**Special Report 981**
July 1997

# Crop Research in the Klamath Basin 1996 Annual Report

## in cooperation with Klamath County



Agricultural Experiment Station
Oregon State University

**For additional copies of this publication, write:**

Ken Rykbost
Klamath Experiment Station
6941 Washburn Way
Klamath Falls, OR 97603-9365

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# CONTENTS

## Note from the Superintendent

Welcome to the 1996 Annual Report for the Klamath Experiment Station (KES). We are pleased to share the results of our various research projects with you in this traditional format. For those of you with access to the Internet, we offer additional information on the Klamath Basin, our agricultural industry, markets, weather, water issues, and much more on the KES home page at: **http://www.orst.edu/dept/kes**. Greg Chilcote, our Klamath County Research Technician, has done an outstanding job designing, updating, and customizing this page, with links to many others web sites that discuss Klamath Basin crops or issues. We welcome any comments you might offer on how the home page can be made more useful for our friends and clients.

We experienced one staffing change in the past year. Our office coordinator, Mrs. Gail Quick, resigned for health reasons. We welcome her successor, Mrs. Carolyn Gardner, who joined our staff in September. Greg Chilcote received recognition for 15 years of service to the KES and Klamath County during 1996. Jerry Maxwell will reach a 30-year milestone for service to KES in November 1997, and plans to retire at that time. Dr. Dovel expanded his horizons internationally in 1996 with trips to Chile and Mexico to explore forage research projects for the future.

These research reports provide some insights to the difficult year the industry experienced in 1996. Most crops suffered reduced yields, impaired quality, or both due to weather extremes. The two main commodities, in economic terms, produced in the Klamath Basin, meat and potatoes, were affected more by surplus supplies and depressed prices than by weather related problems. Record fall crop acreage and record yields have devastated open market prices for potatoes. Scooped-up price to growers for fresh market russets at the end of February 1997 was $1.50/cwt. This compares to prices of $8.00, $4.00, and $3.50/cwt for the three previous years. Returns on the open market represent about one-third of costs of production. Beef prices had advanced to about break-even levels by mid-March, but were well below production costs when most local marketing occurred.

The agricultural industry in the Klamath Basin faces many other challenges that can not be directly addressed within the scope of the limited research capacity of the KES or our cooperators. While this report is not an appropriate medium to address these issues, we encourage those with an interest in Klamath Basin agriculture to become informed on the public policy issues that may be more important to the industry than any fine tuning of production potential we may achieve through our research activities. A visit to our Internet home page will open the door to some of the issues and participants.

Our research reports acknowledge some of our cooperators through authorship. We also want to recognize others who contribute significantly to KES programs in many important ways. Specific funding sources are listed for several projects. The funding for KES facilities, staff, and operations are provided by the Oregon Agricultural Experiment Station (60 percent), Klamath County General Fund (13 percent), gifts and grants from various sources (22 percent), and sales of products from research activities (5 percent). We extend special thanks to the Klamath County Board of Commissioners and the County Budget Committee for their continuing support of the KES and our facilities and programs. Klamath county owns the land and buildings at KES and provided the major share of costs associated with facility improvements implemented over the past decade.

We also express appreciation to past and present members of the KES Advisory Board. Their counsel on research needs and issues affecting the industry, and their input on funding and facilities, is invaluable. Their attendance at extension meetings, field days, stakeholder meetings, and other OSU activities provide support and encouragement.

Finally, I thank all KES staff, including our seasonal employees, for their dedication and efforts. At a time when commitment and productivity of public employees is questioned, government funding is declining, and regulations are increasing, we can be proud of the accomplishments of our staff.

Kenneth A. Rykbost
Superintendent
Klamath Experiment Station

**Major Cooperators in KES Research Programs**

**Oregon State University:**

Mr. Mylen Bohle - Crook County Cooperative Extension Agent
Mr. Brian Charlton - Department of Crop and Soil Science
Mr. Oscar Gutbrod - Department of Crop and Soil Science
Mr. Phil Hamm - Hermiston Agricultural Research And Extension Center
Mr. Dan Hane - Hermiston Agricultural Research and Extension Center
Dr. David Hannaway - Department of Crop and Soil Science
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
Dr. Russell Karow - Department of Crop and Soil Science
Dr. Warren Kronstad - Department of Crop and Soil Science
Mr. Scott Leavengood - Southern Oregon Cooperative Extension Forestry Agent
Dr. Kerry Locke - Klamath County Cooperative Extension Agent
Dr. Alvin Mosley - Department of Crop and Soil Science
Dr. Clinton Shock - Malheur Experiment Station
Mr. Rodney Todd - Klamath County Cooperative Extension Center

**University of California, Davis:**

Dr. Harry Carlson - Director, DANR, Facility Planning and Management
Mr. Don Kirby - Intermountain Research And Extension Center
Mr. Don Lancaster - Modoc County Cooperative Extension Director
Dr. Steve Orloff - Siskiyou County Farm Advisor
Mr. Jerry Schmierer - Lassen County Cooperative Extension Director
Dr. Ron Voss - Department of Vegetable Crops

## Major Cooperators in KES Research Programs (continued)

**Others:**

Dr. Chuck Brown - USDA-ARS, Prosser, Washington
Dr. Dennis Corsini - USDA-ARS, 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 - North Dakota State University
Dr. Joseph Pavek - USDA-ARS, Aberdeen, Idaho
Dr. Darrell Wesenberg - USDA-ARS, Aberdeen, Idaho

## Klamath Experiment Station Staff and Advisory Board

**Staff:**

Dr. Kenneth A. Rykbost - Superintendent, Professor of Crop and Soil Science
Dr. Randy L. Dovel - Associate Professor of Crop and Soil Science
Mr. George E. Carter - Associate Professor Emeritus
Mr. Greg Chilcote (Klamath County) - Research Technician
Mrs. Carolyn Gardner - Office Coordinator
Mr. Lawrence Johnson (Klamath County) - Facility Maintenance Leadworker
Mr. Jerry W. Maxwell - Biological Sciences Research Technician III
Mr. James Rainey III - Biological Sciences Research Technician III
Mr. Raymann (Woody) Woodrum (Klamath County) - Farm Worker
Mr. Aaron Anderson (Klamath County) - Farm Worker

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Dr. Kenneth Rykbost - Secretary, Superintendent KES
Dr. Ron Hathaway - Chairman, Klamath County Cooperative Extension Service
Mr. Steven West - Klamath County Board of Commissioners

## Weather and Crop Summary, 1996

K.A. Rykbost and J. Maxwell[1]

The drought of the 1980's and early 1990's has definitely ended. For the second consecutive year, annual rainfall at Klamath Falls exceeded long term averages by more than 50 percent. Three periods of major flooding occurred in portions of western Oregon in 1996. Warm rains in early February, following high snowfall in the Cascade Mountains, produced widespread flooding in the Willamette Valley and in several coastal streams. In November, and again at the end of December, excessive rainfall extending over several days produced flooding through much of western Oregon. The southcentral portion of the state, including the Klamath Basin, escaped serious flooding in each of these periods, as stream flows and reservoir storage returned to more normal historical levels.

Weather anomalies were not limited to high rainfall in 1996. Frosts were experienced in each month at Klamath Falls, for the second time in four years. Daily record high temperatures were set on several days. July and August were unusually warm, with daily highs of 90 °F or more on 31 days. September was cooler than normal. October experienced warm temperatures early, but cool and wet conditions prevailed after October 18. Weather-related crop problems were more prevalent than in any of the previous 10 years in the Klamath Basin.

Official local weather records at Klamath Falls date to the establishment of a National Oceanic and Atmospheric Administration (NOAA) weather station at the Klamath Falls airport, Kingsley Field, in 1949. This station, located at 42°09'N latitude, 121°44'W longitude, and 4,092 ft. elevation; and situated about one-half mile east of the KES, was officially closed in 1995. The KES weather station was recognized as the official station for Klamath Falls by NOAA in late 1996.

A comparison of data from both stations generally shows minimum air temperatures are 2 to 3 °F lower at KES. This is probably due to the influence of large buildings and extensive paved areas near the Kingsley Field station. Precipitation data have historically shown good agreement between Kingsley Field and KES. Since the closure of the official NOAA station, precipitation data from Kingsley Field has varied from KES data. Annual totals reported for both 1995 and 1996 were more than 15 percent higher for Kingsley Field.

Monthly air and soil temperatures and precipitation are summarized for 1996 and the 12-year period from 1984 through 1995 in Table 1. The period of 1984 to 1995 includes several of the warmest years since 1949. Averaged for the year, air temperatures in 1996 were similar to the 12-year means. Mean temperatures were 3 °F or more higher in 1996 in January, July, November, and December. Similar patterns occurred for soil temperatures. Precipitation was higher in 1996 than for the 12-year mean in all months except March and August. Total monthly precipitation was more than 200 percent of normal in January and December, 1996. The two-month total of 7.77 inches was approximately 65 percent of the long-term mean annual rainfall of 12 inches. Total annual precipitation for 1995 and 1996, 19.06 and 19.54 inches, respectively, was higher than recorded for any year since 1970.

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1/ Superintendent/Professor and Biological Sciences Research Technician III, respectively, Klamath Experiment Station, Klamath Falls, OR.

Weather conditions during the growing season are shown in more detail in Tables 2 and 3. Long-term data were derived from "Climatological Data, Oregon," published by NOAA, for years prior to 1989, and from KES data for 1989 through 1996. The 30-week period from April through late October represents the majority of the local field activity season from early field preparation to harvest of most crops.

Air temperatures were near normal through April, May, and June (Table 2). The low of 19 °F recorded on May 4 was very important for the sugarbeet crop. Temperatures recorded in southern areas of the Tulelake Basin were as low as 12 °F. Most fields with emerged sugarbeet seedlings suffered total stand loss. About 3,800 acres of beets were replanted. An additional 800 acres were abandoned for sugarbeets and planted with cereal crops. This frost effectively shortened the season for sugarbeets by three weeks.

High soil moisture content delayed planting on mineral soils with imperfect drainage, including at the KES. Above normal precipitation in May and June was beneficial for water supply and reduced irrigation requirements, but resulted in lost quality for hay crops. Much of the first cutting of alfalfa was damaged by rains following cutting. Fields where cutting was delayed until after rains in late June, were overmature. A frost on June 18 was the first of several that affected yields and quality of cereal crops in the area.

July and August were warmer than normal. Potato crops were affected in several ways. Several fields of Russet Norkotah experienced early vine death and severely reduced yields. Hollow heart and brown center incidence was high in some varieties. Heat sprouts were observed in many of the single-hill reds at KES.

Frosts recorded at KES on July 19 and August 18 contributed to lost yield and quality in grain crops. Damage varied widely, depending on the stage of crop development. Some fields experienced yield losses of 50 percent or more. Very low test weights occurred in seriously affected fields.

Temperatures through September were highly variable. Frosts were recorded at KES on 6 days, including a low of 24 °F on September 22. Maximum temperatures exceeded 80 °F on 10 days. Potato harvest was delayed at the end of September due to high temperatures. Warm weather continued during the first two weeks in October, but mean daily temperatures declined by about 20 °F in the second half of the month. Potatoes harvested after mid-October experienced some frost injury. Late October also marked the return of above normal precipitation patterns, which continued through the rest of 1996.

Mean growing season temperatures and precipitation from 1970 through 1996 are compared in Table 4. When averaged from April through September, the 1996 air temperatures were nearly the same as in 1995, and for the 27-year mean. Total seasonal precipitation was about 40 percent higher than the mean.

Two consecutive years of near record precipitation have broken the drought cycle, climatologically. Changes in the management and allocation of water from the Klamath Project, however, give irrigators little confidence in the security of water supplies in future years. High releases to the lower Klamath River were maintained throughout the year. The target elevation for Klamath Lake on July 15 was increased by 1.6 feet. These changes in water management resulted in a threatened stoppage of deliveries for irrigation in early July. The low irrigation usage in May and June, and the fact that Klamath Lake was at full pool in late May, combined for the best water supply scenario that can be expected. If changes in supply management make 1996 conditions marginal, water shortages can be anticipated in most years.

Table 1. Mean monthly maximum, minimum, and mean air, and 4-inch soil temperatures, and monthly precipitation recorded at the Klamath Experiment Station, Klamath Falls, OR, for 1996 and the 12-year period from 1984 through 1995.

| Month | Mean monthly temperature | | | | | | Total monthly precipitation |
|---|---|---|---|---|---|---|---|
| | Air | | | 4" Soil | | | |
| | Max | Min | Mean | Max | Min | Mean | |
| | °F | | | | | | inches |
| **1996** | | | | | | | |
| January | 40 | 24 | 32 | 38 | 37 | 38 | 3.86 |
| February | 43 | 27 | 35 | 39 | 38 | 38 | 1.72 |
| March | 53 | 26 | 40 | 41 | 40 | 41 | 1.26 |
| April | 57 | 30 | 43 | 46 | 45 | 45 | 1.23 |
| May | 63 | 34 | 49 | 52 | 50 | 51 | 1.73 |
| June | 75 | 41 | 58 | 60 | 58 | 59 | 1.30 |
| July | 86 | 52 | 69 | 69 | 67 | 68 | 0.54 |
| August | 86 | 46 | 66 | 69 | 66 | 68 | 0.14 |
| September | 73 | 37 | 55 | 62 | 59 | 60 | 0.65 |
| October | 63 | 32 | 47 | 53 | 51 | 52 | 1.36 |
| November | 52 | 26 | 39 | 44 | 43 | 44 | 1.84 |
| December | 42 | 26 | 34 | 38 | 37 | 38 | 3.91 |
| Mean/Total | 61 | 33 | 47 | 51 | 49 | 50 | 19.54 |
| **1984 - 1995** | | | | | | | |
| January | 39 | 18 | 29 | 33 | 32 | 33 | 1.38 |
| February | 45 | 21 | 33 | 35 | 33 | 34 | 1.04 |
| March | 51 | 27 | 39 | 40 | 37 | 38 | 1.38 |
| April | 60 | 31 | 45 | 49 | 43 | 46 | 0.91 |
| May | 66 | 36 | 51 | 56 | 50 | 53 | 1.10 |
| June | 75 | 44 | 60 | 64 | 56 | 60 | 0.82 |
| July | 83 | 48 | 65 | 70 | 62 | 66 | 0.43 |
| August | 83 | 45 | 64 | 70 | 61 | 66 | 0.43 |
| September | 77 | 39 | 58 | 62 | 56 | 59 | 0.83 |
| October | 66 | 30 | 48 | 53 | 48 | 50 | 0.68 |
| November | 48 | 23 | 36 | 42 | 40 | 41 | 1.41 |
| December | 38 | 18 | 28 | 34 | 34 | 34 | 1.57 |
| Mean/Total | 61 | 32 | 46 | 51 | 46 | 48 | 11.98 |

Table 2. Weekly average maximum, minimum, and mean air temperatures for the 1996 growing season, and the 17-year period from 1979 - 1995 at Klamath Falls, OR.

| | Weekly Period | 1996 Weekly average | | | 1979 - 1995 Weekly average | | |
|---|---|---|---|---|---|---|---|
| | | Max | Min | Mean | Max | Min | Mean |
| | | °F | | | | | |
| April | 1 - 7 | 60 | 31 | 46 | 55 | 29 | 42 |
| | 8 - 14 | 59 | 28 | 44 | 57 | 30 | 44 |
| | 15 - 21 | 51 | 30 | 41 | 60 | 32 | 46 |
| | 22 - 28 | 58 | 33 | 45 | 59 | 32 | 45 |
| | 29 - 5 | 65 | 30 | 47 | 62 | 34 | 48 |
| May | 6 - 12 | 66 | 30 | 48 | 63 | 35 | 49 |
| | 13 - 19 | 64 | 44 | 54 | 66 | 36 | 51 |
| | 20 - 26 | 61 | 36 | 48 | 70 | 40 | 55 |
| | 27 - 2 | 67 | 36 | 52 | 69 | 41 | 55 |
| June | 3 - 9 | 85 | 44 | 64 | 69 | 41 | 55 |
| | 10 - 16 | 78 | 43 | 61 | 73 | 42 | 58 |
| | 17 - 23 | 71 | 38 | 55 | 76 | 45 | 60 |
| | 24 - 30 | 68 | 42 | 55 | 79 | 47 | 63 |
| July | 1 - 7 | 84 | 50 | 67 | 78 | 46 | 62 |
| | 8 - 14 | 92 | 57 | 74 | 81 | 47 | 64 |
| | 15 - 21 | 79 | 43 | 61 | 83 | 50 | 66 |
| | 22 - 28 | 94 | 59 | 77 | 84 | 49 | 67 |
| | 29 - 4 | 82 | 47 | 64 | 86 | 49 | 67 |
| August | 5 - 11 | 87 | 45 | 66 | 86 | 49 | 67 |
| | 12 - 18 | 91 | 48 | 69 | 83 | 47 | 65 |
| | 19 - 25 | 86 | 47 | 66 | 81 | 45 | 63 |
| | 26 - 1 | 87 | 46 | 66 | 80 | 43 | 61 |
| September | 2 - 8 | 77 | 38 | 57 | 80 | 43 | 62 |
| | 9 - 15 | 77 | 40 | 58 | 76 | 39 | 58 |
| | 16 - 22 | 63 | 34 | 49 | 74 | 39 | 56 |
| | 23 - 29 | 75 | 37 | 56 | 73 | 38 | 56 |
| | 30 - 6 | 81 | 38 | 60 | 72 | 35 | 54 |
| October | 7 - 13 | 80 | 39 | 59 | 68 | 34 | 51 |
| | 14 - 20 | 56 | 27 | 41 | 63 | 30 | 47 |
| | 21 - 27 | 49 | 30 | 39 | 62 | 31 | 47 |
| Mean | | 73 | 40 | 56 | 72 | 40 | 56 |

