52.4	142.5
Accord	Union Seed/Chemgro	6.34	22.5	32.3	42.0	52.3	142.2
Affinity + Z	America's Alfalfa	6.40	22.6	32.3	42.1	52.3	141.6
HayGrazer	Great Plains Research	6.38	22.6	32.3	42.3	52.3	140.8
Ranger	Public	6.13	22.0	32.4	42.3	52.2	140.4
Oneida VR	Public	5.95	21.8	32.4	42.5	52.2	140.2
Vernal	Public	6.68	22.4	32.2	42.8	52.3	140.1
Baralfa 32 IQ	Barenbrug, USA	6.15	22.1	32.7	42.3	52.0	139.9
Rushmore	Novartis Seeds	6.70	22.4	32.9	42.9	51.9	138.6
LM-331	Loshe Mill	6.43	22.7	32.9	42.9	51.9	138.5
Aspen	Eureka Seeds	6.41	22.0	32.8	43.0	51.9	138.4
Magnum III	Dairyland	6.42	22.0	32.5	43.0	52.2	138.3
5396	Pioneer Hi-Breed Int.	6.90	21.9	33.0	42.8	51.9	138.2
Innovator + Z	America's Alfalfa	6.73	22.0	33.2	43.1	51.7	137.1
W45	Public	6.45	21.6	33.4	43.3	51.5	136.3
Webfoot MPR	Great Lakes Hybrids	6.69	21.8	32.9	43.4	51.9	136.3
Extend	Grasslands West	6.25	22.0	32.9	43.7	51.9	136.1
Blazer	Croplan Genetics	6.38	21.7	33.4	43.4	51.6	135.6
Blazer XL	Croplan Genetics	6.41	21.7	33.6	43.4	51.4	135.2
H 154	Loshe Mill	6.24	21.7	33.1	43.7	51.8	134.9
Baralfa 54	Barenbrug, USA	6.74	21.5	33.5	43.8	51.5	133.9
ABI 9352	America's Alfalfa	6.10	21.8	33.7	44.0	51.4	133.4
Vernema	Public	6.39	21.4	33.9	44.0	51.2	133.3
5246	Pioneer Hi-Breed Int.	6.79	21.5	34.4	43.7	50.9	133.0
LM 459	Loshe Mill	6.84	20.9	34.7	44.3	50.7	130.4
Mean		2.15	22.1	32.9	42.9	51.9	138.1
CV (%)		12	5	5	4	3	6
LSD (.05)		NS	0.9	1.4	1.4	1.4	6.6

Table 10. 2000 season average forage quality across alfalfa varieties as measured by crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients (TDN), and relative feed value (RFV) of 28 varieties planted in 1996 at KES, Klamath Falls, OR.

Cutting	CP	ADF	NDF	TDN	RFV
	%				
1	22.2	34.0 b[1]	43.0 b	51.1 b	135.2 b
2	21.7	34.9 a	45.5 a	50.5 b	126.6 c
3	22.2	29.7 c	40.3 c	54.1 a	152.5 a
Mean	22.1	32.9	42.9	58.5	138.1
CV (%)	9	8	12	5	14
LSD (.05)	NS	0.8	1.7	0.9	6.1

[1]Values followed by the same letter are not significantlly different at P = 0.05.

Table 11. Alfalfa variety fall dormancy rating (FD); and resistance to bacterial wilt (BW), verticillium wilt (VW), fusarium wilt (FW), anthracnose (AN), phytophthera root rot (PRR), spotted alfalfa aphid (SAA), pea aphid (PA), blue alfalfa aphid (BAA), stem nematode (SN), aphanomyces root rot race 1 (APH), southern root knot nematode (SRKN), and northern root knot nematode (NRKN). Data taken from Certified Seed Council's "Fall Dormancy and Pest Resistance Ratings for Alfalfa Varieties", 1997/98 Edition unless otherwise stated.

Variety	FD	BW	VW	FW	AN	PRR	SAA	PA	BAA	SN	APH	SRKN	NRKN
Rushmore	4	HR[1]	R	HR	HR	HR	HR	HR		MR	HR		
Aspen	4	HR	R	HR	HR	HR	HR	HR		R	R		R
Innovator + Z	3	HR	HR	HR	HR	HR	MR	R	S	R	R		
Affinity + Z	4	HR	HR	HR	HR	HR		R		R	R		
ABI 9352[2]	5	R	HR	HR	HR	R	R	MR	HR	R			HR
LM-331[2]	4	R	R	HR	R	R	MR	MR		HR	MR		
H-154	5			HR		R	HR	HR	R	R		R	
LM 459	5	MR	MR	HR	R	R	HR	HR	R	R			R
Accord	4	HR	R	HR	HR	HR		HR		MR	R		MR
DK127	3	HR	R	R	HR	HR	HR	HR		R	HR		R
53962	3	HR	HR	R	R	R	R	R		MR	MR		MR
5246	3	R	R	R	HR	R	R	R		HR	R		
Extend	3	HR	R	HR	HR	HR				R	R		
Charger[2]	3	HR	R	HR	HR	HR				R	R		
Webfoot MPR	4	HR	HR	HR	HR	HR		R			R		
Excalibur II[2]		HR	R	HR	HR	HR	HR	R		MR	R		MR
Magnum III	4	R	MR	R	MR	R	MR	R	MR	MR	LR		
Oneida VR	3	R	HR	HR	MR	MR							
Vernal	2	R		MR									MR
Vernema	4	MR	MR		LR	LR	MR			HR			
W45[2]	5	MR	LR	HR			R			R			
HayGrazer	4	HR	R	HR	R	R	R	R	R		MR	MR	
WL 252 HQ	2	HR	HR	HR	HR	HR	MR	R		MR	R		
Blazer	3	HR	LR	R	LR	MR		HR		HR			
Blazer XL	3	R	R	HR	HR	HR	HR	R		R	R		
Baralfa 54[2]	5	R	R	HR	HR	HR	HR	HR	MR	R			
Baralfa 32 IQ[2]	3	HR	R	HR	HR	HR	HR	R	R	R	HR		
Ranger[2]	3	LR		MR									

[1]HR = highly resistant, R = resistant, MR = moderately resistant, S = susceptible, LR = low resistance.

[2]Data based on company or breeder information.

Spring Barley Variety Screening

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Abstract

The Klamath Basin is the leading production area for spring barley in Oregon. The Klamath Experiment Station (KES) plays an important role in screening new spring barley varieties to enhance production. Screening efforts are made on feed, malting, and hooded lines. The initial screening for the Oregon State University (OSU) spring barley-breeding program occurs at KES. In 2000, 128 varieties were evaluated in this program. Much of this work emphasizes increasing barley stripe rust (BSR) tolerance. In addition to these initial-screening trials, advanced selections from the OSU Statewide Trials and the Western Regional Nurseries are evaluated locally. The Statewide Trials include evaluations at branches of the Oregon Agricultural Experiment Station throughout the state. This year, 25 lines were evaluated in a mineral soil at KES and on an organic soil at a Lower Klamath Lake (LKL) site. Bancroft (malting) and Nebula (feed) were the highest yielding lines at the KES site. At the LKL site, B1202 (malting) and Jersey (feed) were the highest yielding lines. In the Western Regional Spring Barley Nursery, BA2B96-5038 (malting) and ID 93Ab688 (feed) were the highest yielding lines.

Introduction

More than one-quarter of the barley grown in Oregon is produced in the Klamath Basin. In 2000, close to 38,000 acres of barley was produced within the Klamath Irrigation Project, out of a total grain production base of about 55,000 acres. All grain accounted for about 30 percent of total irrigated acreage, while barley represented about 20 percent of acreage in the Klamath Irrigation Project. Barley was second to alfalfa, which accounted for 27 percent of crop acreage in the project.

Local production includes both feed and malting types, with feed types accounting for about two-thirds of the acreage. Klamath Basin data from the Bureau of Reclamation indicated that 10 and 54 percent of the barley grown in Oregon and California, respectively, was intended for malt. Popular feed varieties include Baronesse, Steptoe, Gus, Gustoe, and Nebula. Morex and B1202 are the main malting varieties grown. Newly released varieties Orca, Tango, and UC 960 warrant further consideration due to BSR tolerance.

With the importance of barley to this growing area, plant breeders use the Klamath Basin for initial screening trials. In 2000, Dr. Patrick Hayes and Dr. Lynn Gallagher, OSU and UC Davis barley breeders, respectively, had nurseries of early breeding lines at KES and at the Intermountain Research and Extension Center (IREC) at Tulelake, CA. With the potential for BSR to cause economic ruin to local barley production, much of this work emphasizes incorporation of BSR resistance. In addition to the initial screening

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investigations, barley varieties nearer to release status are screened at KES and IREC. In 2000, the OSU Statewide Spring Barley Variety Trials were evaluated at KES and at a LKL site. The Western Regional Spring Barley Nursery, which is coordinated by the USDA, Agricultural Research Service Small Grains Research Unit at Aberdeen, Idaho, was also grown at KES.

The 2000 barley crop was injured by a severe frost at the end of May. Temperatures dipped to 23^0F at KES, with even colder temperatures experienced at other sites including the LKL area. Barley in experimental plots at KES made it through this frost with little or no visible injury. However, plants at the LKL site, which were from 2 to 4 in high, were frozen back to the ground. These plants appeared to recover, but in general the barley at this site yielded less than in other years. This early frost, along with cool temperatures later, drastically reduced yields in some production fields in the LKL area.

Infections of BSR increase water loss and decrease the amount of photosynthate available for grain filling, resulting in reductions in the number and weight of kernels. This reduction is more severe with early infections. In 2000, BSR breakouts followed a cool, wet period around July 4. The barley in research plots at KES, which was planted April 25, was past the labeled treatment stage (prior to 50 percent heading) for Folicur® (tebuconazole, Bayer) by the time infection was observed. However, later planted barley, as was the case with LKL sites, was treatable after this BSR outbreak. Many producers applied Folicur with fairly good results. In some untreated fields, secondary fungal diseases attacked BSR weakened plants, resulting in further yield reductions.

Procedures

KES

The OSU Statewide and Western Regional trials were conducted on a Poe fine sandy loam soil in a 3-year rotation immediately following potatoes. All trials were arranged in a randomized block design. The OSU Statewide Trial included three replications while the Western Regional Trial included four replications. Seed was planted at a 1-in depth at 30 seeds/ft^2 with a Kincaid (Kincaid Equipment Manufacturing) plot planter on April 25. Plots were 4.5 ft wide (9 rows at 6-in spacing) and 20 ft long. Along ends of plots, 5.5-ft-wide borders were shredded, resulting in 14.5- by 4.5-ft harvest areas.

All plots were fertilized with 50 lb N, 63 lb P_2O_5, and 41 lb S/acre banded at planting (16-20-0-13 at 310 lb/acre) and 50 lb N and 57 lb S/acre broadcast preplant (21-0-0-24 at 240 lb/acre). Weeds were controlled with Buctril® (Bromoxynil, Aventis) at 0.5 lb ai/acre (1.5 pt/acre) and Rhomene® (MCPA, Aventis) at 0.5 lb ai/acre (1 pt/acre) applied with a conventional ground sprayer at the 4-leaf stage. Irrigation was applied with solid-set sprinklers arranged in a 40- by 40-ft pattern in accordance with crop needs.

During the growing season, the date to achieve 50 percent heading was noted and just prior to harvest, plant height and lodging percentages were recorded. Grain was harvested with a Hege (Hans-Ulrich Hege) plot harvester with a 4.5-ft-wide header and yields recorded on August 24 for the Statewide Trial and on August 25 for the Western Regional Trial.

At KES, test weights and plumps and thins were determined for only one replication in the Western Regional Trial. Grain from the Oregon Statewide Trial was sent to Corvallis for determination of test weight, percent protein, and kernel weight. Yield, 50 percent heading date, plant height, and lodging percent data were analyzed statistically with SAS software.

Lower Klamath Lake

The Oregon Statewide Spring Wheat Variety Trial was conducted on an Algoma silt loam soil in a continuous grain rotation. Grain was planted with a Kincaid plot planter on May 19. Seed was placed at a 1-in depth at a seeding rate of 30 seeds/ft^2. Fertilizer included 70 lb N/acre shanked in before planting as anhydrous ammonia and 50 lb N, 63 lb P_2O_5, and 41 lb S/acre banded at planting (16-20-0-13 at 310 lb/acre). Weeds were controlled with a tank mix of 2,4-D (Agriliance, LLC) and Express® (tribenuron-methyl, E.I. duPont de Nemours & Co.) applied at recommended rates. Folicur® (tebuconazole, Bayer) was applied aerially in July to control rust associated with barley in the surrounding field area.

The field was flooded during the winter to restore moisture to the soil profile and received two irrigations during the growing season with an overhead linear move system. During the growing season, the date to achieve 50 percent heading was noted and just prior to harvest, plant height and lodging percentages were recorded. Grain was harvested and yield recorded on September 20 with a Hege (Hans-Ulrich Hege) plot combine with a 4.5-ft-wide header. Samples were evaluated at Corvallis for test weight, percent protein, and kernel weight. All data were analyzed statistically using SAS software.

Results and Discussion

Oregon Statewide Trial: KES

In spite of 23 percent lodging, Bancroft was the highest yielding malt line tested (Table 1). Chinook did not significantly differ from Bancroft in yield. Both of these lines yielded over 2 ton/acre. However, Chinook exhibited a significantly higher protein level than the 13 percent desired by the malting industry. Nebula, WA9504-94, Xena, H3860224, and Baronesse were the highest yielding feed types. Yields for the two hooded lines in the test were considerably less than the top-yielding malt or feed entries. Yields of BSR-resistant lines were mixed. Orca was similar in yield to all of the highest yielding lines except for Nebula. Tango was similar in yield to Orca, but like UC960 had lower test weights.

For lines evaluated in 2000, 1999, and 1998, Xena, Baronesse, and Bancroft were among the highest producers (Table 2). WA9504-94, Steptoe, and Othello joined the above lines in the highest yielding group for average yields over the last 2 years.

Oregon Statewide Trial: LKL

In general, yields at this organic soil site have been greater than yields at the mineral KES site. However, this was not the case in 2000 trials. A 20, 6, and 26 percent yield reduction was noted at the LKL site compared to the KES site for averages across the malting, feed, and hooded lines (Table 3). The yield reduction for the LKL site trial was due to a combination of increased lodging, frost injury, and serious weed competition. Differences between sites were also noted in the top-yielding lines. B1202 was the highest yielding malting entry at the LKL site. This line produced a higher yield on the organic soil than at the mineral soil site. However, protein content of B1202 was higher than the malt standard of 13 percent. As at KES, WA9504-94, Nebula, and Baronesse were among the highest yielding feed-type selections. Jersey, Sprinter, Steptoe, Statehood, and DA587-124 were among the highest yielding entries at LKL, but not at KES. Xena and H3860224 yielded well at KES but performed less favorably at the LKL site. The yield ranking of the hooded lines varied at the two sites.

Averaged over 3 years, Baronesse, B1202, Gus, and Steptoe were grouped together as the top producers (Table 4). WA9504-94 and Baronesse produced the highest average yields for the past 2 years.

Western Regional Nursery: KES

Nineteen of the selections in this nursery were grouped together as top producers (Table 5). Nine malting, nine feed, and one hooded line were included among top- yielding selections. The highest yielding malting lines were BA2B96-5038 and ND 15422. Both of these barley varieties yielded significantly more than the malting standard, Morex. The top-yielding feed varieties, ID 93Ab688 and MTLB-30, both produced over 3.2 ton/acre. The multipurpose hooded line WPB-DA587-124 also yielded over 3.2 ton/acre.

Five of the lines evaluated in each of the last 3 years yielded an average of over 2.5 ton/acre (Table 6). These included UT 5724, Harrington, Steptoe, MT 910189, and WA 9504-94. Among lines tested the last 2 years, the highest yielding group did not include any of the top 3-year average lines. The top 2-year average yielding lines were ID 93Ab688, Baronesse, UT 4467, and WA 11825-95.

Table 1. Oregon Statewide Spring Barley Variety Trial; mineral soil site: agronomic and quality data of spring barley varieties and lines established April 25, 2000 at KES, Klamath Falls, OR.

Variety or line	Row	Use[1]	Yield	Test weight	Protein	Height	50% heading	Lodging
			lb/acre	lb/bu	%	in	Julian	%
Bancroft	2	M	7340	53.8	13.4	35	177	23
Chinook	2	M	6400	51.9	15.3	34	177	0
Harrington	2	M	5960	53.9	13.5	31	177	0
B-1202	2	M	5850	51.7	15.2	31	177	0
Garnet	2	M	5740	53.0	14.4	29	177	0
Galena	2	M	5670	52.1	14.9	28	179	0
Morex	6	M	5580	52.3	15.0	40	175	0
Mean			6080	52.7	14.5	33	177	3
Nebula	6	F	7630	51.1	13.2	30	177	0
WA9504-94	2	F	7080	53.5	14.1	30	179	0
Xena	2	F	6950	53.4	13.5	32	176	0
H3860224	2	F	6840	54.4	14.2	32	177	0
Baronesse	2	F	6710	53.3	13.5	27	177	0
Othello	2	F	6550	54.4	14.5	24	177	0
Orca	2	F	6400	53.8	14.6	33	172	0
DA587-124	2	F	6150	51.8	13.2	22	174	0
Jersey	6	F	6010	52.6	14.4	28	178	0
Steptoe	6	F	5890	49.8	12.5	30	172	0
Statehood	6	F	5760	49.4	12.9	31	174	0
Tango	6	F	5720	49.8	12.8	33	174	0
Valier	6	F	5480	53.9	13.5	31	177	0
UC 960	6	F	5280	47.4	13.7	25	173	0
Gus	6	F	4720	49.6	13.8	24	175	0
Sprinter	6	F	4550	49.7	14.5	27	181	0
Mean			6110	51.7	13.7	29	176	0
Sara-I	2	H	4920	49.2	14.6	38	173	0
Belford	2	H	4490	45.5	13.6	39	175	0
Mean			4710	47.4	14.1	39	174	0
Grand Mean			5940	51.7	14.1	31	176	1
CV (%)			10	1	4	6	1	480
LSD (.05)			980	1.1	0.9	3	1	6

[1]F denotes a feed barley variety, M denotes a malting line, and H a hooded variety.

Table 2. Three-year summary of Oregon Statewide Spring Barley Variety Trial; mineral soil site: grain yield of spring barley established at KES, Klamath Falls, OR, 1998-2000.

Variety or line	Row	Use[1]	Yield 2000	1999	1998	2-year average yield	2-year average rank	3-year average yield	3-year average rank
			lb/acre			lb/acre		lb/acre	
Xena	2	F	6950	5440	6640	6190	2	6340	1
Baronesse	2	F	6710	5950	5510	6330	1	6060	2
Bancroft	2	M	7340	4980	5460	6160	3	5930	3
Steptoe	6	F	5890	5530	5470	5710	6	5630	4
Chinook	2	M	6400	4740	5700	5570	7	5610	5
Othello	2	F	6550	4890	4820	5720	5	5420	6
Tango	6	F	5720	5060	5500	5390	8	5420	7
Orca	2	F	6400	4070	5770	5240	10	5410	8
B1202	2	M	5850	4700	5180	5280	9	5240	9
Galena	2	M	5670	4740	5160	5210	11	5190	10
Gus	6	F	4720	3810	4000	4270	12	4180	11
WA9504-94	2	F	7080	4800		5940	4		
Nebula	6	F	7630						
H3860224	2	F	6840						
DA587-124	2	F	6150						
Jersey	6	F	6010						
Harrington	2	M	5960						
Statehood	6	F	5760						
Garnet	2	M	5740						
Morex	6	M	5580						
Valier	6	F	5480						
UC 960	6	F	5280						
Sara I	2	H	4920						
Sprinter	6	F	4550						
Belford	2	H	4490						
Mean			5990	4890	5380	5580		5490	
CV (%)			10	11	10	8		7	
LSD (.05)			980	940	920	740		620	

[1]F denotes a feed barley variety, M denotes a malting line, and H a hooded variety.