Table 3. Weekly minimum air temperatures, frost days, and precipitation for the 1996 growing season and the 17-year period from 1979 to 1995 at Klamath Falls, OR.

| Weekly period | | Weekly min. | | Frost day/week | | Weekly precip | | Accum-precip | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1996 | 17-year | 1996 | 17-year | 1996 | 17-year | 1996 | 17-year |
| | | -------°F------ | | ----------%--------- | | ---------------- inches--------------- | | | |
| April | 1 - 7 | 25 | 11 | 71 | 75 | 0.20 | 0.18 | 0.20 | 0.18 |
| | 8 - 14 | 18 | 17 | 71 | 65 | 0.18 | 0.16 | 0.38 | 0.34 |
| | 15 - 21 | 21 | 17 | 71 | 53 | 0.34 | 0.23 | 0.72 | 0.57 |
| | 22 - 28 | 25 | 20 | 57 | 54 | 0.51 | 0.28 | 1.23 | 0.85 |
| | 29 - 5 | 19 | 19 | 57 | 35 | 0.00 | 0.24 | 1.23 | 1.09 |
| May | 6 - 12 | 24 | 23 | 71 | 44 | 0.00 | 0.19 | 1.23 | 1.28 |
| | 13 - 19 | 34 | 19 | 0 | 34 | 1.26 | 0.21 | 2.49 | 1.49 |
| | 20 - 26 | 26 | 24 | 43 | 16 | 0.34 | 0.22 | 2.83 | 1.71 |
| | 27 - 2 | 28 | 27 | 43 | 18 | 0.13 | 0.34 | 2.96 | 2.05 |
| June | 3 - 9 | 38 | 27 | 0 | 9 | 0.00 | 0.28 | 2.96 | 2.33 |
| | 10 - 16 | 34 | 27 | 0 | 8 | 0.00 | 0.16 | 2.96 | 2.49 |
| | 17 - 23 | 30 | 30 | 14 | 3 | 0.36 | 0.07 | 3.32 | 2.56 |
| | 24 - 30 | 38 | 31 | 0 | 0 | 0.94 | 0.08 | 4.26 | 2.64 |
| July | 1 - 7 | 43 | 33 | 0 | 0 | 0.00 | 0.07 | 4.26 | 2.71 |
| | 8 - 14 | 51 | 34 | 0 | 0 | 0.37 | 0.03 | 4.63 | 2.74 |
| | 15 - 21 | 32 | 36 | 14 | 0 | 0.10 | 0.14 | 4.73 | 2.88 |
| | 22 - 28 | 53 | 35 | 0 | 0 | 0.00 | 0.05 | 4.73 | 2.93 |
| | 29 - 4 | 39 | 36 | 0 | 0 | 0.07 | 0.07 | 4.80 | 3.00 |
| August | 5 - 11 | 35 | 34 | 0 | 0 | 0.00 | 0.06 | 4.80 | 3.06 |
| | 12 - 18 | 32 | 29 | 14 | 1 | 0.11 | 0.09 | 4.91 | 3.15 |
| | 19 - 25 | 35 | 30 | 0 | 3 | 0.00 | 0.12 | 4.91 | 3.27 |
| | 26 - 1 | 41 | 32 | 0 | 1 | 0.03 | 0.21 | 4.94 | 3.48 |
| September | 2 - 8 | 29 | 31 | 29 | 3 | 0.00 | 0.08 | 4.94 | 3.56 |
| | 9 - 15 | 36 | 24 | 0 | 12 | 0.58 | 0.09 | 5.52 | 3.65 |
| | 16 - 22 | 24 | 26 | 57 | 11 | 0.07 | 0.36 | 5.59 | 4.01 |
| | 23 - 29 | 34 | 24 | 0 | 20 | 0.00 | 0.15 | 5.59 | 4.16 |
| | 30 - 6 | 35 | 20 | 0 | 23 | 0.00 | 0.07 | 5.59 | 4.23 |
| October | 7 - 13 | 33 | 18 | 0 | 40 | 0.02 | 0.17 | 5.61 | 4.40 |
| | 14 - 20 | 18 | 18 | 71 | 67 | 0.34 | 0.08 | 5.95 | 4.48 |
| | 21 - 27 | 15 | 19 | 71 | 61 | 0.71 | 0.32 | 6.66 | 4.80 |

Table 4. Mean maximum, minimum, and mean air temperature for April through September, mean maximum, minimum, and mean 4-inch soil temperatures for May through October; and total precipitation for April through September from 1970 through 1996 at Klamath Falls, OR.

| Year | Air temperature April - September | | | 4" Soil temperature May - October | | | Total precipitation Apr - Sept |
|---|---|---|---|---|---|---|---|
| | Max | Min | Mean | Max | Min | Mean | |
| | °F | | | | | | inches |
| 1996 | 72 | 39 | 56 | 61 | 59 | 60 | 5.50 |
| 1995 | 72 | 40 | 56 | 61 | 57 | 59 | 7.10 |
| 1994 | 76 | 40 | 58 | 63 | 59 | 61 | 3.42 |
| 1993 | 70 | 38 | 54 | 60 | 55 | 58 | 5.82 |
| 1992 | 77 | 42 | 60 | 66 | 58 | 62 | 3.41 |
| 1991 | 73 | 40 | 57 | 61 | 55 | 59 | 3.41 |
| 1990 | 74 | 41 | 58 | 61 | 55 | 58 | 5.66 |
| 1989 | 72 | 40 | 56 | 62 | 55 | 59 | 5.16 |
| 1988 | 75 | 41 | 58 | 64 | 56 | 60 | 3.13 |
| 1987 | 76 | 41 | 59 | 65 | 56 | 61 | 3.24 |
| 1986 | 73 | 42 | 58 | 70 | 59 | 64 | 3.87 |
| 1985 | 74 | 40 | 57 | 64 | 53 | 59 | 5.50 |
| 1984 | 71 | 41 | 56 | 70 | 57 | 64 | 4.36 |
| 1983 | 69 | 40 | 55 | 73 | 59 | 66 | 3.88 |
| 1982 | 70 | 40 | 55 | 71 | 57 | 64 | 4.18 |
| 1981 | 74 | 42 | 58 | 73 | 58 | 66 | 2.43 |
| 1980 | 71 | 41 | 56 | 74 | 59 | 67 | 2.75 |
| 1979 | 74 | 42 | 58 | | | | 3.77 |
| 1978 | 70 | 40 | 55 | 71 | 58 | 65 | 4.57 |
| 1977 | 73 | 43 | 58 | 71 | 58 | 65 | 4.97 |
| 1976 | 69 | 41 | 55 | 72 | 57 | 65 | 4.94 |
| 1975 | 71 | 41 | 56 | | | | 4.10 |
| 1974 | 74 | 42 | 58 | 70 | 56 | 63 | 1.82 |
| 1973 | 75 | 42 | 59 | 69 | 55 | 62 | 1.29 |
| 1972 | 73 | 41 | 57 | | | | 1.87 |
| 1971 | 70 | 40 | 55 | | | | 4.68 |
| 1970 | 74 | 39 | 57 | 70 | 57 | 64 | 1.25 |
| Mean | 73 | 41 | 57 | 68 | 57 | 62 | 3.93 |

# Sugarbeet Variety Evaluations in the Klamath Basin

K.A. Rykbost[1], D. Kirby[2], and R.L. Dovel[1]

## Introduction

The California Beet Growers Association (CBGA) determines the suitability of varieties for commercial production in each region based on performance in local variety trials, and disease resistance determined in regional trials. CBGA sponsored trials are conducted annually at the U.C. Davis Intermountain Research and Extension Center (IREC) and the OSU Klamath Experiment Station (KES). These trials are coded, with variety identity unknown until all data is presented to CBGA officials. The 1996 trials included 34 entries.

## Procedures KES

The KES trial site was a Poe fine sandy loam soil cropped with potatoes in 1995. This soil has approximately 1.0 percent organic matter in the plow layer and a pH of about 6.0. A broadcast application of 400 lb/acre of 12-12-12 fertilizer was incorporated during bed forming with tool-bar mounted sweeps on April 29. Seed beds in 22-inch rows were firmly packed with a flat roller. Varieties were planted in a randomized complete block design with four replications on May 1. Seed was planted at 0.5-inch depth at 6 to 10 seeds/foot with a Planet-Junior type planter. Individual plots were two rows, 22 feet long. Two border rows were planted on the south side and one on the north side of the experiment, and 5-foot borders were used on end plots. Stands were hand thinned to 9-inch plant spacing on June 14.

Weed control measures included applications of Betamix Progress at 0.25 lb active ingredient (ai)/acre on May 26 and May 31, and some hand weeding to control escapes. A minor flea beetle infestation was controlled with carbaryl applied at 1.0 lb ai/acre with the herbicides. An application of 60 lb N/acre as solution 32 on June 19 was incorporated immediately with irrigation. The above applications were made with a conventional ground sprayer. Irrigation, applied with solid-set sprinklers arranged on a 48- by 40-foot spacing, totalled 20 inches. The crop received 4.35 inches of rainfall from planting to harvest.

Beet tops were removed with a flail chopper immediately prior to harvest. Beets were lifted with one-row, tool-bar mounted lifters and hand harvested on October 17. All beets from both rows were counted and weighed. Approximately 25 lb samples from one row of each plot were analyzed for percent sucrose and impurities by Spreckels Sugar Company personnel. Total beet yields were adjusted for tare losses determined in laboratory analyses.

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[1]/ Superintendent/Professor and Associate Professor, respectively, Klamath Experiment Station, Klamath Falls, OR.

[2]/ Acting Superintendent/Research Associate, U.C. Davis Intermountain Research and Extension Center, Tulelake, CA.

**Acknowledgments:** Appreciation is expressed to American Crystal Sugar Company, Betaseed, Inc., Hilleshog Mono-hy, Inc., Holly Sugar Corporation, Seedex, Inc., and Spreckels Sugar Company for financial support; and to Spreckels Sugar Company for analysis of beet samples for sugar content and impurities.

Gross crop values were calculated for each plot based on beet yield and price per ton for beets at the observed sugar content, as determined by terms of the Spreckels Sugar Company contract. The price/ton is described by the equation: Price/ton = (3.518 X % sugar) -15.4 for a net selling price of $24/cwt. Beet population, beet yield, sugar content, total sugar production, recoverable sugar, and gross crop value were analyzed statistically using MSUSTAT software. Three-year summary data was analyzed as a split-plot with years as main plots and variety as split-plots.

## Procedures IREC

The trial was established on Tulebasin fine silty loam soil with approximately 12 percent organic matter content, a highly fertile soil with near neutral reaction. The previous crop was spring barley. Fertilization included a preplant broadcast application of 250 lb/acre of 16-20-0, and a sidedress application of 150 lb/acre of 21-0-0 at bed forming. Beets were seeded into raised 24-inch wide beds using a modified, three-row cone planter on April 11. Seeding rates were adjusted for seed size to achieve a uniform spacing of 2.5 inches for all varieties. Planting depth was approximately 0.25 inches. Individual plots were three rows, 50 feet long, arranged in a randomized complete block design with four replications.

Severe stand loss was experienced in the May 4 frost. Remaining plants were killed with Roundup herbicide applied on May 7, and beets were replanted on May 8. Weed control measures included applications of Betamix at 0.25 lb ai/acre on May 30 and June 1, and 0.33 lb ai/acre on June 11. Beets were cultivated on June 7 and June 19. Carbaryl was applied at 1.0 lb ai/acre on May 19 and May 30 for insect control. Stands were hand thinned to approximately 8-inch plant spacing on June 13. The crop received 21.5 inches of irrigation applied with solid-set sprinklers and 3.4 inches of rainfall from May through harvest.

Beet tops were removed with a flail chopper immediately prior to harvest. Beets were harvested with a modified one-row harvester on October 15. All beets from 45 feet of the center row were weighed and counted. Samples of approximately 25 lb/plot were analyzed for sucrose content and impurities by Spreckels Sugar Company laboratory personnel. Gross crop values were calculated as described above. Data were analyzed statistically as above. An over-location analysis was conducted for 1996 data using a split-plot design with location as the main plot and variety as the split-plot.

## Results and Discussion

The May 4 frost, which resulted in replanting nearly 4,000 commercial acres, killed a majority of plants at IREC. Minimum air temperatures ranged from 21 and 19 °F at Tulelake and KES, respectively, to 12 °F at the southern end of the Tulelake Basin. The KES planting was not damaged as seed had just started to germinate. Excellent stands were achieved in most varieties at both locations. Exceptions included 5CG7004, which had poor emergence at both locations, and Beta 8256, 4CG6245, 96HX405, and SX1404, which had relatively poor stands at KES.

Crop development after establishment was normal with no evidence of serious disease or pest damage at either location. At KES, average beet yield was 28.9 ton/acre (Table 1). This was intermediate between an average of 25.6 ton/acre in the 1995 trial, which was planted two weeks later, and 34.6 ton/acre achieved in 1994 with an April 18 planting date. At IREC, the average yield of 27.6 ton/acre was lower than the 1995 yield of 29.3 ton/acre, and the 1994 yield of 32.4 ton/acre. Planting at IREC occurred on April 15 and April 18 in 1994 and 1995, respectively. The year to year yield variability at both locations is highly correlated with planting date, and is in good agreement with observations from research trials designed to evaluate response to planting date.

The sugar contents observed in the 1996 trials were higher than have been experienced in previous years. Slightly, but not significantly, higher sugar contents at IREC offset slightly lower beet yields, with the result that average total sugar production and gross crop values were similar at both locations. The only significant difference between locations was in plant populations, with lower average populations at KES. The interaction between location and variety was significant for total sugar production, recoverable sugar, and gross crop value. In each year, the performance of some varieties has varied between sites. At individual locations, significant differences between varieties were observed in all parameters.

Gross crop value combines yield, sugar content, and price premiums for high sugar content into the best single measure of relative performance. Averaged over both locations, the 12 top varieties in gross value were statistically similar. While 96HX405 was significantly higher in beet yield than all but two other varieties, it was significantly lower in sugar content than all other varieties. HM Bighorn has been among the highest varieties in gross value at both locations in each of the past three years. Other varieties that produced high gross values at both locations included 96HX401, ACH9623, and HH88. Many of the remaining selections were not consistent across locations.

Twenty-one of the varieties in the 1996 trial have been evaluated in the region for three years or more. A summary of their performance over the past three years is presented (Table 2). Using gross crop value as the defining measure of performance, the IREC results place HM Bighorn, HH88, KW6000, Beta 8256, and HM7006 in a group at the top. At KES, HM Bighorn is at the top of a group of 12 varieties that are not significantly different in gross crop value. The second and third highest at KES, Monohikari and Chinook, are second and fourth from the lowest at IREC. Conversely, Beta 8256 has the lowest gross value at KES, and was significantly lower than all but two other varieties over three years. One other variety that has been among the highest producers in previous years is ACH318. In a comparison over the 1993 to 1995 seasons, ACH318 was first and second in gross value at KES and IREC, respectively.

Three varieties in the 1996 trials were included for the second year. Their performance over two years is compared with the means for all entries in the trials in Table 3. At KES, 3BG6360 produced higher yield, sugar content, total sugar, and gross value than trial means. SX1404 and 4CG6245 were less productive than trial means. At IREC, 4CG6245 and 3BG6360 were above average while SX1404 was below average in performance. The 1996 trials included 10 new selections, not previously evaluated in the region. Several of these, particularly 96HX401 and ACH9623, appear quite promising.