Table 3. Oregon Statewide Spring Barley Variety Trial; organic soil site: agronomic and quality data of spring barley established May 19, 2000, at Klamath County, OR.

Variety or line	Row	Use[1]	Yield	Test weight	Protein	Height	50% heading	Lodging
			lb/acre	lb/bu	%	in	Julian	%
B1202	2	M	6280	52.0	15.3	30	204	25
Bancroft	2	M	5090	54.3	13.9	30	201	10
Galena	2	M	4960	54.5	15.4	33	201	12
Harrington	2	M	4750	52.7	15.4	33	199	22
Chinook	2	M	4290	52.2	15.3	32	203	30
Garnet	2	M	3830	52.1	14.9	30	203	17
Mean			4870	53.0	15.0	31	202	19
Jersey	6	F	6980	49.1	14.4	41	200	13
WA9504-94	2	F	6950	53.3	14.2	30	204	12
Sprinter	6	F	6880	52.9	14.2	32	201	3
Steptoe	6	F	6460	50.4	12.2	35	196	38
Nebula	6	F	6420	53.1	12.8	31	199	0
Statehood	6	F	6310	49.7	11.5	30	196	22
Baronesse	2	F	6280	54.0	15.0	29	203	8
DA587-124	2	F	6250	50.9	12.7	26	199	13
Othello	2	F	5700	45.8	13.8	41	199	80
Tango	6	F	5540	49.0	13.6	28	197	12
Xena	2	F	5460	53.9	13.6	32	200	23
Orca	2	F	4850	51.9	12.8	28	201	7
UC960	6	F	4720	50.3	14.0	27	202	18
H3860224	2	F	4570	51.0	13.1	30	199	2
Valier	6	F	4390	54.0	15.7	32	203	7
Gus	6	F	4300	54.2	12.8	30	203	12
Mean			5750	51.5	13.5	31	200	17
Belford	2	H	4530	51.2	15.8	33	203	35
SaraI	2	H	2410	51.4	13.8	34	199	8
Mean			3470	51.3	14.8	33	201	22
Grand Mean			5340	51.8	14.0	31	201	18
CV (%)			13	3	3	7	1	65
LSD (.05)			1120	2.4	0.6	9	2	19

[1]F denotes a feed barley variety, M denotes a malting line, and H a hooded variety.

Table 4. Three-year summary of Oregon Statewide Spring Barley Variety Trial; organic soil site: grain yield of spring barley established at Klamath County, OR, 1997, 1999, and 2000

			Yield			2-year average		3-year average	
Variety or line	Row	Use[1]	2000	1999	1997	yield	rank	yield	rank
			lb/acre			lb/acre		lb/acre	
Baronesse	2	F	6280	6280	6270	6280	2	6280	1
B1202	2	M	6280	5750	6370	6020	3	6130	2
Gus	6	F	4300	6640	7310	5470	8	6080	3
Steptoe	6	F	6460	5320	5500	5890	5	5760	4
Bancroft	2	M	5090	4760	5810	4920	11	5220	5
Chinook	2	M	4290	4890	5710	4590	12	4960	6
WA9504-94	2	F	6950	6750		6850	1		
Othello	2	F	5700	6290		6000	4		
Galena	2	M	4960	6480		5720	6		
Xena	2	F	5460	5700		5580	7		
Orca	2	F	4850	6000		5420	9		
Tango	6	F	5540	4330		4930	10		
Jersey	6	F	6980						
Sprinter	6	F	6880						
Nebula	6	F	6420						
Statehood	6	F	6310						
DA587-124	2	F	6250						
Harrington	2	M	4750						
UC960	6	F	4720						
H3860224	2	F	4570						
Belford	2	H	4530						
Valier	6	F	4390						
Garnet	2	M	3830						
SaraI	2	H	2410						
Mean			5340	5770	6160	5640		5740	
CV (%)			13	9	9	6		5	
LSD (.05)			1120	910	980	590		520	

[1]F denotes a feed barley variety, M denotes a malting line, and H a hooded variety.

Table 5. Western Regional Spring Barley Nursery: agronomic data for spring barley lines established April 24, 2000, at KES, Klamath Falls, OR.

Variety or line	Use[1]	Row	Yield	Test weight	% above sieve 6/64	5.5/6	pan	Height	50% heading	Lodging
			lb/acre	lb/bu	%			in	Julian	%
BA2B96-5038	M	2	6450	55.5	98	1	0	31	178	0
ND 15422	M	6	6340	54.0	96	3	1	34	175	0
SK-CDC Bold	M	2	6320	54.0	92	5	3	31	177	0
WA 11832-95	M	2	6310	55.0	96	3	1	31	177	0
ID 93Ab859	M	2	6140	56.5	98	1	1	34	179	0
WA 11825-95	M	2	6060	55.0	97	2	1	30	177	0
Harrington	M	2	6020	54.5	92	5	3	33	179	0
BA6B95-2482	M	6	5780	53.0	92	5	3	37	174	0
MT 910189	M	2	5720	55.5	96	3	1	30	177	0
SK TR150	M	2	5690	54.0	97	2	1	35	179	0
Stander	M	6	5610	54.1	96	3	1	37	175	0
2ND 17274	M	2	5490	55.0	98	2	1	34	173	0
OR 2967102	M	2	5440	56.5	98	2	0	25	179	0
BA6B93-2978	M	6	5410	53.0	96	3	1	39	176	0
Morex	M	6	5350	53.5	95	4	2	40	175	0
WA 11801-95	M	2	5330	55.0	97	2	1	33	179	0
BA6B94-8253	M	6	5210	54.0	96	3	1	36	177	0
BA2B96-5119	M	2	5170	56.8	98	2	1	33	177	0
SK-TR346	M	2	4870	54.5	95	4	2	31	178	0
Mean			5730	54.7	96	3	1	34	177	0
ID 93Ab688	F	6	6670	54.0	92	5	4	38	174	0
MTLB-30	F	6	6660	56.0	98	2	0	34	177	0
Baronesse	F	2	6350	56.0	94	4	2	30	177	0
UT 4467	F	2	6320	53.0	89	7	4	32	172	0
MTLB-05	F	6	6240	55.0	97	2	1	33	177	0
Steptoe	F	6	6000	53.0	95	3	1	32	174	0
WA 9504-94	F	6	5810	54.5	93	5	2	29	181	0
Tango	F	6	5790	52.0	97	2	1	33	174	0
UT 3757	F	6	5730	51.8	91	6	3	31	173	0
UT 5724	F	6	5690	52.0	92	5	3	30	172	0
ND 15477	F	6	5560	55.0	96	3	1	33	175	0
PB1-95-2R-517	F	2	5530	56.0	97	2	1	31	177	0
UT 5742	F	6	5260	52.0	94	4	2	29	171	0
PB1-97-2R-7090	F	2	4890	55.0	95	4	2	33	180	0
PB1-95-2R-A629	F	2	4770	54.0	97	2	1	29	177	0
Mean			5820	54.0	94	4	2	32	175	0
WPB-DA587-124	H	6	6430	54.4	95	3	1	23	175	0
WPB-BZ594-35	H	2	3750	56.0	76	16	8	27	177	0
Mean			5090	55.2	86	10	5	25	176	0
Grand Mean			5730	54.4	95	4	2	32	176	0
CV (%)			12	--	--	--	--	8	1	0
LSD (.05)			970	--	--	--	--	4	1	0

[1]F denotes a feed barley variety, M denotes a malting line, and H a hooded variety.

Table 6. Western Regional Spring Barley Nursery: grain yield of spring barley lines planted at KES, Klamath Falls, OR, 1998-2000.

Variety or line	Use[1]	Row	Yield 2000	Yield 1999	Yield 1998	2-year average yield	2-year average rank	3-year average yield	3-year average rank
			lb/acre	lb/acre	lb/acre	lb/acre		lb/acre	
UT 5724	F	6	5690	5490	5430	5590	8	5530	1
Harrington	M	2	6020	4690	5550	5360	10	5420	2
Steptoe	F	6	6000	5270	4240	5640	7	5170	3
MT 910189	M	2	5720	4690	5040	5200	13	5150	4
WA 9504-94	F	6	5810	4380	5190	5100	14	5130	5
Stander	M	6	5610	4450	4540	5030	18	4870	6
Morex	M	6	5350	4470	4530	4910	20	4780	7
BA6B93-2978	M	6	5410	4680	4220	5040	17	4770	8
ID 93Ab688	F	6	6670	5660		6170	1		
Baronesse	F	2	6350	5430		5890	2		
UT 4467	F	2	6320	5230		5770	3		
WA 11825-95	M	2	6060	5460		5760	4		
MTLB-05	F	6	6240	5070		5650	5		
MTLB-30	F	6	6660	4650		5650	6		
ID 93Ab859	M	2	6140	4590		5370	9		
PB1-95-2R-517	F	2	5530	5030		5280	11		
UT 3757	F	6	5730	4830		5280	12		
SK TR150	M	2	5690	4420		5060	15		
ND 15477	F	6	5560	4550		5050	16		
UT 5742	F	6	5260	4620		4940	19		
BA6B94-8253	M	6	5210	4310		4760	21		
PB1-95-2R-A629	F	2	4770	4660		4720	22		
OR 2967102	M	2	5440	3960		4700	23		
WPB-BZ594-35	H	2	3750	3820		3780	24		
BA2B96-5038	M	2	6450						
WPB-DA587-124	H	6	6430						
ND 15422	M	6	6340						
SK-CDC Bold	M	2	6320						
WA 11832-95	M	2	6310						
Tango	F	6	5790						
BA6B95-2482	M	6	5780						
2ND 17274	M	2	5490						
WA 11801-95	M	2	5330						
BA2B96-5119	M	2	5170						
PB1-97-2R-7090	F	2	4890						
SK-TR346	M	2	4870						
Mean			5730	4770	4840	5240		5100	
CV (%)			12	8	14	7		7	
LSD (.05)			970	560	1030	480		520	

[1]F denotes a feed barley variety, M denotes a malting line, and H a hooded variety.

Oat Variety Screening in the Klamath Basin

Donald R. Clark, Jim E. Smith, and Greg Chilcote[1]

Abstract

The Klamath Experiment Station (KES) has participated in the Uniform Northwest Oat Nursery screening program since the 1970's. Commercial varieties used locally and identified through this program include Cayuse, Border, Appaloosa, and Ajay. The 2000 trial at KES evaluated 17 numbered selections and 10 named varieties. Under 2000 growing-season conditions with frequent hard spring frosts, including a major cold snap early in the spring, and a warmer than usual summer, yields of oats were higher than yields of either wheat or barley in 2000 KES trials. Fifteen numbered selections and named varieties did not significantly differ in grain yields. The selection 90Ab1322 produced the highest yield in 2000 and the highest 2- and 3-year average yields. This selection yielded significantly higher over 3 years than all named varieties except Ajay. The Aberdeen breeding lines 91Ab406 and 87Ab4983 also produced consistently high yields over 3 years. Among selections evaluated for the first time, 95Ab10845 and 94Ab5543 produced high yields and test weights.

Introduction

Oats are grown for both hay and grain in the Klamath Basin. In 2000, oats accounted for over 5,100 acres out of 57,000 acres of grain grown within the Klamath Irrigation Project. This is a slight reduction from 1999, with 5,300 acres of oats out of 61,000 acres of grain. Oats account for over 10 percent of the approximate100,000 cereal acres in the region. Oat acreage has increased in the past few years because of concern about stripe rust in spring barley crops and low potato prices. Efforts to identify superior new oat varieties are coordinated with other research personnel at 10 western region locations.

Procedures

The Uniform Northwest Oat Nursery was planted in a Poe fine sandy loam soil at KES on April 24, 2000. Previous crops at the site were annual ryegrass and potatoes. Twenty-seven entries were arranged in a randomized complete block experimental design with four replications. Seed was planted at a 1-in depth with a seeding rate of 110 lb/acre using a Kincaid (Kincaid Equipment Manufacturing) experimental plot planter. Plots were 4.5 ft wide and 20 ft long. All plots were fertilized with 50 lb N, 62.5 lb P_2O_5, and 41 lb S/acre banded at planting (16-20-0-13 at 310 lb/acre); and 50 lb N and 57 lb S/acre broadcast preplant (21-0-0-24 at 240 lb/acre). Weeds were controlled with Buctril® (Bromoxynil, Aventis) at 0.5-lb ai/acre (1.5 pt/acre) and Rhomene® (MCPA, Aventis) at 0.5 lb ai/acre (1 pt/acre), applied with a conventional ground sprayer at the 4-leaf stage. Irrigation was applied with solid-set sprinklers arranged in a 40- by 40-ft pattern

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in accordance with crop needs. Grain was harvested on August 29 with a Hege (Hans-Ulrich Hege) plot harvester with a 4.5-ft-wide header. Grain yield was recorded for all plots. Test weight was measured for only one replication. Yield data were analyzed statistically using SAS software. Least significant differences (LSD) are based on student's *t* at the 5 percent probability level. Yield data over multiple years were analyzed using a split-plot design with year as the main plot and entry as the split-plot.

Results and Discussion

In spite of frequent hard frosts in May and early June, yields and test weights were high (Table 1). The trial average was about 3 ton/acre with mean test weights of 40 lb/bu. These results represent a marked improvement over the 1998 trial, where average yield was 1.5 ton/acre with test weights averaging 30 lb/bu (Table 2). The 2000 crop also showed a slight improvement over 1999 results.

In 2000, the numbered selection 90Ab1322 produced the highest yield at 7,530 lb/acre. This selection also produced the highest yield for 2-year and 3-year averages (Table 2). Several other selections from the Aberdeen, Idaho breeding program performed well in 2000 and in previous years. Ajay was among the highest yielding selections in 2000 and 1999 and was the highest yielding entry in 1998. Cayuse, Monida, Otana, and Derby produced significantly lower yields than Ajay and several numbered selections in 3-year averages. Because variety performance has been inconsistent over years, multi-year data are needed to identify superior selections under Klamath Basin conditions. The 3-year summary suggests 91Ab406, 87Ab4983, and 90Ab14322 may be more consistent in yield than many named varieties and numbered selections. These lines and Ajay appear to be well suited for the Klamath Basin.

Table 1. Northwestern Uniform Oat Nursery grain yield, test weight, lodging, and plant height of varieties or lines established on April 25, 2000, at KES, Klamath Falls, OR.

Variety or line	Yield	Test weight	Lodging	Height	50% heading
	lb/acre	lb/bu	%	in	Julian
90Ab1322	7530	40.0	0	35	180
95Ab10854	7070	44.0	0	40	181
87Ab5125	7060	41.0	0	39	181
87Ab4983	7040	41.0	0	35	176
84Ab825	7020	41.0	0	37	181
91Ab406	7010	39.0	21	38	180
94Ab5543	6940	40.0	9	42	181
Ajay	6490	41.0	0	32	180
ND 930122	6480	42.5	4	38	178
Rio Grande	6400	41.0	0	40	178
87Ab5632	6350	41.0	0	44	180
Whitestone	6150	39.0	3	43	181
AbSP 9-2	6140	43.0	0	45	180
Cayuse	6130	39.0	4	42	179
AbSP 19-9	6110	42.0	3	43	181
91Ab502	6070	42.0	0	35	175
90Ab1620	5840	42.0	9	38	181
89Ab4088	5800	43.0	0	42	178
95Ab12584	5790	41.0	0	37	177
Powell	5480	38.0	0	37	181
Celsia	5350	39.0	0	47	181
95Ab11633	5320	43.0	0	41	182
SA 97388 (OT381)	4930	39.0	0	44	177
CDC Pacer	4830	39.5	5	48	181
Monida	4440	36.0	14	45	181
Derby	3800	36.0	13	52	181
Otana	3420	39.0	0	51	181
Mean	5960	40.4	3	41	180
CV (%)	17	--	326	7	1
LSD (.05)	1420	--	NS	4	1

Table 2. Three-year summary of Northwestern Uniform Oat Nursery: grain yield of varieties and lines established at KES, Klamath Falls, OR, 1998-2000.

Variety or line	Yield 2000	Yield 1999	Yield 1998	2-year average yield	2-year average rank	3-year average yield	3-year average rank
	lb/acre	lb/acre	lb/acre	lb/acre		lb/acre	
90Ab1322	7530	5820	4320	6670	1	5890	1
Ajay	6490	5730	4980	6110	8	5730	2
91Ab406	7010	5980	3990	6490	2	5660	3
87Ab4983	7040	5810	4070	6420	3	5640	4
84Ab825	7020	5360	3940	6190	5	5440	5
87Ab5125	7060	4980	3970	6020	9	5340	6
ND 930122	6480	5880	3540	6180	6	5300	7
Whitestone	6150	5880	3520	6020	10	5180	8
Rio Grande	6400	5590	3550	6000	11	5180	9
AbSP 19-9	6110	5880	3300	6000	12	5100	10
91Ab502	6070	5200	3830	5630	16	5030	11
AbSP 9-2	6140	5750	3080	5940	13	4990	12
Powell	5480	5860	3620	5670	15	4980	13
Cayuse	6130	5750	2950	5940	14	4940	14
89Ab4088	5800	5160	3170	5480	18	4710	15
Celsia	5350	5870	2680	5610	17	4630	16
Monida	4440	5700	3050	5070	20	4400	17
CDC Pacer	4830	5600	2610	5210	19	4350	18
Otana	3420	5040	2250	4230	21	3570	19
Derby	3800	4590	2260	4200	22	3550	20
94Ab5543	6940	5890		6420	4		
87Ab5632	6350	5950		6150	7		
95Ab10854	7070						
90Ab1620	5840						
95Ab12584	5790						
95Ab11633	5320						
SA 97388 (OT381)	4930						
Mean	5960	5600	3430	5800		4980	
CV (%)	17	8	16	10		9	
LSD (.05)	1430	670	800	810		640	

Spring Wheat Variety Screening in the Klamath Basin

Donald R. Clark, Jim E. Smith, and Greg Chilcote[1]

Abstract

Spring wheat breeding lines from the Oregon State University (OSU) and other regional breeding programs are evaluated annually in mineral soils at the Klamath Experiment Station (KES). The Oregon Statewide spring wheat screening trials are also evaluated at an organic soil site in the Lower Klamath Lake (LKL) area. Entries evaluated in 2000 included hard red (HR), soft white (SW), hard white (HW), and triticale (Trit) classes. In mineral soil at KES, SW varieties produced higher yields than other classes. Pomerelle and Treasure produced the highest yield of named varieties at 7,410 and 7,400 lb/acre, respectively. High-producing numbered selections included 4950006 (7,880 lb/acre), SDM 50043 (7,830 lb/acre), IDO 540 (7,570 lb/acre), and IDO 526 (7,010 lb/acre). In the organic soil, ML 037A(5-2) (7,130 lb/acre) and Pomerelle (7,080 lb/acre) were the highest yielding selections.