Table 1. (continued) Beet yield, percent sugar, total sugar production, recoverable sugar, gross crop value, and plant population for 34 sugarbeet varieties grown at Klamath Falls, OR (KES) and Tulelake, CA (IREC), 1996.

| Variety | Beet yield | | | Sugar content | | | Total sugar production | | | Recoverable sugar | | | Gross crop value | | | Population | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | KES | IREC | Mean | KES | IREC | Mean | KES | IREC | Mean | KES | IREC | Mean | KES | IREC | Mean | KES | IREC | Mean |
| | --------ton/A--------- | | | --------------%------------ | | | ------------lb/A------------ | | | -----------lb/A----------- | | | ------------$/A------------ | | | -------1000 beets/A----- | | |
| HH 50 | 29.0 | 27.2 | 28.1 | 19.0 | 19.8 | 19.4 | 11040 | 10750 | 10900 | 10340 | 10150 | 10250 | 1500 | 1470 | 1490 | 31.2 | 32.1 | 31.7 |
| HH 88 | 30.0 | 27.7 | 28.9 | 20.3 | 20.7 | 20.5 | 12190 | 11510 | 11850 | 11540 | 10840 | 11190 | 1680 | 1600 | 1640 | 29.7 | 30.3 | 30.0 |
| 96HX401 | 30.8 | 29.1 | 30.0 | 20.3 | 20.2 | 20.3 | 12520 | 11730 | 12130 | 11920 | 11080 | 11500 | 1730 | 1610 | 1670 | 28.7 | 30.9 | 29.8 |
| 96HX405 | 31.4 | 34.1 | 32.8 | 17.4 | 18.2 | 17.8 | 10850 | 12420 | 11640 | 9960 | 11670 | 10820 | 1430 | 1660 | 1550 | 19.9 | 29.2 | 24.6 |
| Chinook | 28.8 | 27.1 | 28.0 | 19.2 | 19.5 | 19.4 | 11020 | 10550 | 10790 | 10300 | 9980 | 10140 | 1500 | 1440 | 1470 | 28.3 | 33.0 | 30.7 |
| Monohikari | 30.1 | 26.0 | 28.1 | 20.4 | 19.8 | 20.1 | 12240 | 10280 | 11260 | 11570 | 9750 | 10660 | 1690 | 1410 | 1550 | 28.9 | 32.2 | 30.6 |
| Ranger | 31.2 | 28.4 | 29.8 | 18.5 | 19.6 | 19.1 | 11480 | 11080 | 11280 | 10670 | 10430 | 10550 | 1540 | 1510 | 1530 | 28.7 | 29.5 | 29.1 |
| SX1404 | 25.7 | 27.7 | 26.7 | 19.4 | 19.6 | 19.5 | 9880 | 10880 | 10380 | 9260 | 10240 | 9750 | 1340 | 1490 | 1420 | 22.3 | 29.5 | 25.9 |
| SS781R | 27.9 | 27.4 | 27.7 | 18.9 | 18.7 | 18.8 | 10410 | 10240 | 10330 | 9570 | 9590 | 9580 | 1400 | 1380 | 1390 | 30.0 | 30.1 | 30.1 |
| SS-T1 | 30.0 | 26.0 | 28.0 | 19.7 | 20.4 | 20.1 | 11740 | 10570 | 11160 | 11020 | 9980 | 10500 | 1600 | 1460 | 1540 | 23.6 | 30.4 | 27.0 |
| H90450 | 28.4 | 23.7 | 26.1 | 19.7 | 20.2 | 20.0 | 11180 | 9540 | 10360 | 10490 | 8960 | 9730 | 1530 | 1310 | 1420 | 29.3 | 26.6 | 28.0 |
| H92488 | 28.5 | 27.8 | 28.2 | 18.4 | 19.7 | 19.1 | 10480 | 10910 | 10700 | 9750 | 10340 | 10050 | 1410 | 1490 | 1450 | 28.7 | 33.1 | 30.9 |
| H92508 | 28.3 | 27.2 | 27.8 | 19.5 | 20.0 | 19.8 | 11020 | 10880 | 10950 | 10350 | 10300 | 10330 | 1500 | 1490 | 1500 | 27.3 | 26.5 | 26.9 |
| H92758 | 28.8 | 26.2 | 27.5 | 19.5 | 20.5 | 20.0 | 11200 | 10710 | 10960 | 10580 | 10190 | 10390 | 1530 | 1480 | 1510 | 30.6 | 34.0 | 32.3 |
| H947137 | 28.5 | 26.0 | 27.3 | 19.7 | 20.9 | 20.3 | 11220 | 10860 | 10990 | 10570 | 10270 | 10420 | 1540 | 1510 | 1530 | 28.8 | 29.5 | 29.2 |
| Mean | 28.9 | 27.6 | 28.3 | 19.3 | 19.9 | 19.6 | 11120 | 10960 | 11040 | 10420 | 10330 | 10380 | 1510 | 1500 | 1510 | 27.4 | 30.1 | 28.8 |
| CV (%) | 10 | 8 | 10 | 5 | 3 | 4 | 10 | 9 | 9 | 10 | 9 | 9 | 10 | 9 | 10 | 6 | 12 | 10 |
| LSD (0.05) | 4.2 | 3.2 | 2.6 | 1.2 | 0.7 | 0.7 | 1510 | 1340 | 1000 | 1410 | 1270 | 940 | 210 | 190 | 140 | 2.3 | 4.8 | 2.7 |

Table 1. (continued) Beet yield, percent sugar, total sugar production, recoverable sugar, gross crop value, and plant population for 34 sugarbeet varieties grown at Klamath Falls, OR (KES) and Tulelake, CA (IREC), 1996.

| | Beet yield | | | Sugar content | | | Total sugar production | | | Recoverable sugar | | | Gross crop value | | | Population | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variety | KES | IREC | Mean | KES | IREC | Mean | KES | IREC | Mean | KES | IREC | Mean | KES | IREC | Mean | KES | IREC | Mean |
| | --------ton/A--------- | | | --------------%------------ | | | ------------lb/A------------ | | | -----------lb/A------------ | | | ------------$/A------------ | | | -------1000 beets/A----- | | |
| HH 50 | 29.0 | 27.2 | 28.1 | 19.0 | 19.8 | 19.4 | 11040 | 10750 | 10900 | 10340 | 10150 | 10250 | 1500 | 1470 | 1490 | 31.2 | 32.1 | 31.7 |
| HH 88 | 30.0 | 27.7 | 28.9 | 20.3 | 20.7 | 20.5 | 12190 | 11510 | 11850 | 11540 | 10840 | 11190 | 1680 | 1600 | 1640 | 29.7 | 30.3 | 30.0 |
| 96HX401 | 30.8 | 29.1 | 30.0 | 20.3 | 20.2 | 20.3 | 12520 | 11730 | 12130 | 11920 | 11080 | 11500 | 1730 | 1610 | 1670 | 28.7 | 30.9 | 29.8 |
| 96HX405 | 31.4 | 34.1 | 32.8 | 17.4 | 18.2 | 17.8 | 10850 | 12420 | 11640 | 9960 | 11670 | 10820 | 1430 | 1660 | 1550 | 19.9 | 29.2 | 24.6 |
| Chinook | 28.8 | 27.1 | 28.0 | 19.2 | 19.5 | 19.4 | 11020 | 10550 | 10790 | 10300 | 9980 | 10140 | 1500 | 1440 | 1470 | 28.3 | 33.0 | 30.7 |
| Monohikari | 30.1 | 26.0 | 28.1 | 20.4 | 19.8 | 20.1 | 12240 | 10280 | 11260 | 11570 | 9750 | 10660 | 1690 | 1410 | 1550 | 28.9 | 32.2 | 30.6 |
| Ranger | 31.2 | 28.4 | 29.8 | 18.5 | 19.6 | 19.1 | 11480 | 11080 | 11280 | 10670 | 10430 | 10550 | 1540 | 1510 | 1530 | 28.7 | 29.5 | 29.1 |
| SX1404 | 25.7 | 27.7 | 26.7 | 19.4 | 19.6 | 19.5 | 9880 | 10880 | 10380 | 9260 | 10240 | 9750 | 1340 | 1490 | 1420 | 22.3 | 29.5 | 25.9 |
| SS781R | 27.9 | 27.4 | 27.7 | 18.9 | 18.7 | 18.8 | 10410 | 10240 | 10330 | 9570 | 9590 | 9580 | 1400 | 1380 | 1390 | 30.0 | 30.1 | 30.1 |
| SS-T1 | 30.0 | 26.0 | 28.0 | 19.7 | 20.4 | 20.1 | 11740 | 10570 | 11160 | 11020 | 9980 | 10500 | 1600 | 1460 | 1540 | 23.6 | 30.4 | 27.0 |
| H90450 | 28.4 | 23.7 | 26.1 | 19.7 | 20.2 | 20.0 | 11180 | 9540 | 10360 | 10490 | 8960 | 9730 | 1530 | 1310 | 1420 | 29.3 | 26.6 | 28.0 |
| H92488 | 28.5 | 27.8 | 28.2 | 18.4 | 19.7 | 19.1 | 10480 | 10910 | 10700 | 9750 | 10340 | 10050 | 1410 | 1490 | 1450 | 28.7 | 33.1 | 30.9 |
| H92508 | 28.3 | 27.2 | 27.8 | 19.5 | 20.0 | 19.8 | 11020 | 10880 | 10950 | 10350 | 10300 | 10330 | 1500 | 1490 | 1500 | 27.3 | 26.5 | 26.9 |
| H92758 | 28.8 | 26.2 | 27.5 | 19.5 | 20.5 | 20.0 | 11200 | 10710 | 10960 | 10580 | 10190 | 10390 | 1530 | 1480 | 1510 | 30.6 | 34.0 | 32.3 |
| H947137 | 28.5 | 26.0 | 27.3 | 19.7 | 20.9 | 20.3 | 11220 | 10860 | 10990 | 10570 | 10270 | 10420 | 1540 | 1510 | 1530 | 28.8 | 29.5 | 29.2 |
| Mean | 28.9 | 27.6 | 28.3 | 19.3 | 19.9 | 19.6 | 11120 | 10960 | 11040 | 10420 | 10330 | 10380 | 1510 | 1500 | 1510 | 27.4 | 30.1 | 28.8 |
| CV (%) | 10 | 8 | 10 | 5 | 3 | 4 | 10 | 9 | 9 | 10 | 9 | 9 | 10 | 9 | 10 | 6 | 12 | 10 |
| LSD (0.05) | 4.2 | 3.2 | 2.6 | 1.2 | 0.7 | 0.7 | 1510 | 1340 | 1000 | 1410 | 1270 | 940 | 210 | 190 | 140 | 2.3 | 4.8 | 2.7 |

Table 2. Summary of sugarbeet variety performance for 1994 - 1996 at Klamath Falls, OR (KES) and Tulelake, CA (IREC).

**KES: 3-Year Means**

| Variety | Beet yield | Sugar content | Sugar yield | Gross value |
|---|---|---|---|---|
| | ton/A | % | lb/A | $/A |
| Bighorn | 32.7 | 18.7 | 12190 | 1610 |
| Monohikari | 31.3 | 19.0 | 11880 | 1570 |
| Chinook | 31.8 | 18.6 | 11790 | 1540 |
| Beta 1996 | 30.4 | 19.0 | 11550 | 1530 |
| HH 88 | 29.9 | 19.2 | 11510 | 1520 |
| SS-T1 | 30.5 | 18.9 | 11490 | 1510 |
| HH 50 | 30.4 | 18.9 | 11460 | 1510 |
| HM 5892 | 31.6 | 18.2 | 11530 | 1510 |
| Beta 4885 | 29.6 | 19.2 | 11370 | 1500 |
| Beta 8422 | 31.1 | 18.4 | 11450 | 1490 |
| ACH 318 | 32.1 | 17.9 | 11500 | 1490 |
| HM WS 91 | 30.4 | 18.7 | 11310 | 1480 |
| KW 6000 | 30.9 | 18.4 | 11340 | 1480 |
| Ranger | 31.6 | 17.9 | 11270 | 1460 |
| ACH 203 | 30.2 | 18.5 | 11140 | 1460 |
| ACH 211 | 29.2 | 18.9 | 11020 | 1450 |
| HM 7006 | 29.7 | 18.8 | 11100 | 1450 |
| H 92488 | 30.6 | 18.2 | 11100 | 1450 |
| ACH 191 | 27.8 | 18.9 | 10510 | 1390 |
| Beta 8450 | 29.3 | 18.0 | 10510 | 1360 |
| Beta 8256 | 26.9 | 18.8 | 10050 | 1320 |
| Mean | 30.4 | 18.6 | 11290 | 1480 |
| CV (%) | 10 | 4 | 10 | 10 |
| LSD (0.05) | 2.4 | 0.7 | 880 | 120 |

**IREC: 3-Year Means**

| Variety | Beet yield | Sugar content | Sugar yield | Gross value |
|---|---|---|---|---|
| | ton/A | % | lb/A | $/A |
| Bighorn | 32.2 | 19.0 | 12200 | 1610 |
| HH 88 | 30.5 | 19.7 | 12000 | 1600 |
| KW 6000 | 31.0 | 19.0 | 11750 | 1550 |
| Beta 8256 | 30.4 | 19.0 | 11540 | 1520 |
| HM 7006 | 30.9 | 18.8 | 11570 | 1520 |
| ACH 191 | 29.8 | 19.2 | 11420 | 1510 |
| HH50 | 31.5 | 18.4 | 11490 | 1500 |
| HMWS91 | 30.7 | 18.6 | 11370 | 1490 |
| Beta 1996 | 29.5 | 19.0 | 11200 | 1480 |
| Ranger | 31.5 | 18.3 | 11460 | 1480 |
| Beta 4885 | 30.0 | 18.8 | 11220 | 1470 |
| ACH 203 | 29.9 | 18.8 | 11220 | 1470 |
| H92488 | 30.8 | 18.3 | 11250 | 1470 |
| ACH318 | 31.6 | 18.0 | 11300 | 1470 |
| Beta 8450 | 30.3 | 18.5 | 11160 | 1460 |
| SS-T1 | 28.7 | 19.1 | 10930 | 1440 |
| Beta 8422 | 29.9 | 18.5 | 11030 | 1440 |
| Chinook | 30.2 | 18.2 | 10970 | 1420 |
| ACH 211 | 28.3 | 18.8 | 10610 | 1400 |
| Monohikari | 28.2 | 18.8 | 10580 | 1390 |
| HM 5892 | 28.8 | 18.4 | 10580 | 1380 |
| Mean | 30.2 | 18.7 | 11280 | 1480 |
| CV (%) | 7 | 4 | 7 | 8 |
| LSD (0.05) | 1.6 | 0.5 | 670 | 100 |

Table 3. Two-year summary of performance of three sugarbeet varieties, grown at Klamath Falls, OR (KES) and Tulelake, CA (REC) in 1995 and 1996.

| Variety | Beet yield | Sugar content | Sugar yield | Gross crop value |
|---|---|---|---|---|
| | ton/A | % | lb/A | $/A |
| | | KES | | |
| 3BG6360 | 28.9 | 19.7 | 11350 | 1530 |
| SX 1404 | 25.9 | 18.6 | 9610 | 1260 |
| 4CG6245 | 25.2 | 18.8 | 9400 | 1250 |
| Trial Means[1] | 27.3 | 18.8 | 10210 | 1360 |
| | | IREC | | |
| 4CG6245 | 30.7 | 18.7 | 11440 | 1510 |
| 3BG6360 | 29 | 19.1 | 11030 | 1470 |
| SX1404 | 27.7 | 18.8 | 10400 | 1380 |
| Trial means | 28.5 | 19 | 10760 | 1430 |

[1]/ Means for all entries in the 1995 and 1996 CBGA coded trials

## Sugarbeet Planting Date and Plant Population Studies

K.A. Rykbost[1], H.L. Carlson[2], D. Kirby[2], and R.L. Dovel[1]

### Introduction

Difficult conditions during crop establishment frequently result in stand loss in local sugarbeet crops. Replanting has been necessary on 5 to 50 percent of local crops in the seven years commercial sugarbeet crops have been grown in the region. Producers need a basis for decisions on replanting when less than total stand loss results from frost, insect, wind, or other crop damage. Previous research established effects of delayed planting on crop yields and economic returns. Delaying planting past May 1 has been shown to reduce beet yield about 1.75 tons/acre for each week delay past May 1, at a loss in gross crop value of about $85/acre/week. Incidental observations in variety trials have shown sugarbeets compensate very well for low populations under local conditions. Stands at 50 percent of target have produced yields nearly equal to those for varieties with target populations. The decision to replant must consider the consequences of lower yield potential for delayed planting against the potential reduction in yield expected for low populations. This study was initiated in 1994 to evaluate effects of plant populations in sugarbeet crops established from early April through late May.

Experiments were conducted at the Intermountain Research and Extension Center (IREC) in Tulelake, CA in 1994, 1995, and 1996. Wet soil conditions in 1995 delayed field work at the Klamath Experiment Station (KES), precluding the opportunity to plant prior to mid-May. The study was conducted at KES in 1994 and 1996. Results for 1996 and over the duration of the study are presented in this report.

### Procedures (KES)

Field preparations, planting method, cultural practices, and harvest methods, were the same as described for the CBGA variety trial on page 10. The 1996 experiment was a split-plot design with planting dates of April 30, May 10, May 20, and May 29 as main plots; plant populations of approximately 32,000, 24,000, 16,000, 12,000, and 8,000 plants/acre as split-plots; and five replications. Individual plots were three rows, 24 feet long. Plant populations were established by hand-thinning the four planting date main plots on June 15, June 18, June 28, and July 2, or about 5 weeks after planting. The variety HM Bighorn was used for all planting dates.

All beets were harvested on October 14. Total weight and number of beets was

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1/ Superintendent/Professor and Associate Professor, respectively, Klamath Experiment Station, Klamath Falls, OR.

2/ Past Superintendent/Farm Advisor and Acting Superintendent/Research Associate, respectively, University of California Intermountain Research and Extension Center, Tulelake, CA.

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All beets were harvested on October 14. Total weight and number of beets was recorded from the center row of each plot. Approximately 25-pound samples from each plot were sent to the Spreckels Sugar Company laboratory for determination of tare loss, sugar content, and impurities. Total sugar content was calculated as the product of yield, adjusted for tare loss, and percent sugar. Recoverable sugar was determined using an empirical formula to account for impurities. Gross crop values were calculated based on a net selling price of $24/cwt, beet yield, sugar content, and terms of the CBGA-processor contract for 1996.

The procedures were essentially the same in the 1994 study. Planting dates were April 15, April 29, May 11, and May 27. The WS62 variety was grown in 1994. All beets were harvested on October 13. The 1994 laboratory analyses did not include impurities and therefore recoverable sugar could not be determined.

## Procedures (IREC)

The trial site was a Tulebasin fine silty loam soil with approximately 12 percent organic matter. The previous crop was spring barley. Fertilization included a pre-plant broadcast application of 250 lb/acre of 16-20-0 and a banded application of 150 lb/acre of 21-0-0 at planting. Beets of the variety WS62 were seeded into raised 24-inch beds with a modified 3-row belted cone research planter. Seeds were spaced at 3.5 inches at a depth of 0.25 inches. Plots were three 24-inch rows, 50 feet long, arranged in a split-plot design with planting dates of April 5, April 18, May 2, May 22, and May 31 as main plots. Plant population variables were randomly assigned to split-plot treatments and were achieved by hand-thinning 4 to 6 weeks after planting.