The results for the HR spring wheat lines in the mineral soil showed that the varieties Iona (5,990 lb/acre), McKay (5,920 lb/acre), and Hank (5,860 lb/acre) were the highest yielding. Superior numbered lines in the Western Regional trial were N96-0060 (6,810 lb/acre) and SDM 50040 (6,550 lb/acre). At the KES OSU Elite Nursery top yielders included 4990113 (5,970 lb/acre) and 4990118 (5,940 lb/acre). In the organic soil, Hank (6,510 lb/acre), Zak (6,480 lb/acre), and OR4970039 (6,260 lb/acre) produced high yields.

Winsome was the best HW named variety grown in both the mineral (7,490 lb/acre) and organic soils (7,250 lb/acre). In statewide and regional trials, the highest yielding HW lines were from Idaho. At KES, IDO 533, IDO 560, and IDO 552 yielded 7,480, 7,450, and 6,950 lb/acre, respectively. In the organic soil, IDO 377S looked promising, yielding 6,900 lb/acre.

Introduction

Wheat producers in the Klamath Basin have seen spring frosts at the critical pollination stage totally destroy winter wheat. Although these spring and early fall frosts can affect spring wheat production, it is less likely that total crop loss will occur. In the 2000 growing season, 13,500 acres of spring wheat was produced within the Klamath Irrigation Project. This was less than the 1999 acreage by almost 25 percent. Much of this decline could be attributed to late August frosts in 1999 that resulted in yield and quality losses. Farmers responded to these losses by reducing their 2000 acreage, in contrast to recent trends where increases in wheat acreage at the expense of barley acreage were noted. The longer-term trend for increased wheat production can be attributed to more favorable prices, government subsidies, and the occurrence of barley stripe rust.

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Hard red spring wheat accounts for about 70-80 percent of wheat produced in the Klamath Basin, with the rest mainly being soft white varieties. With the extra fertilizer input necessary to produce high-protein HR wheat, the percentage of SW varieties may increase in future plantings. For HR production, Yecora Rojo and Westbred 936 are the most popular varieties. Alpowa was the most popular SW variety seeded in 2000.

In the 2000 growing season, frosts occurred 12 times between trial planting and harvest. A frost on May 31 fell to 24^0F at KES. Temperatures were even lower at the LKL site. The LKL wheat was about 4 in tall at this time. Like much of the wheat and barley in the area, plants were frozen back to ground level. In addition to stresses from the cold temperatures, a low incidence of wheat stem maggot occurred at KES, with a limited number of heads dying back and not reaching maturity.

Spring wheat screening trials conducted at KES in 2000 included OSU Elite Nurseries for HR, SW, and HW selections; a Western Regional Nursery Trial including all classes; and an Oregon Statewide Trial including all classes plus triticale. The Statewide Trial was also planted at an LKL organic soil site.

Procedures

KES

All spring wheat-screening trials were conducted on a Poe fine sandy loam soil in a 3-year rotation immediately following potatoes. All trials were arranged in a randomized block design. The OSU HR, SW, and HW trials included four replications while the Statewide and Western Regional trials included three replications. Seed was planted at a 1-in depth at 30 seeds/ft^2 with a Kincaid (Kincaid Equipment Manufacturing) plot planter on April 25. Plots were 4.5 ft wide (9 rows at 6-in spacing) and 20 ft long. At ends of plots, 5.5-ft borders were shredded, resulting in 14.5- by 4.5-ft harvest areas.

All plots were fertilized with 50 lb N, 63 lb P_2O_5, and 41 lb S/acre banded at planting (16-20-0-13 at 310 lb/acre) and 50 lb N and 57 lb S/acre broadcast preplant (21-0-0-24 at 240 lb/acre). Weeds were controlled with Buctril® (Bromoxynil, Aventis) at 0.5 lb ai/acre (1.5 pt/acre) and Rhomene® (MCPA, Aventis) at 0.5 lb ai/acre (1 pt/acre), applied with a conventional ground sprayer at the 4-leaf stage. Irrigation was applied with solid-set sprinklers arranged in a 40- by 40-ft pattern in accordance with crop needs.

During the growing season, the date to achieve 50 percent heading was noted and just prior to harvest, plant height and lodging percentages were recorded. Grain was harvested and yields recorded on August 24 for the Statewide trial, August 28 for the OSU HW and HR trials, and on August 29 for the OSU SW and the Western Regional trials with a Hege (Hans-Ulrich Hege) plot harvester with a 4.5-ft-wide header.

At KES, test weights were determined for only one replication in the OSU Elite Nurseries and Western Regional Trial. Grain from the Oregon Statewide Trial was sent to Corvallis for determination of test weight, percent protein, and kernel weight. Yield, 50 percent heading date, plant height, and lodging percent data were analyzed statistically with SAS software.

Lower Klamath Lake

The Oregon Statewide Spring Wheat Variety Trial was conducted on an Algoma silt loam soil in a continuous grain rotation. Grain was planted with a Kincaid plot planter on May 19. Seed was placed at 1-in depth at a seeding rate of 30 seeds/ft^2. Fertilizer included 70 lb N/acre shanked in before planting as anhydrous ammonia and 50 lb N, 63 lb P_2O_5, and 41 lb S/acre banded at planting (16-20-0-13 at 310 lb/acre). Weeds were controlled with a tank mix of 2,4-D (Agriliance, LLC) and Express ® (tribenuron-methyl, E.I. duPont de Nemours & Co.) applied at recommended rates. Folicur® (tebuconazole, Bayer) was applied aerially in July to control rust associated with the barley in the surrounding field area.

The field was flooded during the winter to restore moisture to the soil profile and received two irrigations during the growing season with an overhead linear move system. During the growing season, the date to achieve 50 percent heading was noted and just prior to harvest, plant height and lodging percentages were recorded. Grain was harvested and yield recorded on September 20 with a Hege (Hans-Ulrich Hege) plot combine with a 4.5-ft-wide header. Samples were evaluated at Corvallis for test weight, percent protein, and kernel weight. All data were analyzed statistically using SAS software.

Results and Discussion

OSU Spring Wheat Elite Nurseries

Five standard varieties and 16 numbered selections were included in the 2000 SW nursery. Five selections yielded over 3.5 ton/acre and did not significantly differ from the highest yielding line, 4950006 (Table 1). Ten selections were included in the previous 2 years of testing. The 3-year average yield for these 10 indicated that 4950006 was the highest producing line and 4950006 was next, significantly out-yielding the other lines (Table 2). All 2000 entries were also tested in the 1999 SW trial. Averaged over 2 years, yield of 4950006 was significantly higher than all other selections except Pomerelle.

The HR nursery included 3 standard varieties, the HW standard Klasic, and 28 numbered HR selections (Table 3). Mean yields for the HR entries were more than 0.5 ton/acre below mean yields in the SW trial. Only five SW entries numerically yielded less than the top yielding HR line. Among HR selections, 14 lines did not differ from the highest yielding entry, 4990113. These 14 lines included the standards, McKay, Westbred 936, and the HW Klasic. Numerically, the locally common variety, Yecora Rojo, produced the lowest yield, but did not significantly differ in yield from 15 other varieties. Considering lines that had been tested the previous 2 years, 4870410 and 3900362 were not different than the top 3-year average yielding line, McKay (Table 4). For these 3-year averages, Klasic was not different from the second highest yielding line 4870410, while Yecora Rojo was not different from the third highest yielding line 3900362. Among lines tested at least 2 years, 4870410 did not differ from the top 2-year-average yielding line, McKay. In addition, 4970074 and 3900362 yields were not different from 4870410, the second highest 2-year-average yielding line.

The 2000 HW nursery included Winsome and 29 numbered selections. Mean yields were similar to mean yields in the HR trial. The top 10 yielding lines in 2000, led by Winsome, did not significantly differ from each other. The top yielding numbered lines were 4910006 and 4990032 (Table 5). For lines tested in both of the previous years, six did not different from 4910006, the highest yielding entry over 3 years (Table 6). Winsome, 4910006, and 942834 were among the top in 2-year-average yields, while 8 selections were not different from the top line, 4910006.

Western Regional Spring Wheat Nursery

The 2000 Western Regional Trial included 15 HR, 7 HW, and 17 SW selections. Mean yields were higher by about 700 lb/acre for SW and HW entries compared with HR entries (Table 7). Four SW (SDM 50043, IDO 540, WA 7883, IDO 560) and two HW (IDO 541, and IDO 552) selections were the highest producing lines in the 2000 trial. The highest producing HR line, N96-0060, was not different in yield from the six previously mentioned lines, except for SDM 50043. CA1162 (HW) and OR942845 (SW) were the top producers among selections evaluated in 1998, 1999, and 2000 (Table 8). Although not quite as productive as CA1162, 7 lines exhibited 3-year-average yields similar to OR942845. OR4920002 was in this group and was the highest yielding HR line. IDO 541 and Penewawa, both SW lines, and OR4920307 (HW) produced the highest 2-year-average yields for 1999 and 2000. Six lines were similar to Penewawa in 2-year mean yields. Serra and McKay, the highest yielding HR lines, were included in this group.

Oregon Statewide Spring Wheat Trial (KES)

The 2000 Oregon Statewide Trial included 16 SW, 6 HW, 10 HR, and 2 Trit entries. Penewawa was evaluated at three seeding rates. The ranking of class mean yields from high to low was HW, Trit, SW, and HR (Table 9). Yield variability was high in this trial. A rather large difference, 1,560 lb/acre, was required for significance. Sixteen lines were not different from the highest producing line, Winsome. These lines included 4 HW, 8 SW, 2 HR, and 2 Trit selections. Numerically, the highest lines from each class were Winsome and IDO 533 (HW), Treasure and IDO 526 (SW), Iona (HR), and M94-4393 and Trical 2700 (Trit). The lowest seeding rate for Penawawa (3,990 lb/acre) yielded less than the two higher seeding rates, (5,340 and 5,950 lb/acre).

M94-4393 had higher test weights and reached 50 percent heading ahead of Trical 2700. Winsome had slightly less protein content and lower kernel weight than the other top HW variety, IDO 533. Treasure and IDO 526 were similar in all of the quality assessments within the SW class.

For 3-year-average yields, 7 selections yielded within the 750-lb/acre least significant difference from the numerically highest yielding line (Table 10). IDO 506 and Pomerelle were the highest yielding SW lines and IDO 377S and IDO 533 were the highest HW lines. No HR lines were included in these highest yielding lines. However, Jefferson's yield was not significantly less than yields for Alpowa or Wawawai.

Nine lines yielded within the least significant difference, 890 lb/acre, of the top yielding line for the 2-year yield average. Treasure and Pomerelle were the highest yielding SW lines, Winsome and IDO 533 were the highest yielding HW lines, and M94-4393 (Trit) was among these top nine lines. Scarlet was the highest yielding HR line, producing a yield similar to IDO 533.

Oregon Statewide Spring Wheat Trial (Lower Klamath Lake)

In spite of the hard frost at this site that caused extensive early plant injury, yields were only slightly below those at the mineral soil site (Table 11). The ranking for averages across wheat classes for the organic soil site did vary from the mineral soil site. For this site, the ranking from high to low yields was HW, SW, Trit, and HR. Differences in yields for the two sites in class means were 250 (HW), 210 (SW), 1,200 (Trit), and 230 (HR) lb/acre. This indicates that the early frost plus other undefined factors tended to impede triticale lines more than other classes of wheat.

Although not in every case, top-yielding selections in the organic soil also varied from those in the mineral soil. Across all wheat classes, 12 lines did not differ from the highest yielding line. Of these, Winsome (HW), Pomerelle (SW), IDO 377S (HW), Treasure (SW), IDO 560 (HW), IDO 533 (HW), and OR 4970039 (SW) were among the highest yielding group in the mineral soil trial. Those that yielded highest only in the organic soil trial were ML 037A(5-2) (SW), Chalis (SW), Hank (HR), Zak (SW), and ML 455 (HW).

Ten selections in the 2000 organic soil trial were also evaluated in 1999 and 1998 (Table 12). Eight of these were similar to Pomerelle, the highest 3-year-average yielding line. These eight included 5 SW, 2 HW, and 1 HR lines. Numerically, Pomerelle and Treasure were the highest yielding two SW lines, Winsome and IDO 377S were the highest HW lines, and Westbred 936 was the highest yielding HR variety. Over 2 years, ML 455 and IDO 533 (HW) and Zak and Scarlet (HR) also deserve attention. Penawawa tended to yield more at the higher seeding rates, which leads to questions about whether the seeding rates used in the trials were adequate to maximize grain yields.

Summary

Promising new varieties are emerging for all spring wheat classes. Data obtained in these trials over several years indicate performance differences between the KES and LKL sites. Differences in soil type that affect moisture and fertility levels, and differences in frost severity could explain some of this variable variety response.

For mineral soils, promising new SW lines include 4950006, 4850001, SDM 50043, IDO 540, and IDO 526. At the LKL site, good performance was observed for first-year entries ML 037A(5-2) and Chalis. These deserve further evaluation against the standard SW varieties Pomerelle, Alpowa, and Treasure.

Numbered HR lines for further investigation include 4990113, 4990118, 4870410, N96-0060, SDM 50040, OR4920002, and OR4880189. These should be compared with the named varieties Hank, Iona, and Scarlet.

HW numbered lines for further evaluation include 4910006, 4990032, IDO 533, IOD 377S, IDO 560, and ML 455. Winsome performed best of the named standard lines and should be used as the standard in these evaluations.

The number of triticale lines investigated should be increased. The local knowledge base for this hybrid cereal used as a grain or as forage is limited. Positive results from other areas of the country need to be confirmed under local growing conditions.

Table 1. OSU Soft White Spring Wheat Nursery: agronomic and grain quality data for spring wheat varieties and lines established on April 24, 2000, at KES, Klamath Falls, OR.

Variety or line	Yield	Test weight	Lodging	Height	50% head
	lb/acre	lb/bu	%	in	Julian
4950006	7880	63.0	0	35	177
Pomerelle	7410	63.0	0	37	180
Alpowa	7210	64.0	0	36	179
Whitebird	7050	62.0	0	35	179
4850001	7020	62.0	0	38	178
942845	6820	61.5	0	38	178
Dirkwin	6800	59.0	0	36	178
4970039	6650	62.0	0	36	179
4950027	6500	63.0	0	40	178
9640085	6490	63.0	0	38	178
Penawawa	6490	61.0	0	39	181
942838	6240	61.5	0	36	178
4970062	6140	64.0	0	39	179
WA 7831	6090	63.0	0	38	177
4970063	6030	61.5	0	39	178
4970001	5970	58.5	0	34	177
4880013	5850	61.0	0	39	181
9640078	5840	61.0	0	36	178
942885	5790	62.5	0	37	177
942889	5640	62.5	0	39	178
9640089	4840	61.0	0	36	177
Mean	6420	61.7	0	37	178
CV (%)	11	--	0	4	1
LSD (.05)	990	--	0	2	1

Table 2. OSU Soft White Spring Wheat Elite Nursery at KES: 3-year yield summary, 1998-2000.

Variety or line	Yield 2000	Yield 1999	Yield 1998	2-year average yield	2-year average rank	3-year average yield	3-year average rank
	lb/acre			lb/acre		lb/acre	
4950006	7880	6930	5930	7400	1	6910	1
4850001	7020	5640	6300	6330	4	6320	2
4950027	6500	5750	5210	6130	8	5820	3
942845	6820	5690	4930	6250	5	5810	4
Dirkwin	6800	5490	4900	6140	7	5730	5
4880013	5850	5510	5550	5680	14	5640	6
942838	6240	5640	4750	5940	11	5540	7
942889	5640	5440	5150	5540	17	5410	8
WA 7831	6090	5490	4320	5790	12	5300	9
942885	5790	5030	4940	5410	19	5250	10
Pomerelle	7410	6680		7040	2		
Alpowa	7210	5910		6560	3		
Whitebird	7050	5280		6170	6		
Penewawa	6490	5720		6110	9		
9640085	6490	5500		6000	10		
4970001	5970	5580		5780	13		
4970062	6140	5090		5620	15		
4970039	6650	4490		5570	16		
9640078	5840	5180		5510	18		
4970063	6030	4800		5410	19		
9640089	4840	4950		4890	20		
Mean	6420	5510	5200	5970		5770	
CV (%)	11	5	8	6		5	
LSD (.05)	990	410	620	550		430	

Table 3. OSU Hard Red Spring Wheat Nursery: agronomic and grain quality data for spring wheat varieties and lines established April 24, 2000, at KES, Klamath Falls, OR.

Variety or line	Yield	Test weight	Lodging	Height	50% head
	lb/acre	lb/bu	%	in	Julian
4990113	5970	64.0	0	32	177
4990118	5940	62.5	0	32	180
McKay	5920	62.0	0	35	177
4870410	5720	63.5	0	36	177
4970074	5640	62.5	0	35	177
4990094	5540	64.0	0	29	176
4990106	5540	66.0	0	33	176
4990098	5450	65.0	0	29	176
4990128	5400	63.0	0	31	178
4990126	5370	62.0	0	34	177
3900362	5350	64.0	0	29	175
Westbred 936	5340	63.0	0	31	175
4990112	5260	66.0	0	32	177
Klasic	5260	65.5	0	24	173
4970003	5230	65.0	0	32	177
4990099	5190	64.0	0	30	177
4990117	5060	66.0	0	31	177
4880189	5050	63.5	0	30	175
4990095	5050	63.0	0	31	176
4895011	5040	64.0	0	32	176
4990123	5010	65.0	0	23	173
4990114	4870	66.0	0	31	178
4990103	4850	62.0	0	31	175
4990115	4840	65.0	0	33	178
4990122	4830	63.0	0	31	175
4990120	4780	63.0	0	28	175
4990101	4770	62.0	0	30	179
4990110	4750	66.0	0	33	177
4990119	4660	60.0	0	26	175
4990111	4660	65.0	0	32	176
WA 7824	4630	63.0	0	33	173
Yecora Rojo	4450	64.0	0	24	172
Mean	5210	64	0	31	176
CV (%)	10	--	0	5	1
LSD (.05)	710	--	0	2	2

Table 4. OSU Hard Red Spring Wheat Elite Nursery at KES: 3-year yield summary, 1998-2000.

Variety or line	Yield 2000	Yield 1999	Yield 1998	2-year average yield	2-year average rank	3-year average yield	3-year average rank
	lb/acre			lb/acre		lb/acre	
McKay	5920	5850	5830	5880	1	5870	1
4870410	5720	5670	5360	5700	2	5590	2
3900362	5350	4870	5410	5110	4	5210	3
4880189	5050	4460	4580	4760	8	4700	4
Klasic	5260	4640	3890	4950	6	4600	5
Yecora Rojo	4450	4370	4310	4410	10	4370	6
4970074	5640	4600		5120	3		
4895011	5040	4920		4980	5		
WPB 936	5340	4490		4920	7		
4970003	5230	4140		4690	9		
4990113	5970						
4990118	5940						
4990094	5540						
4990106	5540						
4990098	5450						
4990128	5400						
4990126	5370						
4990112	5260						
4990099	5190						
4990117	5060						
4990095	5050						
4990123	5010						
4990114	4870						
4990103	4850						
4990115	4840						
4990122	4830						
4990120	4780						
4990101	4770						
4990110	4750						
4990111	4660						
4990119	4660						
WA 7824	4630						
Mean	5170	4800	4900	4780		4920	
CV (%)	10	8	22	10		14	
LSD (.05)	710	540	NS	710		1070	

Table 5. OSU Hard White Spring Wheat Nursery: agronomic and grain quality data for spring wheat varieties and lines established April 24, 2000, at KES, Klamath Falls, OR.