Weeds were controlled with applications of Betamix at 0.25 lb ai/acre on May 7, and Betamix Progress at 0.25 lb ai/acre on May 29, June 4, and June 10. Insect control was achieved with applications of carbaryl at 1.0 lb ai/acre on June 4 and Malathion at 1.0 lb ai/acre on August 17. The crop received approximately 20 inches of irrigation applied through solid-set sprinklers arranged on a 30- by 50-foot spacing.

Beet tops were removed with a flail chopper immediately prior to harvest. Beets were harvested with a modified one-row harvester on October 14. All beets from 45 feet of the center row were weighed and counted. Samples of approximately 25 lb/plot were analyzed for tare loss, sugar content, and impurities by Spreckels Sugar Company laboratory personnel. Gross crop values were calculated as described for KES data.

Similar procedures were followed in studies conducted in 1994 and 1995. The variety WS62 was grown in each year. Planting dates were nearly the same each year and the harvest was completed within one or two days of October 15.

## Results and Discussion (KES)

The 1996 KES crop was not affected by the frost of May 4 that killed most fields that were emerged at the time. Seedlings in the first planting date did not emerge until about May 12. None of the later frosts damaged plantings in this study. Sufficient plant stands were obtained in all planting dates to achieve targeted populations. Crop development was normal through the season. Plants remained vigorous until harvest. As in 1994, a prostrate growth habit observed at low populations did not appear to influence beet production.

Effects of planting date on beet yield were similar to results observed in several previous years of research. Beet yield declined by about 1.4 tons/acre/week over the planting period from April 30 to May 29 (Table 2). The yield decrease from April 30 to May 10 was not significant, but successive planting delays resulted in significant yield reductions. The 0.5 percent increase in sugar content from first to last planting dates was not statistically significant. The largest decline in beet yield, total sugar production, and gross crop value occurred between the third and fourth planting dates. Similar trends occurred in the 1994 KES statistical significance in yield differences between each date. Planting date did not affect sugar content in 1994.

Yield differences between the four highest plant populations in 1996 were not statistically significant (Table 2). The lowest population produced 89 percent of the yield achieved at the highest population. Lower populations resulted in lower sugar content, however. The three lowest populations resulted in significantly lower sugar content than the two high populations. A similar trend occurred at KES in 1994 (Table 1). The combined effects of population on yield and sugar content are measured by gross crop value. In 1996, gross value differed by only $100/acre among the four highest populations, and was significantly lower at the lowest population (Table 2). Loss in crop value from highest to lowest population was $260 and $330/acre in 1996 and 1994, respectively. For comparison, loss due to delaying planting from earliest to latest date was $250 and $570/acre, respectively (Table 1).

Effects of plant population on crop performance were similar over the range of planting dates in both years. The interaction between planting date and plant population was not statistically significant for any parameter in either year. The highest population produced the highest crop value in the earliest planting in both years while the second highest population produced the highest crop value for the latest planting.

## Results and Discussion (IREC)

With the exception of serious frost damage to April plantings in 1996, the effects of planting date and populations on sugarbeet production were similar to results observed at KES (Tables 3-5). Beet seedlings in cotyledon to four true leaf stages suffered severe damage in the May 4, 1996 frost at IREC. Sufficient seedlings survived to maintain the plantings and obtain useful data, but the reduced stands were not uniformly spaced as in plots where populations were established by hand thinning. It is interesting to note that all early plantings with populations of 12,000 plants/acre or more produced higher beet yields than any population levels achieved in the May 16 planting (Table 5). In spite of low plant populations, the April 19 planting produced significantly higher yields than later plantings.

Beet yields declined by about 10 and 8 tons/acre from early April to late May in IREC plantings in 1994 and 1995, respectively (Tables 3 and 4). The reductions were greatest after early May in both years. As at KES, sugar content was not affected by planting date in 1994. In 1995, a significant reduction in sugar content was observed at the latest planting date. The eight week delay in planting from early April to late May reduced gross crop value by about $400/acre in both years

Yield differences between the four highest populations were quite small and in many cases not statistically significant (Tables 3-5). Averaged over planting dates, the highest population produced significantly lower beet yields than one or more lower populations in each year. The lowest population was significantly lower in beet yield than all other populations in 1994 and 1996. Effects of population on sugar content were not significant in 1994 or 1996. The lowest population produced significantly lower sugar content than all other population levels in 1995. The interaction between planting date and plant population was not significant in any year, indicating that population effects were independent of planting date.

## Results and Discussion (over years and locations)

Data from both locations and all years were subjected to a multiple regression analysis. The statistical significance of factors analyzed and R-squared values for the four parameters are presented in Table 6. The analyses revealed a highly significant effect of linear and quadratic components of plant population on all parameters. Planting date effects were also highly significant for beet yield, sugar yield, and gross crop value, but not for sugar content. The interaction between planting date and population was significant for beet yield and sugar content, but not for sugar yield or gross value.

A summary of the analysis for effects of plant population and planting date on beet yield is presented in Figure 1. The three-dimensional surface derived from the data shows how yield is affected by plant population over the two month planting period. The analysis indicates that beet yield response to both planting date and plant population was not linear, but quadratic. Effects of these factors were greater at the extremes of late May planting and very low populations, while effects between early plantings and higher population levels were small. The interaction between planting date and plant population is shown as a more abrupt decline in yield for low population at late May planting than for early April planting. The combination of planting date and plant population treatments accounted for nearly 60 percent of the variability in beet yield in the study. Differences between years and locations undoubtedly account for much of the remaining variability.

Planting date did not significantly affect sugar content. The quadratic response of sugar content to plant population (Figure 2) shows slightly lower sugar content for both high and low populations, with maximum levels predicted at about 20,000 plants/acre. The low R-squared value indicates that most of the observed variability in sugar content was due to other factors. Variability over years and location accounts for much of this.

Response surfaces showing effects of planting date and population on sugar yield and gross return are quite similar to the beet yield response (Figures 3 and 4). These factors accounted for over 50 percent of observed variability. The very small response of sugar content to population had little effect on total sugar production or crop value.

## Summary

The study reaffirmed the importance of early planting to high yields and economic returns for sugarbeets in the Klamath Basin. Effects of population on crop performance were much less than expected. Findings indicate that stand losses greater than 50 percent in early plantings will still support higher yields and economic returns than high populations planted several weeks later. An interpretation of the findings from this study must consider that plants were uniformly spaced in these trials, and weed competition was not a factor. This may not be the case in fields where partial stand loss occurs naturally.

Table 1. Effects of planting date and plant population on beet yield, sugar content, total sugar production, and gross crop value of WS62 sugarbeets grown at Klamath Falls, OR, 1994.

| Planting date | Plant population | Beet yield | Sugar content | Total sugar production | Gross crop value |
|---|---|---|---|---|---|
| | 1000 pl/A | ton /A | % | lb/A | $/A |
| April 15 | 29.7 | 34.2 | 18.1 | 12400 | 1590 |
| | 22.3 | 34.9 | 17.4 | 12100 | 1530 |
| | 14.1 | 34.3 | 17.5 | 12000 | 1520 |
| | 10.9 | 33.2 | 17.8 | 11800 | 1510 |
| | 7.9 | 30.3 | 17.5 | 10600 | 1350 |
| April 29 | 30.1 | 34.3 | 17.7 | 12200 | 1550 |
| | 24.0 | 32.8 | 18.1 | 11900 | 1520 |
| | 14.9 | 31.4 | 17.9 | 11200 | 1440 |
| | 11.9 | 31.2 | 17.4 | 10800 | 1370 |
| | 8.1 | 25.9 | 18.0 | 9300 | 1190 |
| May 11 | 30.9 | 30.4 | 18.1 | 11000 | 1410 |
| | 23.2 | 30.0 | 17.9 | 10700 | 1370 |
| | 15.4 | 29.9 | 17.9 | 10700 | 1370 |
| | 11.5 | 27.5 | 17.4 | 9600 | 1210 |
| | 8.1 | 24.7 | 17.5 | 8600 | 1090 |
| May 27 | 28.3 | 22.5 | 18.1 | 8200 | 1050 |
| | 23.4 | 23.9 | 17.9 | 8600 | 1100 |
| | 15.1 | 23.4 | 17.8 | 8300 | 1060 |
| | 12.1 | 19.1 | 17.3 | 6600 | 840 |
| | 8.3 | 14.1 | 17.6 | 5000 | 630 |
| Planting date main effect (average of five populations) | | | | | |
| April 15 | 17.0 | 33.4 | 17.7 | 11800 | 1500 |
| April 29 | 17.8 | 31.1 | 17.8 | 11100 | 1410 |
| May 11 | 17.8 | 28.5 | 17.7 | 10100 | 1290 |
| May 27 | 17.4 | 20.6 | 17.7 | 7300 | 930 |
| CV (%) | 8 | 9 | 3 | 9 | 9 |
| LSD (0.05) | NS | 1.5 | NS | 540 | 70 |
| Population effect (average of four planting dates) | | | | | |
| | 29.8 | 30.4 | 18.0 | 10900 | 1400 |
| | 23.2 | 30.4 | 17.8 | 10800 | 1380 |
| | 14.9 | 29.8 | 17.8 | 10600 | 1350 |
| | 11.6 | 27.8 | 17.5 | 9700 | 1230 |
| | 8.1 | 23.4 | 17.7 | 8400 | 1070 |
| CV (%) | 6 | 10 | 3 | 10 | 10 |
| LSD (0.05) | 0.6 | 1.8 | 0.3 | 650 | 90 |

Table 2. Effects of planting date and plant population on beet yield, sugar content, total sugar production, and gross crop value of HM Bighorn sugarbeets, Klamath Falls, OR, 1996.

| Planting date | Plant population | Beet yield | Sugar content | Total sugar production | Gross crop value |
|---|---|---|---|---|---|
| | 1000 pl/A | ton /A | % | lb/A | S/A |
| April 30 | 29.5 | 29.2 | 18.9 | 11080 | 1500 |
| | 22.6 | 26.8 | 18.8 | 10070 | 1360 |
| | 16.4 | 27.5 | 18.1 | 10020 | 1340 |
| | 11.7 | 29.0 | 18.3 | 10600 | 1420 |
| | 7.9 | 27.8 | 17.0 | 9460 | 1240 |
| May 10 | 30.5 | 27.5 | 18.7 | 10320 | 1390 |
| | 23.0 | 27.4 | 19.0 | 10390 | 1410 |
| | 15.2 | 26.5 | 18.4 | 9780 | 1310 |
| | 11.3 | 27.5 | 18.3 | 10080 | 1350 |
| | 8.1 | 25.9 | 16.8 | 8440 | 1130 |
| May 20 | 31.1 | 26.1 | 19.2 | 9960 | 1350 |
| | 23.6 | 25.1 | 19.3 | 9650 | 1310 |
| | 16.2 | 27.1 | 18.1 | 9800 | 1300 |
| | 11.7 | 24.4 | 18.1 | 8850 | 1180 |
| | 8.3 | 20.5 | 18.7 | 7640 | 1030 |
| May 29 | 30.3 | 22.7 | 19.1 | 8650 | 1170 |
| | 24.0 | 23.7 | 19.8 | 9360 | 1280 |
| | 16.4 | 23.3 | 18.2 | 8470 | 1130 |
| | 12.1 | 21.7 | 18.1 | 7810 | 1040 |
| | 8.7 | 19.5 | 18.5 | 7190 | 960 |
| Planting date main effect (average of five populations) | | | | | |
| April 30 | 17.6 | 28.1 | 18.2 | 10240 | 1370 |
| May 10 | 17.6 | 27.0 | 18.2 | 9800 | 1320 |
| May 20 | 18.2 | 24.7 | 18.7 | 9180 | 1240 |
| May 29 | 18.3 | 22.2 | 18.7 | 8300 | 1120 |
| CV (%) | 9 | 10 | 5 | 12 | 13 |
| LSD (0.05) | NS | 1.5 | NS | 690 | 100 |
| Population effect (average of four planting dates) | | | | | |
| | 30.3 | 26.4 | 19.0 | 10000 | 1350 |
| | 23.3 | 25.8 | 19.2 | 9870 | 1340 |
| | 16.1 | 26.1 | 18.2 | 9520 | 1270 |
| | 11.7 | 25.7 | 18.2 | 9340 | 1250 |
| | 8.3 | 23.4 | 17.8 | 8180 | 1090 |
| CV (%) | 8 | 11 | 5 | 11 | 12 |
| LSD (0.05) | 1.0 | 1.7 | 0.6 | 660 | 100 |

Table 3. Effects of planting date and plant population on beet yield, sugar content, total sugar production, and gross crop value of WS62 sugarbeets, Tulelake, CA, 1994.

| Planting date | Plant population | Beet yield | Sugar content | Total sugar production | Gross crop value |
|---|---|---|---|---|---|
| | 1000 pl/A | ton /A | % | lb/A | $/A |
| April 5 | 36.4 | 33.4 | 17.8 | 11800 | 1510 |
| | 23.2 | 34.2 | 17.5 | 12000 | 1520 |
| | 16.3 | 35.6 | 17.8 | 12600 | 1610 |
| | 10.9 | 33.4 | 17.5 | 11600 | 1480 |
| | 7.3 | 29.8 | 17.7 | 10600 | 1340 |
| April 19 | 33.1 | 33.0 | 17.8 | 11800 | 1500 |
| | 23.7 | 34.6 | 18.0 | 12400 | 1590 |
| | 16.3 | 35.8 | 17.6 | 12600 | 1600 |
| | 11.4 | 34.3 | 17.8 | 12200 | 1560 |
| | 7.7 | 28.9 | 17.8 | 10200 | 1310 |
| May 3 | 33.5 | 31.6 | 17.9 | 11400 | 1450 |
| | 23.0 | 32.6 | 18.0 | 11800 | 1510 |
| | 15.3 | 30.4 | 17.9 | 10800 | 1390 |
| | 10.9 | 29.9 | 18.0 | 10800 | 1380 |
| | 7.8 | 27.7 | 18.1 | 10000 | 1280 |
| May 17 | 27.7 | 26.3 | 17.5 | 9200 | 1170 |
| | 21.9 | 27.7 | 17.8 | 9800 | 1260 |
| | 16.8 | 27.9 | 17.6 | 9800 | 1250 |
| | 11.3 | 28.4 | 18.0 | 10200 | 1310 |
| | 9.0 | 25.0 | 17.5 | 8800 | 1110 |
| May 31 | 25.9 | 23.4 | 17.8 | 8400 | 1060 |
| | 22.0 | 23.8 | 17.7 | 8400 | 1070 |
| | 15.7 | 24.6 | 17.9 | 8800 | 1120 |
| | 10.6 | 23.6 | 18.0 | 8400 | 1090 |
| | 7.2 | 19.4 | 17.8 | 6800 | 880 |
| Planting date main effect (average of five populations) | | | | | |
| April 5 | 18.8 | 33.3 | 17.6 | 11800 | 1490 |
| April 19 | 18.4 | 33.3 | 17.8 | 11800 | 1510 |
| May 3 | 18.1 | 30.4 | 18.0 | 10800 | 1400 |
| May 17 | 17.3 | 27.1 | 17.7 | 9600 | 1220 |
| May 31 | 16.3 | 22.9 | 17.8 | 8200 | 1040 |
| CV (%) | 9 | 7 | 3 | 6 | 6 |
| LSD (0.05) | 0.9 | 1.1 | NS | 390 | 50 |
| Population effect (average of five dates) | | | | | |
| | 31.3 | 29.5 | 17.8 | 10400 | 1340 |
| | 22.8 | 30.6 | 17.8 | 10800 | 1390 |
| | 16.1 | 30.9 | 17.7 | 11000 | 1400 |
| | 11.0 | 29.9 | 17.9 | 10600 | 1360 |
| | 7.8 | 26.1 | 17.8 | 9200 | 1180 |
| CV (%) | 9 | 7 | 2 | 7 | 7 |
| LSD (0.05) | 0.9 | 1.1 | NS | 400 | 50 |

Table 4. Effects of planting date and plant population on beet yield, sugar content, total sugar production, and gross crop value of WS62 sugarbeets, Tulelake, CA, 1995.