Variety or line	Yield	Test weight	Lodging	Height	50% heading
	lb/acre	lb/bu	%	in	Julian
Winsome	6140	63.5	0	31	177
4910006	6060	63.0	0	33	172
4990032	6020	64.0	0	33	175
4970044	5840	64.0	0	33	175
942834	5730	65.0	0	34	177
4990021	5730	65.0	0	29	175
4920307	5530	63.0	0	32	175
4990030	5480	64.0	0	27	175
4920311	5420	64.0	0	32	173
4990025	5320	64.0	0	29	175
942505	5260	63.0	0	35	176
4940139	5170	64.0	0	32	175
4990039	5130	63.5	0	31	175
4990033	5110	61.0	0	26	175
4990028	5020	65.0	0	29	175
4990038	4990	63.0	0	30	175
4990040	4970	65.0	0	30	175
4990041	4890	63.5	0	31	175
9640151	4890	64.0	0	32	173
4970025	4880	63.5	0	34	175
9640081	4870	65.0	0	33	177
4990037	4860	63.0	0	29	175
4990014	4800	64.0	0	31	175
4990009	4800	65.0	0	32	175
4870255	4790	66.0	0	32	175
4990034	4710	65.0	0	27	175
4970018	4600	66.0	0	34	175
9640074	4560	64.0	0	32	175
4930230	4370	66.0	0	36	180
3940124	3970	64.5	0	29	175
Mean	5130	64.1	0	31	175
CV (%)	850	--	0	6	0.3
LSD (.05)	12	--	0	3	0.8

Table 6. OSU Hard White Spring Wheat Elite Nursery at KES: 3-year yield summary, 1998-2000.

Variety or line	Yield 2000	Yield 1999	Yield 1998	2-year average yield	2-year average rank	3-year average yield	3-year average rank
		lb/acre		lb/acre		lb/acre	
4910006	6060	5360	4110	5710	1	5180	1
942834	5730	5590	3380	5660	3	4900	2
4940139	5170	5210	4230	5190	8	4870	3
942505	5260	5580	3690	5420	4	4840	4
Winsome	6140	5200	2830	5670	2	4720	5
9640151	4890	4790	4250	4840	12	4640	6
4920307	5530	4950	2920	5240	7	4470	7
9640081	4870	4850	3350	4860	11	4360	8
4920311	5420	5160	2460	5290	6	4340	9
4870255	4790	4820	2910	4810	13	4170	10
4930230	4370	4420	2830	4400	15	3870	11
4970044	5840	4780		5310	5		
4970025	4880	5060		4970	9		
9640074	4560	5300		4930	10		
4970018	4600	4550		4580	14		
4990032	6020						
4990021	5730						
4990030	5480						
4990025	5320						
4990039	5130						
4990033	5110						
4990028	5020						
4990038	4990						
4990040	4970						
4990041	4890						
4990037	4860						
4990009	4800						
4990014	4800						
4990034	4710						
3940124	3970						
Mean	5130	5040	3360	5120		4580	
CV (%)	12	9	23	9		9	
LSD (.05)	850	660	1100	680		580	

Table 7. Western Regional Spring Wheat Nursery: agronomic and grain quality data for spring wheat varieties and lines established on April 24, 2000, at KES, Klamath Falls, OR.

Variety or line	Type[1]	Yield	Test weight	Lodge	Height	50% heading
		lb/acre	lb/bu	%	in	Juilian
N96-0060	HR	6810	64.0	0	34	176
SDM 50040	HR	6550	66.0	0	32	176
IDO 557	HR	6320	63.0	0	33	177
Serra	HR	6230	63.0	0	33	176
McKay	HR	6070	63.0	0	35	178
CA 1161	HR	6040	57.0	0	33	178
OR 4920002	HR	5960	62.0	0	30	177
IDO 529	HR	5840	64.0	0	33	174
IDO 559	HR	5750	64.0	0	30	175
N96-0144	HR	5550	64.0	0	34	176
Norpro	HR	5540	62.0	0	32	176
Nora	HR	5150	63.5	0	30	176
WA 7839	HR	5150	64.0	0	34	174
XKW940W01	HR	5120	63.0	0	33	176
WA 7859	HR	3820	62.5	0	42	176
Mean		5730	63.0	0	33	176
IDO 560	HW	7270	62.0	0	35	178
IDO 552	HW	6950	63.0	0	32	181
OR 4920307	HW	6610	63.0	0	33	180
IDO 533	HW	6290	61.5	0	34	176
OR 4920311	HW	6110	64.5	0	34	177
CA 1162	HW	5980	64.0	0	35	176
Klasic	HW	5930	64.0	0	29	172
Mean		6450	63.1	0	33	177
SDM 50043	SW	7830	63.5	0	35	177
IDO 540	SW	7570	64.5	0	39	178
WA 7883	SW	7440	66.0	0	35	177
IDO 541	SW	7210	61.5	0	31	179
IDO 553	SW	6750	62.5	0	34	175
ML 66A-14-4	SW	6640	62.0	0	38	180
WA 7877	SW	6590	64.0	0	39	178
ML 037A-6-8	SW	6480	63.5	0	33	180
ML 037C-6-2	SW	6460	64.0	0	35	180
OR 942845	SW	6450	63.0	0	36	178
IDO 556	SW	6400	65.5	0	30	179
OR 942889	SW	6020	64.5	0	37	176
IDO 563	SW	5830	66.0	0	31	173
Penewawa	SW	5800	63.0	0	30	177
WA 7864	SW	5490	63.5	0	37	176
WA 7867	SW	5130	62.0	0	32	176
Federation	SW	4840	60.0	0	45	181
Mean		6410	63.5	0	35	178
Grand Mean		6150	63.0	0	34	177
CV (%)		9	--	0	6	1
LSD (.05)		940	--	0	3	2

[1]SW denotes soft white, HW denotes hard white, HR denotes hard red.

Table 8. Western Regional Spring Wheat Nursery: grain yield of spring wheat varieties and lines established at KES, Klamath Falls, OR, 1998-2000.

Variety or line	Type[1]	Yield 2000	Yield 1999	Yield 1998	2-year average yield	2-year average rank	3-year average yield	3-year average rank
		lb/acre			lb/acre		lb/acre	
CA1162	HW	5980	5810	7070	5900	6	6290	1
OR942845	SW	6450	5360	5530	5910	4	5780	2
OR4920002	HR	5960	4970	6090	5460	8	5670	3
Penewawa	SW	5800	6510	4700	6160	2	5670	4
Serra	HR	6230	5590	5150	5910	5	5660	5
IDO533	HW	6290	5010	5550	5650	7	5620	6
McKay	HR	6070	4810	5030	5440	9	5300	7
CA1161	HR	6040	4750	4810	5400	10	5200	8
Klasic	HW	5930	4390	4370	5160	12	4900	9
Federation	SW	4840	4510	4210	4680	15	4520	10
IDO541	SW	7210	5720		6470	1		
OR4920307	HW	6610	5420		6020	3		
OR942889	SW	6020	4710		5360	11		
WA7839	HR	5150	4450		4800	13		
XKW940W01	HR	5120	4380		4750	14		
SDM50043	SW	7830						
IDO540	SW	7570						
WA7883	SW	7440						
IDO560	HW	7270						
IDO552	HW	6950						
N96-0060	HR	6810						
IDO553	SW	6750						
ML66A-14-4	SW	6640						
WA7877	SW	6590						
SDM50040	HR	6550						
ML037A-6-8	SW	6480						
ML037C-6-2	SW	6460						
IDO556	SW	6400						
IDO557	HR	6320						
OR4920311	HW	6110						
IDO529	HR	5840						
IDO563	SW	5830						
IDO559	HR	5750						
N96-0144	HR	5550						
Norpro	HR	5540						
WA7864	SW	5490						
Nora	HR	5150						
WA7867	SW	5130						
WA7859	HR	3820						
Mean		6150	5090	5250	5540		5460	
CV (%)		9	9	13	5		6	
LSD (.05)		940	810	1180	490		610	

[1]SW denotes soft white, HW denotes hard white, HR denotes hard red.

Table 9. Oregon Statewide Spring Wheat Trial: mineral soil, agronomic and grain quality data for spring wheat varieties and lines established on April 24, 2000, at KES, Klamath Falls, OR.