| Planting date | Plant population | Beet yield | Sugar content | Total sugar production | Gross crop value |
|---|---|---|---|---|---|
| | 1000 pl/A | ton /A | % | lb/A | $/A |
| April 5 | 37.7 | 29.1 | 16.9 | 9790 | 1270 |
| | 22.2 | 31.4 | 16.6 | 10450 | 1350 |
| | 16.5 | 29.9 | 16.7 | 9970 | 1290 |
| | 10.6 | 29.9 | 16.5 | 9910 | 1280 |
| | 7.7 | 28.2 | 16.2 | 9090 | 1160 |
| April 19 | 34.7 | 28.3 | 16.5 | 9330 | 1210 |
| | 23.0 | 28.1 | 17.3 | 9730 | 1280 |
| | 16.1 | 29.1 | 16.5 | 9560 | 1230 |
| | 11.8 | 29.3 | 16.4 | 9590 | 1240 |
| | 8.2 | 26.7 | 16.4 | 8740 | 1130 |
| May 3 | 37.2 | 25.8 | 16.8 | 8660 | 1130 |
| | 23.3 | 28.3 | 16.7 | 9440 | 1230 |
| | 16.6 | 28.6 | 16.9 | 9670 | 1260 |
| | 11.6 | 27.4 | 16.9 | 9280 | 1210 |
| | 8.8 | 26.0 | 15.7 | 8150 | 1030 |
| May 17 | 35.4 | 24.3 | 16.1 | 7830 | 1000 |
| | 23.5 | 24.7 | 16.8 | 8300 | 1080 |
| | 19.6 | 25.5 | 16.4 | 8370 | 1080 |
| | 11.6 | 26.3 | 16.9 | 8930 | 1170 |
| | 7.5 | 23.9 | 16.2 | 7750 | 1000 |
| May 31 | 34.3 | 20.7 | 15.8 | 6520 | 830 |
| | 22.0 | 22.2 | 16.0 | 7120 | 910 |
| | 15.8 | 22.3 | 16.6 | 7400 | 960 |
| | 10.6 | 21.9 | 16.4 | 7180 | 930 |
| | 7.1 | 20.2 | 15.7 | 6360 | 810 |
| Planting date main effect (average of five populations) | | | | | |
| April 5 | 18.0 | 29.7 | 16.6 | 9840 | 1270 |
| April 19 | 18.8 | 28.3 | 16.6 | 9390 | 1220 |
| May 3 | 18.9 | 27.2 | 16.6 | 9040 | 1170 |
| May 17 | 19.5 | 24.9 | 16.5 | 8240 | 1070 |
| May 31 | 19.5 | 21.5 | 16.1 | 6910 | 890 |
| CV (%) | 16 | 9 | 3 | 10 | 10 |
| LSD (0.05) | NS | 1.4 | 0.3 | 490 | 70 |
| Population effect (average of five planting dates) | | | | | |
| | 35.9 | 25.6 | 16.4 | 8430 | 1090 |
| | 22.8 | 26.9 | 16.7 | 9010 | 1170 |
| | 16.9 | 27.1 | 16.6 | 8990 | 1170 |
| | 11.3 | 27.0 | 16.6 | 8980 | 1160 |
| | 7.9 | 25.0 | 16.0 | 8020 | 1030 |
| CV (%) | 13 | 8 | 4 | 8 | 9 |
| LSD (0.05) | 1.4 | 1.1 | 0.4 | 390 | 60 |

Table 5. Effects of planting date and plant population on beet yield, sugar content, total sugar production, and gross crop value of WS62 sugarbeets, Tulelake, CA, 1996.

| Planting date | Plant population | Beet yield | Sugar content | Total sugar production | Gross crop value |
|---|---|---|---|---|---|
| | 1000 pl/A | ton /A | % | lb/A | $/A |
| April 5 | 12.4 | 26.8 | 18.5 | 9880 | 1330 |
| | 14.3 | 29.5 | 18.5 | 10870 | 1460 |
| | 12.0 | 28.5 | 18.4 | 10510 | 1410 |
| | 8.9 | 25.3 | 18.7 | 9490 | 1280 |
| | 7.4 | 19.6 | 18.4 | 7220 | 970 |
| April 19 | 14.8 | 31.7 | 18.6 | 11760 | 1580 |
| | 12.9 | 33.0 | 18.3 | 12070 | 1620 |
| | 12.7 | 27.4 | 18.2 | 9990 | 1340 |
| | 10.4 | 27.3 | 18.5 | 10060 | 1350 |
| | 8.6 | 26.6 | 18.0 | 9540 | 1270 |
| May 2 | 26.1 | 28.7 | 18.6 | 10680 | 1440 |
| | 23.2 | 30.0 | 18.8 | 11300 | 1530 |
| | 16.3 | 29.4 | 18.9 | 11140 | 1510 |
| | 16.7 | 27.8 | 18.8 | 10480 | 1410 |
| | 10.2 | 26.2 | 18.4 | 9630 | 1290 |
| May 16 | 33.2 | 25.8 | 18.6 | 9590 | 1290 |
| | 20.6 | 26.0 | 18.5 | 9640 | 1300 |
| | 16.5 | 26.7 | 19.0 | 10150 | 1370 |
| | 16.6 | 23.3 | 18.7 | 8710 | 1170 |
| | 8.3 | 22.4 | 18.7 | 8360 | 1130 |
| May 30 | 33.1 | 23.4 | 19.1 | 8960 | 1220 |
| | 19.1 | 25.0 | 18.8 | 9400 | 1270 |
| | 14.8 | 23.7 | 18.9 | 8990 | 1220 |
| | 17.6 | 21.3 | 18.6 | 7930 | 1070 |
| | 14.0 | 19.2 | 18.4 | 7080 | 950 |
| Planting date main effect (average of five populations) | | | | | |
| April 5 | 11.0 | 25.9 | 18.5 | 9590 | 1290 |
| April 19 | 11.9 | 29.2 | 18.3 | 10680 | 1430 |
| May 2 | 18.5 | 28.5 | 18.7 | 10650 | 1440 |
| May 16 | 19.0 | 24.9 | 18.7 | 9290 | 1250 |
| May 30 | 19.7 | 22.5 | 18.8 | 8470 | 1140 |
| CV (%) | 31 | 11 | 3 | 12 | 12 |
| LSD (0.05) | 3.0 | 1.7 | 0.4 | 690 | 100 |
| Population effect (average of five planting dates) | | | | | |
| | 23.9 | 27.3 | 18.7 | 10170 | 1370 |
| | 18.0 | 28.7 | 18.6 | 10660 | 1430 |
| | 14.5 | 27.2 | 18.7 | 10150 | 1370 |
| | 14.0 | 25.0 | 18.7 | 9330 | 1260 |
| | 9.7 | 22.8 | 18.4 | 8370 | 1120 |
| CV (%) | 42 | 10 | 3 | 10 | 10 |
| LSD (0.05) | 3.8 | 1.4 | NS | 530 | 80 |

Table 6. Statistical significance of linear and quadratic regression effects of planting date (days after March 31), plant population, and their interaction on beet yield, sugar content, sugar yield, and gross value at two locations over 1994 - 1996.

| Regression factor | Level of significance [1] | | | |
|---|---|---|---|---|
| | Beet Yield | Sugar | Sugar Yield | Gross Value |
| Days | ** | NS | ** | ** |
| $(Days)^2$ | ** | NS | ** | ** |
| Population | ** | ** | ** | ** |
| $(Population)^2$ | ** | ** | ** | ** |
| Days x Population | ** | * | NS | NS |
| $(Days \times Population)^2$ | * | NS | NS | NS |
| Multiple $R^2$ | 0.58 | 0.04 | 0.54 | 0.51 |

1/ Level of significance: NS - not significant
* - significant at 0.05 probability
** - significant at 0.01 probability

Figure 1. Beet Yield Response to Planting Date and Plant Population from KES and IREC data, 1994-1996.

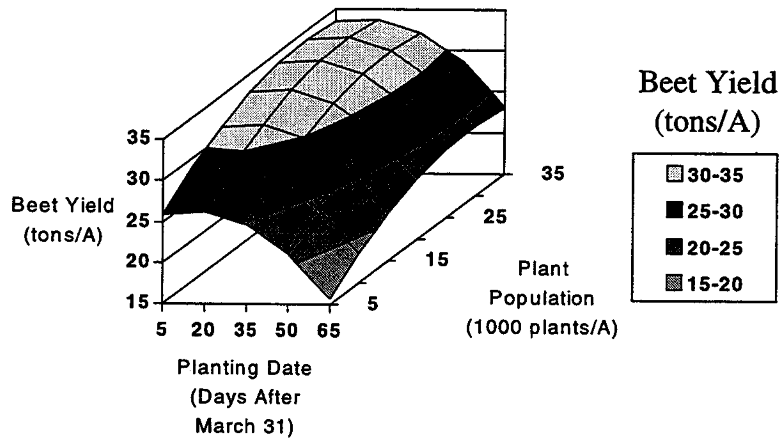



Figure 2. Beet Sugar Concentration Response to Planting Date and Plant Population from KES and IREC data, 1994-1996.

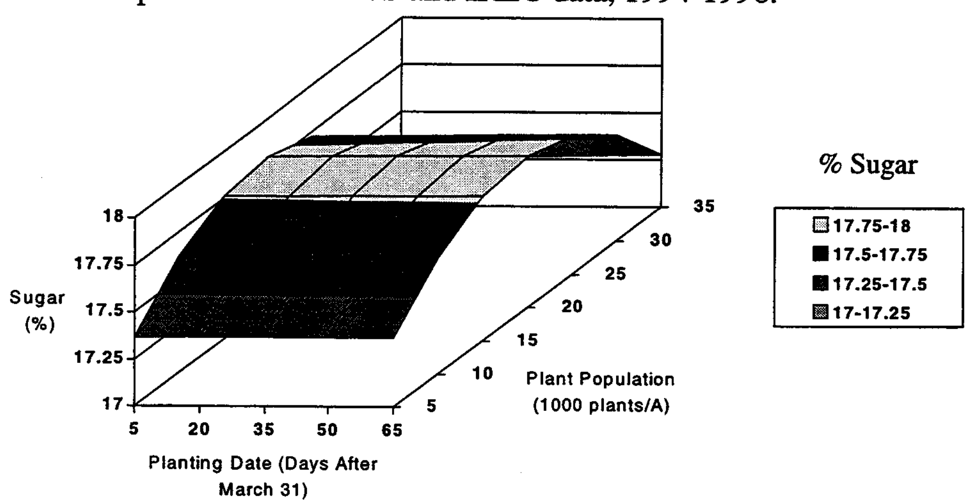


Figure 3. Sugar Yield Response to Planting Date and Plant Population from KES and IREC data, 1994-1996.

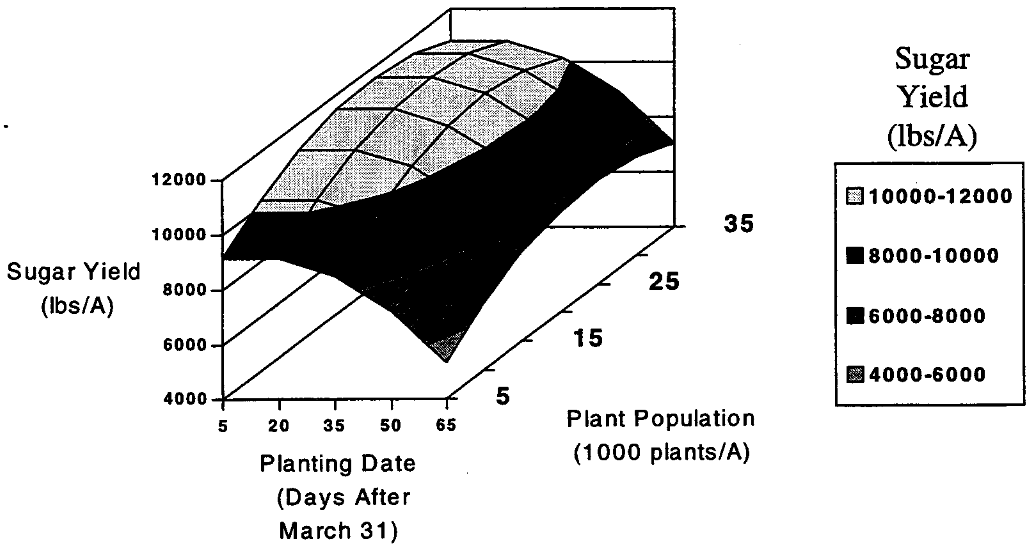
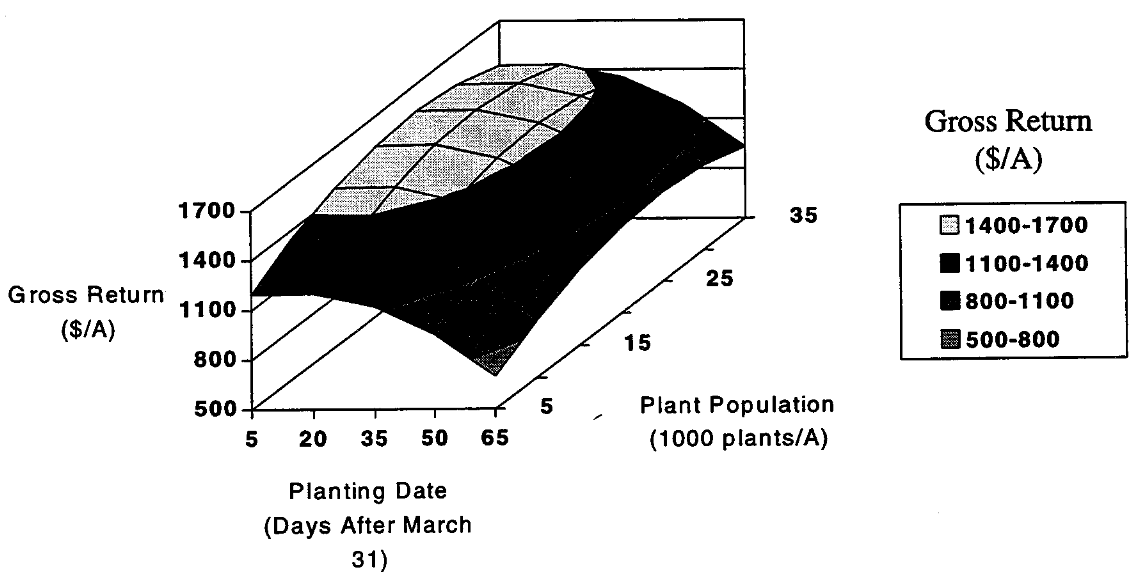



Figure 4. Planting Date and Plant Population Effects on Gross Return from Sugarbeets Grown at KES and IREC, 1994-1996.



# Klamath Basin Sugarbeet Weed Control Studies

K. Locke[1], K.A. Rykbost[2], and R.L. Dovel[2]

## Introduction

Lack of adequate weed control continues to be the most limiting factor for profitable sugarbeet production in the intermountain region. The cost of chemical and mechanical weed control represents 20 percent or more of variable costs of production. Field trials are conducted each year to evaluate herbicides for sugarbeet tolerance and weed control efficacy.

## Procedures

Trial sites included the Klamath Experiment Station (KES), one commercial field on an organic soil, and two commercial fields with mineral soils. On all commercial field standard grower cultural practices were used except for the weed control treatments applied. At each site, 3-row, 25-foot plots were arranged in a randomized complete block design with four replications. All chemical treatments were applied with a $CO_2$ backpack sprayer in 20 gallons per acre (gpa) of solution at 30 pounds per square inch (psi) pressure. Treatments evaluated at each site are described in Tables 1-5. Weed species were identified and counted from a 15 square foot quadrant of the middle row of each plot.

The KES trial site (Site #3) was a Poe fine sandy loam soil with approximately 1.0 percent organic matter content, a soil pH of about 6.0, and previous crops of potatoes in 1995 and alfalfa from 1986-1994. A broadcast application of 400 lb/acre 12-12-12 fertilizer was incorporated during bed forming with tool-bar mounted sweeps on April 29. Seed beds in 22-inch rows were firmly packed with a flat roller. The variety HM7006 was planted with a Planet-Junior type planter at 0.5-inch depth at 6 to 10 seeds/foot on April 30. Stands were hand-thinned to about 8-inch plant spacing on June 18. A minor flea beetle infestation was controlled with carbaryl applied at 1.0 lb ai/acre on May 25 and May 31. Supplemental nitrogen was applied as Solution 32 at 60 lb N/acre and immediately incorporated with 0.5 inches of irrigation on June 19. A total of 20 inches of irrigation was applied with solid-set sprinklers arranged on a 40- by 48-foot spacing. The crop received 4.35 inches of precipitation from planting to harvest.

At the KES, beet tops were removed with a flail chopper immediately prior to harvest. Beets were mechanically lifted and hand harvested on October 14. All beets from the center row of each plot were weighed and counted. A 25-pound sample was analyzed for tare loss and sugar content. Crop values were calculated using beet yield, sugar content, and price/ton based on the CBGA price card values for a net selling price of \$26/cwt of sugar.

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1/ Klamath County Cooperative Extension Agent, Klamath Falls, OR.
2/ Superintendent/Professor and Associate Professor, respectively, Klamath Experiment Station, Klamath Falls, OR.

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## Results and Discussion

### Site #1

The site was an organic soil with a high salt content and a history of a kochia weed problem. Sugarbeets were planted at this site on April 28. Pre-emergence herbicide treatments (2-9 Table 1) were applied in 7-inch bands over the rows and incorporated by hand raking on April 30. Sugarbeet and weed emergence began on May 8. By May 15, beets were 55 percent emerged and weeds were rapidly emerging during rainy weather.

First post-emergence treatments (2-5 and 8-15) were broadcast applied on May 20 when beets were about 60 percent emerged and most weeds were in the cotyledon stage. Some kochia and lambsquarter seedlings were in the 2nd true leaf stage at this time. Weather conditions at the time included a low of 27 °F on May 20, and 0.31 inches of rain between May 21 and 22, based on KES data. No phytotoxicity effects on sugarbeets or injury to weed seedlings from the first post-emergence herbicide treatments were observed.

The second post-emergence herbicide treatments were applied on May 28 at the same rates used on May 20. Beets and weed seedlings were in various stages of development. A third application of treatments was made on June 4. Higher rates were used for some of the products (Table 1). All plots were visually rated after the third application for injury to sugarbeets and percent of weed control, relative to the untreated control.

Heavy weed pressure, salt injury to sugarbeets, and varying growth stages of weeds caused a difficult set of circumstances at this site. The lay-by treatment of Eptam to pre-emergence treatments 6, 7, and 9 was not applied at off-station sites because these sites were not intended to be harvested for yield. The pre-emergence treatments provided effective weed control during weather unfavorable for post-emergence applications, until these applications could be made (Figure 1). Pre-emergence treatments 6 and 7 provided adequate control of weeds in the treated band without post-emergence treatments.