Variety or line	Type[1]	Yield	Test weight	Protein	1,000 Kernel weight	Height	50% heading	Lodging
		lb/acre	lb/bu	%	grams	in	Julian	%
M94-4393	Trit	6640	54.0	11.8	41.9	33	176	0
Trical 2700	Trit	6340	48.3	11.5	43.7	33	180	0
Mean		6490	51.1	11.6	42.8	33	178	0
Iona	HR	5990	62.3	14.3	41.9	32	176	0
Hank	HR	5860	60.0	14.4	44.7	33	176	0
OR 4880189	HR	5630	61.7	13.7	37.0	29	176	0
Scarlet	HR	5590	61.0	14.4	42.8	33	176	0
OR 4870410	HR	5490	60.5	13.8	36.9	35	176	0
Jefferson	HR	5430	62.1	13.8	40.8	30	174	0
Yecora Rojo	HR	5310	62.3	14.7	41.5	30	174	0
WA 7869	HR	5180	60.5	13.9	45.7	33	174	0
WA 7824	HR	4580	59.8	14.9	44.3	31	174	0
Westbred 936	HR	4140	59.1	16.2	43.7	30	174	0
Mean		5320	60.9	14.4	41.9	32	175	0
Winsome	HW	7490	60.4	12.2	39.5	31	180	0
IDO 533	HW	7480	62.1	13.0	47.4	31	176	0
IDO 560	HW	7450	62.2	11.7	40.1	33	178	0
IDO 377S	HW	6630	62.0	13.1	41.6	33	176	0
ML 455	HW	5760	60.1	13.0	44.2	33	178	0
OR 4920311	HW	5200	60.4	12.9	32.3	28	176	0
Mean		6670	61.2	12.7	41	31	178	0
Treasure	SW	7400	61.0	11.1	41.1	31	178	0
IDO 526	SW	7010	60.9	11.2	39.9	30	177	0
OR 4970039	SW	6870	60.1	11.6	41.1	32	177	0
Pomerelle	SW	6760	62.2	11.0	39.1	30	178	0
Wawawai	SW	6720	59.0	12.1	50.1	31	176	0
Whitebird	SW	6600	60.4	11.2	36.4	30	179	0
IDO 506	SW	6180	61.2	11.7	38.6	33	176	0
OR 4970062	SW	6110	59.9	12.4	43.3	26	177	0
Penawawa (40 seeds/f^2)	SW	5950	60.1	12.4	41.0	35	178	0
IDO 525	SW	5730	61.8	11.7	37.1	30	177	0
ML 037A(5-2)	SW	5590	59.4	12.4	38.9	28	180	0
Zak (WA7850)	SW	5400	61.1	12.0	41.2	30	178	0
Alpowa	SW	5490	61.8	12.2	41.5	28	177	0
Penawawa (30 seeds/ft^2)	SW	5340	58.8	13.0	39.7	30	178	0
OR 942885	SW	5260	61.8	13.4	38.4	32	176	0
OR 4970025	SW	5050	61.8	13.2	42.2	30	176	0
Chalis	SW	4700	59.8	12.1	36.3	30	176	0
Penawawa (20 seeds/ft^2)	SW	3990	58.2	13.1	37.3	35	177	0
Mean		5900	60.5	12.1	40.2	31	177	0
Grand Mean		5900	60.2	12.7	41.0	36	177	0
CV (%)		16	2	4	5	9	1	0
LSD (.05)		1560	1.7	0.7	3.1	5	2	0

[1]SW denotes soft white, HW denotes hard white, HR denotes hard red, and Trit denotes triticale.

Table 10. OSU Statewide Spring Wheat Trial: mineral soil, grain yield of spring wheat varieties and lines established at KES, Klamath Falls, OR, 1998-2000.

Variety or line	Type[1]	Yield 2000	Yield 1999	Yield 1998	2-year average yield	2-year average rank	3-year average yield	3-year average rank
		lb/acre			lb/acre		lb/acre	
IDO 506	SW	6180	6380	6700	6280	11	6420	1
Pomerelle	SW	6760	6730	5690	6750	2	6390	2
IDO 377S	HW	6630	6060	5810	6340	8	6160	3
Whitebird	SW	6600	6020	5770	6310	9	6130	4
IDO 533	HW	7480	5480	5320	6480	4	6090	5
Alpowa	SW	6270	5860	5450	6070	12	5860	8
Wawawai	SW	6720	5870	4660	6290	10	5750	9
Jefferson	HR	5430	4570	5480	5000	20	5160	10
Yecora Rojo	HR	5310	4780	4410	5050	19	4830	11
Westbred 936	HR	4140	5590	4430	4860	21	4720	12
Treasure	SW	7400	6320		6860	1		
Winsome	HW	7490	6000		6750	3		
M94-4393	Trit	6640	6270		6460	5		
IDO 526	SW	7010	5760		6390	7		
Scarlet	HR	5590	5990		5790	14		
Penawawa	SW	5340	5890		5620	15		
ML 455	HW	5590	5540		5560	16		
Zak (WA7850)	SW	5400	5690		5540	17		
IDO 525	SW	5730	5340		5530	18		
IDO 560	HW	7450						
OR 4970039	SW	6870						
Trical 2700	Trit	6340						
OR 4970062	SW	6110						
Iona	HR	5990						
Hank	HR	5860						
ML 037A(5-2)	SW	5760						
OR 4880189	HR	5630						
OR 4870410	HR	5490						
OR 942885	SW	5260						
OR 4920311	HW	5200						
WA 7869	HR	5180						
OR 4970025	SW	5050						
Chalis	SW	4700						
WA 7824	HR	4580						
Mean		5980	5800	5370	6000		5750	
CV (%)		16	10	11	9		8	
LSD (.05)		1560	980	960	890		750	

[1]SW denotes soft white, HW denotes hard white, HR denotes hard red, and Trit denotes triticale.

Table 11. Oregon Statewide Spring Wheat Trial: organic soil, agronomic and grain quality data for spring wheat varieties and lines established on May 19, 2000, at Klamath County, OR.

Variety or line	Type[1]	Yield	Test weight	Protein	Height	50% heading	Lodging
		lb/acre	lb/bu	%	In	Julian	%
Trical 2700	Trit	5580	43.0	11.8	45	203	0
M94-4393	Trit	4990	51.6	11.4	37	200	0
Mean		5290	47.3	11.6	41	201	0
Hank	HR	6510	59.5	14.5	32	196	0
OR 4880189	HR	5780	60.6	13.8	32	199	0
OR 4870410	HR	5540	55.9	14.1	32	197	5
Iona	HR	5280	59.9	14.5	31	200	13
Scarlet	HR	5100	58.1	15.5	32	197	12
Jefferson	HR	4800	61.7	14.1	30	196	3
WA 7824	HR	4670	61.4	14.8	34	196	0
Yecora Rojo	HR	4640	60.6	14.3	24	196	0
Westbred 926	HR	4440	57.9	15.5	30	196	0
WA 7869	HR	4130	55.9	15.0	30	197	8
Mean		5090	59.1	14.6	31	197	4
Winsome	HW	7250	59.3	11.9	32	202	2
IDO 377S	HW	6900	59.3	12.7	33	199	0
IDO 560	HW	6440	61.0	11.9	33	200	0
IDO 533	HW	6330	59.4	12.9	34	197	0
ML 455	HW	6280	58.4	12.1	33	203	3
OR 4920311	HW	5290	56.6	12.2	28	201	5
Mean		6420	59.0	12.3	32	200	2
ML 037A(5-2)	SW	7130	59.8	11.3	32	201	7
Pomerelle	SW	7080	56.1	11.8	32	201	0
Treasure	SW	6870	51.3	11.6	32	202	8
Chalis	SW	6760	59.7	11.3	33	199	5
Zak (WA7850)	SW	6480	55.4	11.9	35	200	8
OR 4970039	SW	6260	55.2	11.9	35	201	7
Penawawa (40 seeds/ft-2)	SW	6000	60.1	11.4	30	200	0
Penawawa (30 seeds/ft-2)	SW	5680	58.8	11.9	31	199	3
Whitebird	SW	5460	59.7	11.8	33	201	0
OR 4970025	SW	5460	60.9	12.5	32	199	3
OR 942885	SW	5360	61.2	12.8	34	197	0
Wawawai	SW	5330	56.8	12.3	33	196	60
IDO 525	SW	5290	57.6	11.3	32	200	2
IDO 506	SW	5220	57.9	11.8	32	201	0
OR 4970062	SW	4940	60.4	13.9	35	197	3
IDO 526	SW	4930	59.6	11.3	32	200	3
Alpowa	SW	4140	57.9	12.8	30	199	8
Penawawa (20 seeds/ft-2)	SW	4070	58.8	11.5	30	200	20
Mean		5690	58.2	11.9	32	200	8
Grand Mean		5660	58.1	12.6	32	199	5
CV (%)		12	4	3	6	1	136
LSD (.05)		1110	3.5	0.7	3	1	12

[1]SW denotes soft white, HW denotes hard white, HR denotes hard red, and Trit denotes triticale.

Table 12. OSU Statewide Spring Wheat Trial: 3-year yield summary for organic soil site in Klamath County, OR, 2000, 1999, and 1997.

Variety or line	Type[1]	Yield 2000	Yield 1999	Yield 1997	2-year average yield	2-year average rank	3-year average yield	3-year average rank
		lb/acre	lb/acre	lb/acre	lb/acre		lb/acre	
Pomerelle	SW	7080	4270	8790	5670	5	6710	1
Treasure	SW	6870	4850	8090	5860	4	6600	2
Penawawa (40 seeds/ft^2)	SW	6000	4930	8820	5470	6	6590	3
Winsome	HW	7250	4720	7460	5990	2	6480	4
IDO377S	HW	6900	3940	7700	5420	7	6180	5
Westbred 936	HR	4440	5440	8570	4940	10	6150	6
Alpowa	SW	4140	5630	8360	4890	11	6040	7
Whitebird	SW	5460	3680	7060	4570	14	5400	8
Wawawai	SW	5330	3680	6820	4510	16	5280	9
Yecora Rojo	HR	4640	3050	7330	3840	19	5010	10
ML 455	HW	6280	6010		6140	1		
IDO533	HW	6330	5450		5890	3		
Zak (WA7850)	HR	6480	4090		5290	8		
Scarlet	HR	5100	4980		5040	9		
IDO526	SW	4930	4840		4880	12		
Penawawa (30 seeds/ft^2)	SW	5680	4000		4840	13		
IDO525	SW	5290	3820		4560	15		
IDO506	SW	5220	3340		4280	17		
Jefferson	HR	4800	3580		4190	18		
Penawawa (20 seeds/ft^2)	SW	4070	3310		3690	20		
ML037A(5-2)	SW	7130						
Chalis	SW	6760						
Hank	HR	6510						
IDO560	HW	6440						
OR4970039	HR	6260						
OR4880189	HR	5780						
Trical 2700	Trit	5580						
OR4870410	HR	5540						
OR4970025	SW	5460						
OR942885	SW	5360						
OR4920311	HW	5290						
Iona	HR	5280						
M94-4393	Trit	4990						
OR4970062	SW	4940						
WA 7824	HR	4670						
WA 7869	HR	4130						
Mean		5620	4380	7900	5000		6040	
CV (%)		12	28	9	14		13	
LSD (.05)		1110	NS	1240	1190		1390	

[1]SW denotes soft white, HW denotes hard white, HR denotes hard red, and Trit denotes triticale.