Weed identification and counts were determined in the first replication on June 24. Treatment 11 had the poorest weed control due to a failure to control kochia (Figure 1). An uneven distribution of weed species and population was indicated by the higher population of weeds in four of the treated plots than in the untreated control. This may also be partially due to chemical crop injury that reduced crop competition.

Treatment 5 provided the greatest weed control at this site. This treatment was the high rate of Nortron followed by three applications of Betamix. Except for treatment 10 (standard Betamix applications), pre-emergence and combinations of pre- and post-emergence treatments provided better weed control on organic soil than post-emergence treatments alone. This reflects the advantage of having a pre-emergence herbicide applied when weather conditions prevent timely post-emergence applications. Use of a pre-emergence herbicide provides greater flexibility in responding to conditions later. It also allows selection of products with different chemistry, reducing the risk for development of herbicide resistant weed populations.

### Site #2

This was a mineral soil site with the lowest weed pressure of all commercial sites evaluated. The main species present were redroot pigweed, hairy nightshade, and lambsquarter. Ladysthumb and mustards were present, but insufficient in numbers to evaluate. Sugarbeets were planted on May 1. Pre-emergence treatments (Table 2) were applied to 7-inch bands and incorporated with 0.5 inches of irrigation on May 2.

Emergence of sugarbeets and weeds was noted on May 15. The first post-emergence treatments were broadcast applied on May 26. Beets were about 50 percent emerged and most weed seedlings were in the cotyledon stage. The first post-emergence treatments did not injure the beets or provide control of weed seedlings.

Higher product rates were used for the second post-emergence applications of some materials on June 5. All plots were visually rated for percent of weed control and injury to sugarbeets, as compared with the untreated control. The lay-by application of Eptam to treatments 6, 7, and 9 was not applied as originally planned. Treatment 6 provided acceptable control of weeds in the treated band without post-emergence treatment (Figure 2).

Weed identification and counts were determined on one replication on July 6. Treatments 2, 12, and 13 had the least effective weed control due to failure to control redroot pigweed. Treatments 5 and 6 provided the best control at this site. These treatments were low and high rates of Nortron, with treatment 5 including one application of Betamix. In contrast to Site #1, where pre-emergence treatments were required for acceptable control, good control was achieved at this site with post-emergence treatments, in addition to pre-emergence or combination treatments. Pyramin did not provide adequate weed control at this site.

## Site #3

This site had a relatively low weed population. The main species present were redstem filaree, hairy nightshade, common mallow, shepardspurse, and lambsquarter. Volunteer potatoes were a serious problem in isolated areas of the site. Pre-emergence treatments (Table 3) were applied to 7-inch bands on May 1 and incorporated with 0.5 inches of irrigation on May 2. Sugarbeets and weeds began to emerge on May 13.

The first application of post-emergence treatments was made on May 26, when beets were about 50 percent emerged and most weed seedlings were in the cotyledon stage. There was no evidence of phytotoxic injury to sugarbeet seedlings or injury to weed seedlings. A second post-emergence application of treatments on June 5 included higher rates of some of the products (Table 3). All plots were visually rated to determine percent of weed control and degree of injury to sugarbeet seedlings.

Treatment 7 plots were cultivated with a Mantis cultivator between the bands that received pre-emergence herbicide. A lay-by treatment of Eptam was applied and incorporated with irrigation on July 9. Except for treatment 9, pre-emergence treatments provided effective weed control during unfavorable weather for post-emergence applications, until applications could be made (Figure 3).

Weeds were identified and counted in all replications at this site. Treatment 12 provided the least weed control (Figure 3). The best control was achieved by treatment 4, which included the high rate of Nortron pre-emergence followed by two applications of Upbeet plus Betamix. Combinations of pre- and post-emergence herbicides resulted in better weed control than treatments using only post-emergence products.

Weed competition in the untreated control resulted in significantly lower beet yield than in any of the herbicide treatments (Table 4). Five treatments, including two with pre-emergence and post-emergence treatments, were not significantly different in beet yield. Herbicide treatments did not affect sugar content. The pre-emergence products produced minor beet injury symptoms, but no consistent reduction in yield.

## Site #4

Sugarbeets were planted on May 10 at this mineral soil site, which had the highest potential weed population based on counts in control plots. The main species present at the site were redroot pigweed, hairy nightshade, redstem filaree, shepardspurse, and lambsquarter. Pre-emergence treatments (Table 5) were applied in 7-inch bands on May 11. First post-emergence treatments were broadcast applied on June 1 when beets were 75 percent emerged and most weed seedlings were in the cotyledon stage. The second application of post-emergence treatments was made on June 11. Sugarbeets were in the two to four leaf stage and weed seedlings were at varying growth stages. Higher rates of some of the products were used (Table 5).

All plots were visually rated for percent control of weeds and injury to sugarbeets on June 28. Although this site had the highest weed population in control plots, treatments provided better control than at other sites with less weed pressure. This may have been due to later planting and better weather conditions after emergence, which allowed for more timely applications of herbicides. Pre-emergence treatments 6, 7, and 9 provided good weed control in the treated band (Figure 4). The best control was observed for treatments 6 and 7.

Weed identification and counts in the first replication were made on July 1. All treatments provided good weed control compared to the untreated plot (Figure 4). The pre-emergence treatments, alone or in combination with post-emergence herbicides, produced better weed suppression than post-emergence treatments. Using a pre-emergence herbicide provides greater flexibility, may reduce the number of post-emergence treatments required, and allows the selection of different chemistries to reduce the risk of herbicide resistance developing in the weed population.

## Summary

In general, pre-emergence treatments, alone and in combination with post-emergence treatments, were more effective in controlling weeds than post-emergence treatments alone (Figures 1-4). Nortron provided more consistent control than Pyramin. Treatments 5, 6, and 7 provided the best weed control across sites. Except for the most difficult site, (#1), pre-emergence treatments provided sufficient control within rows to allow for a lay-by Eptam treatment after cultivation. This reflects the advantage of having a pre-emergence herbicide in place providing weed control when weather conditions prevent timely applications of post-emergence treatments. Pre-emergence use may allow reduced applications of post-emergence products, and offers the opportunity to select products with different chemistries, reducing the risk of herbicide resistance in weed populations.

Post-emergence treatments 12 and 13 were least effective in controlling weeds across locations. Upbeet provided adequate weed control except at Site #1 where kochia was a problem. Betamix Progress was the most effective post-emergence product (Figures 1-4).

Table 1. Herbicide treatments evaluated for sugarbeet weed control at Site #1, Klamath Falls, OR, 1996.

| Treatment number | Products and rate in lb ai/acre | Application dates |
|---|---|---|
| 1 | Untreated control | |
| 2 | Pyramin DF (1.05), Treatment 15 | 4/30, 5/20, 5/28, 6/4 |
| 3 | Pyramin DF (1.15), Treatment 14 | 4/30, 5/20, 5/28, 6/4 |
| 4 | Nortron SC (0.42), Treatment 11 | 4/30, 5/20, 5/28, 6/4 |
| 5 | Nortron SC (0.53), Treatment 10 | 4/30, 5/20, 5/28, 6/4 |
| 6 | Nortron SC (0.42) | 4/30 |
| 7 | Pyramin DF (1.05) | 4/30 |
| 8 | Pyramin DF (1.05), Treatment 13 | 4/30, 5/20, 5/28, 6/4 |
| 9 | Pyramin DF (1.05), Treatment 13 | 4/30, 5/20, 5/28, 6/4 |
| 10 | Betamix (0.25), Betamix (0.25) | 5/20, 5/28 |
| | Betamix (0.33) | 6/4 |
| 11 | Upbeet (0.0156) + Betamix (0.25) | 5/20, 5/28 |
| | Upbeet (0.0156) + Betamix (0.33) | 6/4 |
| 12 | Upbeet (0.0156) + Stinger (0.07) + Surfactant (0.25%) | 5/20, 5/28, 6/4 |
| 13 | Upbeet (0.0156) + Stinger (0.07) + Nortron SC (0.25) + Surf (0.25%) | 5/20, 5/28, 6/4 |
| 14 | Betamix Progress (0.25) | 5/20, 5/28 |
| | Betamix Progress (0.33) | 6/4 |
| 15 | Betamix Progress (0.25) + Upbeet (0.0156) | 5/20, 5/28 |
| | Betamix Progress (0.33) + Upbeet (0.0156) | 6/4 |

Table 2. Herbicide treatments evaluated for sugarbeet weed control at Site #2, Klamath Falls, OR, 1996.

| Treatment number | Product and rate in lb ai/acre | Application dates |
|---|---|---|
| 1 | Untreated control | |
| 2 | Pyramin DF (1.05), Treatment 15 | 5/2, 5/26, 6/5 |
| 3 | Pyramin DF (1.05), Treatment 14 | 5/2, 5/26, 6/5 |
| 4 | Nortron SC (0.42), Treatment 11 | 5/2, 5/26, 6/5 |
| 5 | Nortron SC (0.53), Treatment 10 | 5/2, 5/26, 6/5 |
| 6 | Nortron SC (0.42) | 5/2 |
| 7 | Pyramin DF (1.05) | 5/2 |
| 9 | Pyramin DF (1.05), Treatment 13 | 5/2, 5/26, 6/5 |
| 10 | Betamix (0.25) | 5/26 |
| | Betamix (0.33) | 6/5 |
| 11 | Upbeet (0.0156) + Betamix (0.25) | 5/26 |
| | Upbeet (0.0156) + Betamix (0.33) | 6/5 |
| 12 | Upbeet (0.0156) + Stinger (0.07) + Surfactant (0.25%) | 5/26, 6/5 |
| 13 | Upbeet (0.0156) + Stinger (0.07) + Nortron SC (0.25) + Surf (0.25%) | 5/26, 6/5 |
| 14 | Betamix Progress (0.25) | 5/2 |
| | Betamix Progress (0.33) | 6/5 |
| 15 | Betamix Progress (0.25) + Upbeet (0.0156) | 5/26 |
| | Betamix Progress (0.33) + Upbeet (0.0156) | 6/5 |

Table 3. Herbicide treatments evaluated for sugarbeet weed control at Site #3, Klamath Falls, OR, 1996.

| Treatment number | Product and rate in lb ai/acre | Application dates |
|---|---|---|
| 1 | Untreated control | |
| 2 | Pyramin DF (1.05) | 5/1 |
| | Betamix Progress (0.33) + Upbeet (0.0156) | 5/26, 6/5 |
| 4 | Nortron SC (0.42), Upbeet (0.0156) + Betamix (0.25) | 5/1, 5/26 |
| | Upbeet (0.0156) + Betamix (0.33) | 6/5 |
| 6 | Nortron SC (0.42) | 5/26 |
| 7 | Pyramin DF (1.05) | 5/1 |
| | Eptam 7E (3.06) | 7/9 |
| 9 | Pyramin DF (1.05), Treatment 13 | 5/1, 5/26, 6/5 |
| 10 | Betamix (0.25) | 5/26 |
| | Betamix (0.33) | 6/5 |
| 12 | Upbeet (0.0156) + Stinger (0.07) + Nortron SC (0.25) + Surf. (0.25%) | 5/26, 6/5 |
| 13 | Upbeet (0.0156) + Stinger (0.07) + Nortron SC (0.25) + Surf. (0.25%) | 5/26, 6/5 |
| 14 | Betamix Progress (0.25) | 5/26 |
| | Betamix Progress (0.33) | 6/5 |

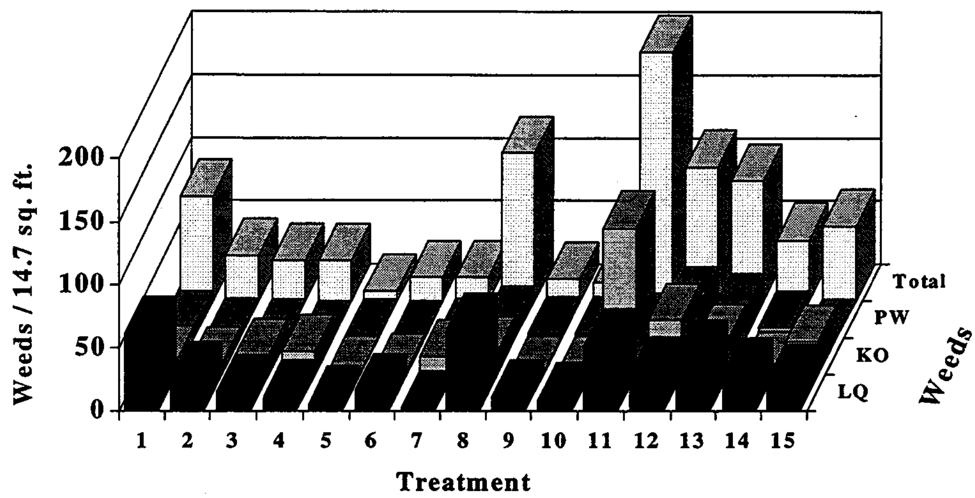
Table 4. Effect of herbicide treatments on beet yield, sugar content, total sugar production, and gross value of sugarbeets grown at the Klamath Experiment Station, Klamath Falls, OR, 1996.

| Treatment number | Beet yield | Sugar content | Sugar production | Gross value |
|---|---|---|---|---|
| | ton/A | % | ton/A | $/A |
| 1 | 15.5 | 19.1 | 2.96 | 790 |
| 2 | 23.0 | 19.6 | 4.51 | 1200 |
| 4 | 26.2 | 19.5 | 5.12 | 1360 |
| 7 | 26.3 | 19.4 | 5.09 | 1360 |
| 9 | 23.2 | 19.1 | 4.44 | 1180 |
| 10 | 21.9 | 19.1 | 4.19 | 1120 |
| 12 | 24.0 | 19.1 | 4.59 | 1220 |
| 13 | 27.2 | 19.3 | 5.21 | 1400 |
| 14 | 25.6 | 19.7 | 5.04 | 1350 |
| Mean | 23.7 | 19.3 | 4.57 | 1220 |
| LSD (0.05) | 3.6 | NS | 0.71 | 190 |
| CV (%) | 11 | 2 | 11 | 11 |

Table 5. Herbicide treatments evaluated for sugarbeet weed control at Site #4, Klamath Falls, OR, 1996.

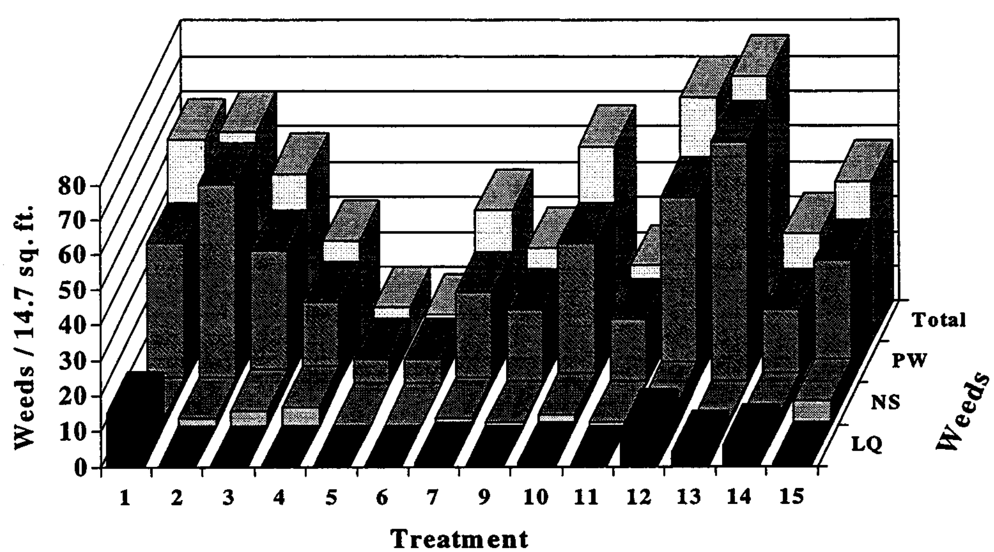
| Treatment number | Products and rate in lb ai/acre | Application dates |
|---|---|---|
| 1 | Untreated control | |
| 2 | Pyramin DF (1.05), Treatment 15 | 5/11, 6/1, 6/11 |
| 3 | Pyramin DF (1.15), Treatment 14 | 5/11, 6/1, 6/11 |
| 4 | Nortron SC (0.42), Treatment 11 | 5/11, 6/1, 6/11 |
| 5 | Nortron SC (0.53), Treatment 10 | 5/11, 6/1, 6/11 |
| 6 | Nortron SC (0.42) | 5/11 |
| 7 | Pyramin DF (1.05) | 5/11 |
| 8 | Pyramin DF (1.05),Treatment 13 | 5/11, 6/1, 6/11 |
| 9 | Pyramin DF (1.05), Treatment 13 | 5/11, 6/1, 6/11 |
| 10 | Betamix (0.25), Betamix (0.33) | 6/1, 6/11 |
| | Betamix (0.33) | 6/11 |
| 11 | Upbeet (0.0156) + Betamix (0.25) | 6/1 |
| | Upbeet (0.0156) + Betamix (0.33) | 6/11 |
| 12 | Upbeet (0.0156) + Stinger (0.07) + Surfactant (0.25%) | 6/1, 6/11 |
| 13 | Upbeet (0.0156) + Stinger (0.07) + Nortron SC (0.25) + Surf (0.25%) | 6/1, 6/11 |
| 14 | Betamix Progress (0.25) | 6/1 |
| | Betamix Progress (0.33) | 6/11 |
| 15 | Betamix Progress (0.25) + Upbeet (0.0156) | 6/1 |
| | Betamix Progress (0.33) + Upbeet (0.0156) | 6/11 |

Figure 1. Herbicide treatment effects on weed species in sugarbeets, Site 1, 1996.




**LQ** = lambsquarter **KO** = kochia **PW** = redroot pigweed

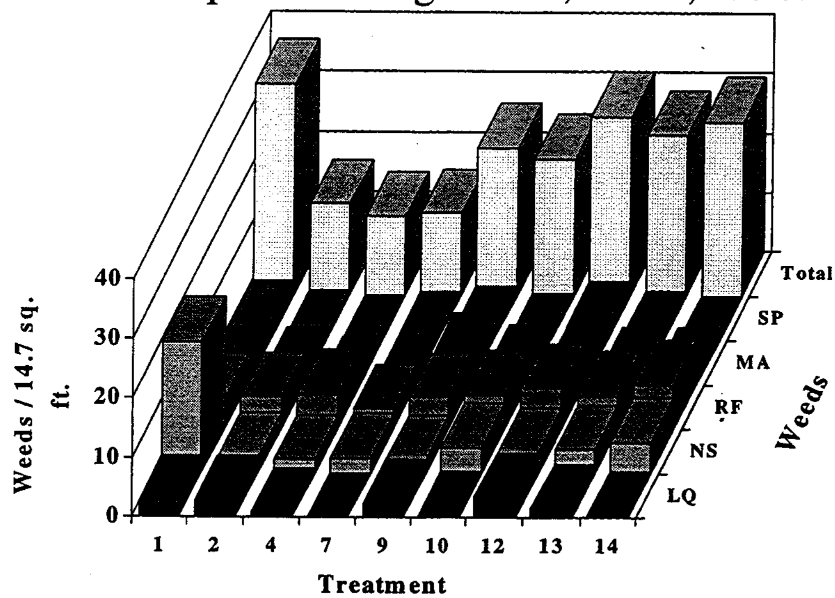
Figure 2. Herbicide treatment effects on weed species in sugarbeets, Site 2, 1996.




**LQ** = lambsquarter **NS** = hairy nightshade

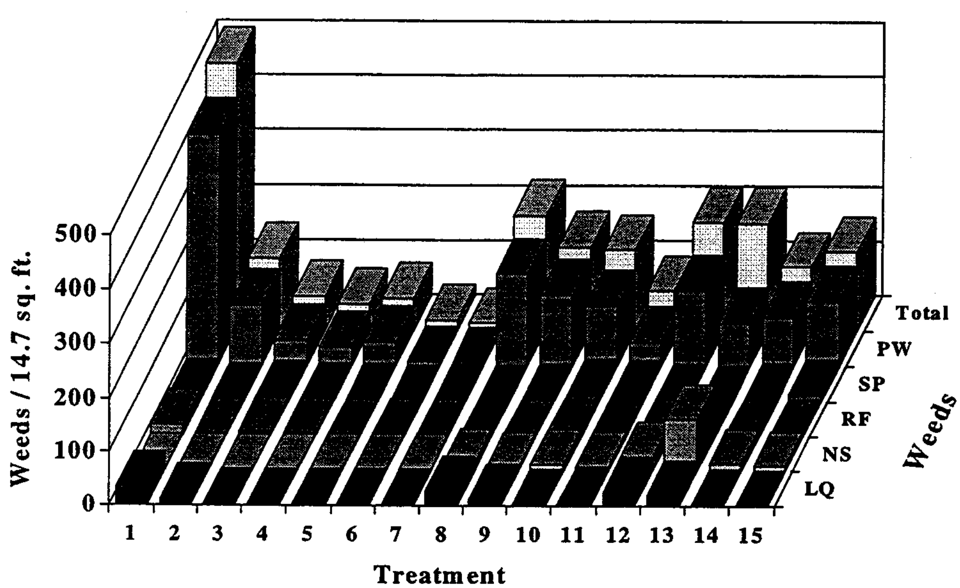
**PW** = redroot pigweed

Figure 3. Herbicide treatment effects on weed species in sugarbeets, Site 3, 1996.




**LQ**= lambsquarter **NS**= hairy nightshade **RF**= redstem filaree **MA**= mallow **SP**= shepardspurse

Figure 4. Herbicide treatment effects on weed species in sugarbeets, Site 4, 1996.




**LQ**= lambsquarter **NS** = hairy nightshade **RF**= redstem filaree

**SP**= shepardspurse **PW**= redroot pigweed

# Potato Variety Screening Trials

K.A. Rykbost and J. Maxwell[1]

## Introduction

Russet Burbank was the dominant potato variety in Oregon and the northwest a decade ago. It accounted for over 80 percent of seed grown in Oregon and over 95 percent of commercial production in Idaho. In 1996, Oregon certified seed acreage was approximately equally distributed between Russet Norkotah, Russet Burbank, and the total of all other varieties. Klamath Basin acreage included more Russet Norkotah than Russet Burbank. Other varieties accounted for a significant portion of northwest processing crops. Emerging replacements for Russet Burbank are less sensitive to environmental stress-caused disorders, but are more susceptible to several diseases than Russet Burbank. While new techniques are being used to improve existing varieties, the need for traditional breeding efforts to develop superior varieties has not diminished. This report summarizes the involvement of KES in the Oregon and regional programs devoted to breeding, selection, evaluation, and development of new varieties to meet the changing needs of the region's potato industry.

The KES participates in Oregon and western regional potato variety development programs by conducting Oregon preliminary and statewide replicated yield trials, and serving as one of 13 sites to conduct the regional variety trial. The preliminary yield trial evaluates clones initially selected at Powell Butte and Hermiston in the first and second year following greenhouse production of mini-tubers from true seed. Preliminary trials are also conducted at Powell Butte, Hermiston, and Ontario. Clones saved from this trial advance to the statewide trial for up to three years. Material advanced from the statewide trial is evaluated for one to two years in tri-state trials. Variety development programs in other states contribute selections to tri-state trials. Hermiston serves as the only Oregon site for this trial. Western regional trials are the final stage of formal evaluation prior to release of new varieties. Successful clones remain in the regional trial for three years. Following completion of formal testing in these trials, release is usually delayed for two years or more as seed supplies are increased and commercial experience is gained.

## Procedures

All trials were conducted on a Poe fine sandy loam soil in a two-year rotation with cereal crops. Control of nematodes and related diseases was achieved with Telone II applied at 18 gallons per acre (gpa) in October, 1995. All seed lots were hand-cut to 1.5 to 2.5 ounces per seedpiece, treated with thiophanate-methyl (Tops 5.0) at 0.5 lb/100 lb seed, and suberized at 55 °F and 95 percent relative humidity for 10 to 14 days prior to planting.

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1/ Superintendent/Professor and Biological Sciences Research Technician III, respectively, Klamath Experiment Station, Klamath Falls, OR.

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Potatoes were planted at 8.7-inch spacing in 32-inch rows with an assisted-feed, two-row planter. Di-syston insecticide was applied in the seed furrow at 3.0 lb active ingredient (ai)/acre at planting. Fertilizer was banded on both sides of rows at planting at 1,000 lb/acre of 15-15-15. Weed control was accomplished with Eptam at 3.0 lb ai/acre and Matrix at 1.0 ounce/acre (0.0156 lb ai/acre) applied with a conventional ground sprayer and incorporated with a rolling cultivator on June 3.

Fungicides, applied aerially, included Bravo at 1.5 lb ai/acre on July 10 and August 3, Ridomil-Mz at 2.0 lb ai/acre on July 20, and Mancozeb at 2.0 lb ai/acre on August 18. The insecticide Monitor was included with fungicide applications at 0.75 lb ai/acre on July 20 and August 18. Vines were desiccated with Diquat applied with a ground sprayer at 1.0 pint/acre on September 12. Irrigation was applied twice weekly with solid-set sprinklers arranged on 40-foot x 48-foot spacing. Total crop water, including irrigation and rainfall, was approximately 20 inches.

All trials were planted on May 24. The preliminary yield trial included 5 standard varieties and 59 numbered selections. Individual plots were 20 hills with two replications arranged in a randomized block design. Five standard varieties and 19 numbered selections were included in the statewide trial with 4 replications of 30-hill plots. The regional trial had 3 standard varieties and 11 clones in 30-hill plots with 4 replications. Emergence data were recorded for all trials on June 17, June 24, and July 1. Vine vigor and vine maturity observations were made on July 8 and September 2, respectively.

Potatoes were harvested from the regional trial on September 27 and from preliminary and statewide trials on September 30 with a one-row digger-bagger. All tubers from each plot were stored at about 55 °F and 90 percent relative humidity until samples were graded in late October. External tuber characteristics were noted for each replication during grading. Ten large tubers/sample were cut longitudinally and inspected for internal defects. Specific gravity was determined using the weight-in-air, weight-in-water method on 10 lb samples of U.S. No.1s in the 6- to 12-ounce size range. USDA grade standards were followed to separate B size (under 4 ounces), U.S. No.1s (4 to 12 ounces and over 12 ounces), U.S. No.2s, and culls. Yields of No.1s were not adjusted for external blemishes such as rhizoctonia or scab, or internal disorders such as hollow heart or brown center. Samples of 6- to 12-ounce tubers were saved from one replication of each selection in all trials for culinary quality evaluations.

French fry tests were conducted to determine fry color on entries in all trials. Samples from statewide and regional trials were also evaluated for boiling, oven baking, and microwave preparation methods. These tests were designed to detect serious quality deficiencies such as after-cooking darkening, sloughing, off flavors, or poor texture. Tests were conducted between mid-November and mid-December.

Yield, grade, and specific gravity data from statewide and regional trials were statistically analyzed using MSUSTAT software. Since the preliminary trial only included two replications, no statistical evaluations were made. Only a portion of data collected will be presented in this report. Disposition decisions on selections at all levels of evaluation are based on all data accumulated at all trial locations. Data from the four Oregon locations of preliminary and statewide trials is compiled and reviewed jointly by all Oregon variety development committee members. Cooperators at Aberdeen, Idaho compile tri-state and regional trial data, which is reviewed at annual committee meetings attended by up to 30 cooperators and industry representatives.

## Results and Discussion

Emerged plants were protected from frost with sprinkler irrigation on June 18. A low of 29 °F was recorded in the KES weather station. Irrigation was started at 3:15 am and prevented foliage damage. Frost protection was also used on July 19 when a low of 32 °F was recorded. At the other extreme, high temperatures exceeded 90 °F on 31 days in July and August. Plants frequently exhibited moisture stress in late afternoon in spite of twice weekly irrigation applications. Heat sprouts were noted in some selections. A high incidence of hollow heart and brown center was observed in tubers from several research projects at KES, including these variety trials. The incidence of second growth and growth cracks were also higher than normal for the region. Further evidence of stress to crops was noted in relatively low specific gravity and heavy and irregular netting on russet skinned selections. Yields were generally higher than those observed in 1995, when planting was late due to wet soil conditions, but lower than yields achieved in 1992 through 1994.

### Preliminary Yield Trial

Following the review of data from all trial locations, 10 selections in the 1996 preliminary trial were advanced to the statewide trial for further evaluation in 1997. KES data for standard varieties and the selections to be retained are presented in Tables 1 and 2. Vine maturity data suggest eight of these selections are relatively late maturing. Four of the selections had a high incidence of hollow heart at KES. This problem was not observed at other locations. All of the selections retained are russet skinned.

Yields of U.S. No.1s varied from a low of 148 cwt/acre to 723 cwt/acre among the 64 entries in this trial. Russet Burbank and Russet Norkotah ranked 47 and 57, respectively, in yield of No.1s at KES. AO92023-3 and AO92016-2 were ranked first and second at KES, and first and seventh over all locations in No.1 yields. AO92173-2 produced the highest yield at Hermiston and was fourth at KES and second over all locations. AO92023-3 and AO92173-2 appear to be unsuited for processing. The other selections may have acceptable quality for processing.

### Statewide Trial

Entries in the statewide trial included two selections scheduled for release (AO82611-7 and COO83008-1), one selection included in the regional trial (AO85165-1), and three selections in the 1996 tri-state trial (AO87119-3, AO87277-6, and AO89128-4). Data for all selections in the statewide trial are presented in Tables 3 and 4. A high incidence of hollow heart was observed in AO85165-1, AO88103-3, and AO91004-6. All other selections had less hollow heart than Atlantic.

Russet Burbank and Russet Norkotah were among the lowest yielding selections in the trial at KES and at other locations, ranking 17 and 18 at KES, and 21 and 22 over all locations in No.1 yield, respectively. Based on its performance in these trials, AO87119-3 will be discarded. The other entries included in the 1996 tri-state trial (AO87277-6 and AO89128-4) will be advanced to the regional trial in 1997. Five selections were retained for further testing at the statewide trial level. AO91812-1 and AO91812-2 appear to be excellent prospects for chipping. Both selections had higher yield, as good color and solids content, and fewer internal defects than Atlantic. Both are round with bright white skin color and a relatively high tuber set.

The most promising first year russet selection in the statewide trial was AO91522-4. It produced the highest No.1 yield at Powell Butte and was second highest at Hermiston and KES. Specific gravity of AO91522-4 was marginal for processing, but fry color was acceptable. In the 1995 preliminary trial, it was second in No.1 yield out of 75 entries and had acceptable solids and fry color for processing. This clone has had few internal defects and has relatively attractive appearance.

AO90319-1 is a very attractive russet with yellow flesh color. It does not have processing quality and was only moderate in yield in both 1995 and 1996. If there is a market niche for a yellow-fleshed russet, this is an excellent candidate. The other selection retained for the 1997 statewide trial is AO88103-3. This selection has blocky shape, acceptable processing quality, good appearance, and moderate yields. Hollow heart was observed in AO88103-3 in both 1995 and 1996 at KES.

### Western Regional Trial

Data from the western regional trial is presented in Tables 5 and 6. As in preliminary and statewide trials, hollow heart was commonly observed in several of the selections. Data from other trial locations showed hollow heart incidence was highest in Russet Burbank, TX1229-2Ru, A8792-1, AO85165-1, and A86102-6 in descending order.

Three selections completed three years of regional evaluation in 1996. The Oregon fresh market selection, AO85165-1 has been among the highest in No.1 yields each year over all locations. It has attractive tubers with a tendency for oversize, which accounts to some extent for its hollow heart susceptibility. Additional data on AO85165-1 follows later. The other selections completing three years of evaluation are A84118-3 and TX1229-2Ru. A84118-3 is a medium-late maturing dual purpose russet with intermediate yields and attractive appearance. At KES, and averaged over nine late harvest locations, A84118-3 was the only selection with lower No.1 yield than Russet Burbank. TX1229-2Ru is a medium-early maturing dual purpose russet, with high yields in early harvest trials. Yields have been intermediate in late harvest trials. A84118-3 and TX1229-2Ru are not expected to be released.

TXSN112 and TXSN278 are strains of Russet Norkotah selected in Texas for greater vine vigor and higher yields under Texas conditions. They were included in the regional trial for the first time in 1996. Both selections exhibited better vine vigor than the standard Norkotah at KES and averaged over all locations. Vine maturity was later than for Norkotah for both selections at KES, but was the same when averaged over locations. Total yield of No.1s was significantly higher for TXSN112 than for the Norkotah standard at KES. Averaged over nine late harvest locations, both selections produced 391 cwt/acre No.1s compared to 326 cwt/acre for the standard Norkotah. TXAV657-27Ru produced the highest yield of No.1s at KES and averaged over all locations. This selection was also among the highest yielding selections in the 1995 regional trial and will continue in the trial for one more year. A86102-6 will be dropped from the trial. Evaluation of A8792-1, CO85026-4, TX1385-12 Ru, and the Norkotah selections will continue in 1997.

### Advanced Oregon Selections

The dual purpose Oregon russet selections COO83008-1 and AO82611-7 are being considered for formal release in 1997 as varieties Russet Legend and Umatilla Russet, respectively. Legend has shown promise as a processing selection in the Treasure Valley area of eastern Malheur County in Oregon, and southwestern Idaho, and as a fresh market selection in eastern Idaho. Umatilla is primarily of interest as a processing selection for the Columbia Basin. The yield performance of these selections over several years at KES is compared with Russet Burbank and Russet Norkotah in Table 7. Data used for comparison with Russet Burbank includes all years of evaluation in the statewide and regional trials. As Russet Norkotah was not entered in the regional trials prior to 1991, or the statewide trial prior to 1989, comparisons with Russet Norkotah represent fewer trial years. The fresh market Oregon selection AO85165-1 is also compared with Russet Burbank and Russet Norkotah in Table 7.

AO82611-7 has been similar to Russet Burbank in total yields with slightly higher yields of larger No.1s. It has produced higher total yields than Russet Norkotah with smaller tubers. COO83008-1 has consistently produced higher No.1 yields and larger tubers than both

Russet Burbank and Norkotah. Under local conditions, neither of these selections produce tubers with shape or appearance as desirable as Norkotah. COO83008-1 has blocky tubers with slightly flattened shape. AO82611-7 tubers are longer than COO83008-1 but tend to be pointed at the apical end.

AO85165-1 produces very high yields with large tubers and good appearance. The most serious deficiency observed in trials at KES is the susceptibility to hollow heart in large tubers. High plant populations and careful timing of topkilling will be required to control this limitation. The KES experience with these selections shows AO85165-1 as the clear choice among the three for local production for fresh markets.

Commercial experience with AO82611-7 and COO83008-1 is fairly extensive. In 1996, over 300 acres of AO82611-7 and 170 acres of COO83008-1 seed passed certification in northwest states. Both selections have been evaluated for processing in plant scale tests involving crops from several acres. To date, AO85165-1 has not been grown commercially. A significant AO85165-1 seed increase will be started in 1997.

Unfortunately, a fairly serious problem has surfaced in Russet Legend. In the winter of 1995-1996, one or more lots in Idaho were observed to have a stem-end necrosis that went into the tuber to a significant depth. Other lots were subsequently checked to determine whether this was an isolated incident, or a more common and widespread occurrence. Other problem lots were found with varying degrees of symptoms. Efforts to isolate a causal pathogen were unsuccessful. This problem has again surfaced in 1996 seed crops in Idaho and Oregon. It appears to develop, or at least intensify, in storage. While the problem was not observed over many years of evaluation in research conditions, the degree to which it has occurred in commercial situations requires serious consideration. The decision to release this selection has been delayed.

Table 1. Characteristics of entries selected from the Preliminary Yield Trial for further evaluation, Klamath Falls, OR, 1996.

| Variety/ selection | Percent stand | Vigor rating [1] | Vine maturity [2] | Specific gravity | Percent H.H. + B.C. [3] |
|---|---|---|---|---|---|
| Russet Burbank | 100 | 4.5 | 2.0 | 1.087 | 15 |
| Ranger Russet | 100 | 4.0 | 3.0 | 1.086 | 5 |
| Shepody | 93 | 3.0 | 2.5 | 1.079 | 25 |
| Norkotah | 95 | 3.5 | 2.0 | 1.063 | 5 |
| Atlantic | 90 | 5.0 | 2.5 | 1.089 | 25 |
| AO92004-5 | 98 | 2.0 | 2.5 | 1.079 | 70 |
| AO92007-2 | 88 | 4.0 | 3.0 | 1.075 | 15 |
| AO92016-2 | 90 | 4.0 | 3.0 | 1.077 | 20 |
| AO92016-3 | 100 | 4.0 | 2.0 | 1.074 | 10 |
| AO92017-6 | 100 | 3.0 | 3.5 | 1.086 | 5 |
| AO92019-1 | 90 | 2.5 | 4.0 | 1.078 | 85 |
| AO92019-13 | 98 | 3.0 | 3.5 | 1.088 | 40 |
| AO92023-3 | 100 | 4.5 | 3.5 | 1.076 | 0 |
| AO92056-7 | 98 | 2.5 | 3.0 | 1.087 | 10 |
| AO92173-2 | 98 | 5.0 | 4.0 | 1.078 | 70 |

[1]/ Vigor rating: (1 - small, weak plant; 5 - large, robust plant)

[2]/ Vine maturity: (1 - early; 5 - late)

[3]/ H.H. + B.C. : (Hollow heart plus brown center in 10 large tubers/sample)

Table 2. Tuber yield by grade for entries selected from the Preliminary Yield Trial for further evaluation, Klamath Falls, OR, 1996.

| Variety/ Selection | Yield U.S. No. 1s | | | Yield | | | |
|---|---|---|---|---|---|---|---|
| | 4 - 12 oz. | > 12 oz. | Total | Bs | No. 2s | Culls | Total |
| | cwt/A | | | | | | |
| Russet Burbank | 359 | 36 | 395 | 88 | 25 | 14 | 522 |
| Ranger Russet | 365 | 102 | 467 | 53 | 44 | 19 | 583 |
| Shepody | 303 | 133 | 436 | 42 | 27 | 7 | 510 |
| Norkotah | 267 | 45 | 312 | 63 | 10 | 7 | 392 |
| Atlantic | 404 | 85 | 489 | 80 | 4 | 4 | 577 |
| AO92004-5 | 298 | 107 | 405 | 41 | 36 | 14 | 496 |
| AO92007-2 | 343 | 28 | 371 | 38 | 37 | 0 | 446 |
| AO92016-2 | 466 | 191 | 657 | 43 | 32 | 9 | 741 |
| AO92016-3 | 402 | 41 | 443 | 67 | 41 | 22 | 573 |
| AO92017-6 | 392 | 33 | 425 | 64 | 10 | 7 | 506 |
| A092019-1 | 355 | 138 | 493 | 77 | 25 | 6 | 601 |
| AO92019-13 | 430 | 115 | 545 | 49 | 20 | 11 | 625 |
| AO92023-3 | 468 | 255 | 723 | 44 | 18 | 0 | 785 |
| AO92056-7 | 293 | 84 | 377 | 63 | 31 | 14 | 485 |
| AO92173-2 | 421 | 139 | 560 | 78 | 17 | 0 | 655 |
| Mean [1] | 371 | 102 | 473 | 59 | 25 | 9 | 566 |

[1]/ Means for standard varieties and clones selected only.

Table 3. Characteristics of entries in the Oregon Statewide Trial, Klamath Falls, OR, 1996.

| Variety/ selection | Percent stand | Vigor rating [1] | Vine maturity [2] | Specific gravity | Percent H.H + B.C. [3] |
|---|---|---|---|---|---|
| Russet Burbank | 96 | 4.3 | 2.5 | 1.081 | 10 |
| Ranger Russet | 98 | 4.3 | 3.0 | 1.084 | 3 |
| Shepody | 99 | 3.5 | 2.0 | 1.079 | 5 |
| Norkotah | 99 | 3.8 | 2.0 | 1.062 | 6 |
| Atlantic | 94 | 3.8 | 2.5 | 1.084 | 30 |
| AO82611-7 | 92 | 3.3 | 3.0 | 1.085 | 3 |
| COO83008-1 | 82 | 3.5 | 3.0 | 1.081 | 15 |
| AO85165-1 | 98 | 2.8 | 2.8 | 1.080 | 61 |
| AO87119-3 | 92 | 4.3 | 2.3 | 1.067 | 0 |
| AO87277-6 | 85 | 4.3 | 2.0 | 1.088 | 18 |
| AO89128-4 | 95 | 3.8 | 3.0 | 1.092 | 15 |
| COO90071-1 | 85 | 3.0 | 3.0 | 1.083 | 5 |
| AO90014-1 | 95 | 4.0 | 2.5 | 1.083 | 3 |
| AO90017-4 | 94 | 3.5 | 2.5 | 1.085 | 5 |
| AO90045-13 | 93 | 3.5 | 3.5 | 1.081 | 20 |
| AO90088-1 | 100 | 3.8 | 2.5 | 1.090 | 13 |
| AO90319-1 | 93 | 3.5 | 2.5 | 1.076 | 3 |
| AO88102-6 | 100 | 4.5 | 2.8 | 1.098 | 0 |
| AO88103-3 | 99 | 4.0 | 3.3 | 1.082 | 78 |
| AO88162-2 | 99 | 3.5 | 3.0 | 1.080 | 8 |
| AO91004-6 | 98 | 3.3 | 3.3 | 1.095 | 56 |
| AO91522-4 | 99 | 2.8 | 3.5 | 1.078 | 10 |
| AO91812-1 | 83 | 3.8 | 3.5 | 1.083 | 5 |
| AO91812-2 | 96 | 3.3 | 3.8 | 1.082 | 3 |
| Mean | 94 | 3.5 | 2.8 | 1.082 | 16 |
| LSD (0.05) | | | | 0.005 | |

[1]/ Vigor rating: (1 - small, weak plant; 5 - large, robust plant)
[2]/ Vine maturity: (1 - early; 5 - late)
[3]/ H.H. + B.C. : (Hollow heart plus brown center in 10 large tubers/sample)

Table 4. Tuber yield by grade for entries in the Oregon Statewide Trial, Klamath Falls, OR, 1996.

| Variety/ 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/A | | | | | | |
| Russet Burbank | 291 | 40 | 330 | 90 | 47 | 13 | 480 |
| Ranger Russet | 301 | 70 | 371 | 55 | 45 | 16 | 487 |
| Shepody | 293 | 140 | 433 | 27 | 34 | 19 | 513 |
| Norkotah | 278 | 45 | 323 | 64 | 8 | 1 | 395 |
| Atlantic | 374 | 54 | 427 | 63 | 6 | 5 | 502 |
| AO82611-7* | 295 | 46 | 340 | 49 | 31 | 30 | 450 |
| COO83008-1* | 240 | 114 | 354 | 17 | 32 | 20 | 422 |
| AO85165-1* | 296 | 123 | 419 | 31 | 18 | 14 | 481 |
| AO87119-3 | 253 | 49 | 303 | 55 | 72 | 52 | 482 |
| AO87277-6* | 300 | 61 | 361 | 54 | 9 | 13 | 437 |
| AO89128-4* | 325 | 24 | 349 | 69 | 16 | 12 | 446 |
| COO90071-1 | 306 | 103 | 409 | 45 | 42 | 21 | 516 |
| AO90014-1 | 322 | 50 | 373 | 54 | 8 | 7 | 440 |
| AO90017-4 | 279 | 7 | 285 | 88 | 8 | 6 | 387 |
| AO90045-13 | 201 | 343 | 544 | 8 | 19 | 0 | 572 |
| AO90088-1 | 268 | 12 | 280 | 115 | 8 | 2 | 404 |
| AO90319-1* | 229 | 16 | 245 | 65 | 6 | 8 | 324 |
| AO88102-6 | 260 | 0 | 260 | 93 | 5 | 2 | 360 |
| AO88103-3* | 324 | 54 | 377 | 73 | 15 | 3 | 469 |
| AO88162-2 | 258 | 8 | 267 | 100 | 8 | 4 | 378 |
| AO91004-6 | 314 | 34 | 348 | 92 | 14 | 10 | 463 |
| AO91522-4* | 387 | 143 | 530 | 20 | 12 | 4 | 566 |
| AO91812-1* | 418 | 82 | 500 | 39 | 10 | 3 | 552 |
| AO91812-2* | 400 | 25 | 424 | 87 | 12 | 4 | 528 |
| Mean | 300 | 68 | 369 | 60 | 20 | 11 | 460 |
| CV (%) | 15 | 64 | 17 | 28 | 63 | 104 | 14 |
| LSD (0.05) | 63 | 62 | 90 | 24 | 16 | 16 | 94 |

* Retained for further evaluation

Table 5. Characteristics of entries in the Western Regional Trial, Klamath Falls, OR, 1996.

| Variety/ Selection | Percent Stand | Vigor rating [1] | Vine maturity [2] | Specific gravity | Percent H.H.+B.C.[3] |
|---|---|---|---|---|---|
| Russet Burbank | 98 | 4.3 | 2.3 | 1.083 | 10 |
| Ranger Russet | 98 | 3.8 | 2.8 | 1.084 | 13 |
| Norkotah | 96 | 3.0 | 1.5 | 1.065 | 13 |
| A82360-7 | 98 | 3.5 | 3.5 | 1.090 | 5 |
| A84118-3 | 96 | 2.0 | 4.0 | 1.088 | 18 |
| A86102-6 | 98 | 3.5 | 2.8 | 1.082 | 20 |
| A8792-1 | 98 | 4.3 | 3.0 | 1.087 | 45 |
| AO85165-1 | 93 | 2.5 | 3.0 | 1.078 | 33 |
| CO85026-4 | 98 | 2.0 | 3.3 | 1.084 | 0 |
| TX1229-2RU | 84 | 2.3 | 2.5 | 1.069 | 35 |
| TX1385-12RU | 97 | 3.8 | 2.0 | 1.079 | 13 |
| TXAV657-27RU | 97 | 4.3 | 2.3 | 1.079 | 4 |
| TXNS112 | 98 | 3.8 | 2.0 | 1.067 | 15 |
| TXNS278 | 99 | 4.3 | 2.8 | 1.070 | 30 |
| Mean | 96 | 3.4 | 2.7 | 1.079 | 18 |
| LSD (0.05) | | | | 0.005 | |

1/ Vigor rating: (1 - small, weak plant; 5 - large, robust plant)
2/ Vine maturity: (1 - early; 5 - late)
3/ H.H. + B.C. : (Hollow heart plus brown center in 10 large tubers/sample)

Table 6. Tuber yield by grade for entries in the Western Regional Trial, Klamath Falls, OR, 1996.

| Variety/ 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/A------- | | | | | | |
| Russet Burbank | 289 | 33 | 321 | 99 | 29 | 6 | 455 |
| Ranger Russet | 319 | 40 | 359 | 74 | 17 | 9 | 459 |
| Norkotah | 326 | 36 | 362 | 71 | 3 | 2 | 437 |
| A82360-7 | 350 | 18 | 368 | 67 | 41 | 17 | 493 |
| A84118-3 | 277 | 15 | 292 | 82 | 11 | 7 | 391 |
| A86102-6 | 340 | 64 | 404 | 65 | 29 | 20 | 518 |
| A8792-1 | 355 | 93 | 447 | 55 | 31 | 18 | 552 |
| AO85165-1 | 287 | 96 | 383 | 49 | 15 | 16 | 463 |
| CO85026-4 | 277 | 79 | 356 | 37 | 5 | 11 | 409 |
| TX1229-2RU | 144 | 199 | 343 | 15 | 63 | 33 | 454 |
| TX1385-12RU | 294 | 109 | 403 | 45 | 15 | 11 | 474 |
| TXAV657-27RU | 343 | 145 | 488 | 57 | 9 | 5 | 558 |
| TXNS112 | 377 | 97 | 474 | 75 | 9 | 4 | 562 |
| TXNS278 | 352 | 71 | 423 | 101 | 10 | 8 | 541 |
| Mean | 309 | 78 | 387 | 64 | 21 | 12 | 483 |
| CV (%) | 11 | 48 | 13 | 27 | 57 | 104 | 9 |
| LSD (0.05) | 51 | 53 | 73 | 25 | 17 | NS | 64 |

Table 7. Comparison of yield and specific gravity of AO82611-7, COO83008-1, and AO85165-1 with Russet Burbank and Russet Norkotah in statewide and regional trials at Klamath Falls, OR, from 1987 to 1996.

| Variety/ selection | Yield U.S. No. 1s | | | Yield | | | | Specific gravity |
|---|---|---|---|---|---|---|---|---|
| | 4 - 12[1] oz | > 12[1] oz. | Total | Bs | No. 2s | Culls | Total | |
| | ----- | ----- | ----- | cwt/A | ----- | ----- | ----- | |
| | | | | **13 Trial Years** | | | | |
| Russet Burbank | 280 | 46 | 326 | 72 | 45 | 33 | 476 | 1.084 |
| AO82611-7 | 282 | 82 | 364 | 58 | 27 | 13 | 461 | 1.087 |
| | | | | **11 Trial Years** | | | | |
| Russet Norkotah | 240 | 96 | 336 | 42 | 15 | 11 | 404 | 1.069 |
| AO82611-7 | 280 | 82 | 362 | 59 | 24 | 13 | 456 | 1.086 |
| | | | | **12 Trial Years** | | | | |
| Russet Burbank | 294 | 46 | 340 | 76 | 42 | 25 | 483 | 1.085 |
| COO83008-1 | 268 | 143 | 412 | 28 | 21 | 14 | 473 | 1.086 |
| | | | | **10 Trial Years** | | | | |
| Russet Norkotah | 248 | 82 | 330 | 44 | 11 | 9 | 394 | 1.069 |
| COO83008-1 | 268 | 150 | 418 | 29 | 20 | 12 | 479 | 1.086 |
| | | | | **11 Trial Years** | | | | |
| Russet Burbank | 293 | 35 | 328 | 82 | 40 | 21 | 471 | 1.084 |
| Russet Norkotah | 256 | 76 | 332 | 42 | 11 | 9 | 394 | 1.069 |
| AO85165-1 | 318 | 173 | 491 | 35 | 17 | 16 | 559 | 1.078 |

[1]/ Size grades of 4 - 10 ounces and over 10 ounces used from 1987 to 1990 and 4 - 12 ounces and over 12 ounces from 1991 to 1996.

# Red-skinned Potato Variety Development, 1996

K.A. Rykbost[1], R. Voss[2], A. Mosley[3], J. Maxwell[1], and B. Charlton[3]

## Introduction

Red-skinned potato varieties are a small segment of the western states potato industry. However, they account for about 7,000 acres of California production, and interest in reds for fresh and processed products is increasing in the northwest. The standard varieties currently available are not meeting the quality criterion preferred by many of the buyers. Red LaSoda, the most commonly grown variety, produces high yields but has deep eyes, light color in most areas, and produces large tubers. For several market niches, small tubers, shallow eyes, and bright color command premium prices.

The KES red-skinned potato variety selection program was initiated in 1988 to supplement northwest variety development efforts that focus on russet-skinned selections. The 1996 program evaluated single-hill progeny from crosses made at North Dakota and Colorado State University potato breeding programs. Evaluation of more advanced selections was coordinated with interested cooperators. The KES program experienced a temporary setback in 1994 and 1995 due to virus infection of seed lots in central Oregon. In 1996, seed increase plots were relocated to Powell Butte. Meristem propagation of the most promising KES red-skinned clones was initiated at Corvallis, and plans were implemented to provide clean plant materials of promising red selections to Colorado for an alternate seed source. While advanced KES reds were not entered in the regional red-skinned trials in 1996, several clones were screened in Willamette Valley and California sites. This report will summarize project progress.

## I. Single-hill Seedling Screening

### Procedures

North Dakota State University provided over 5,000 clones from 41 crosses and Colorado State University provided over 4,700 clones from 24 crosses of primarily red-skinned parental lines. Due to space limitations, the families were pre-selected to reduce numbers to about 2,700 North Dakota selections and 2,350 Colorado clones in the single-hill, first generation screening trial. Preplanting selections were based on skin color, shape, size, and general condition of the greenhouse produced tuberlings.

1/ Superintendent/Professor and Biological Sciences Research Technician III, respectively, Klamath Experiment Station, Klamath Falls, OR.
2/ Extension Specialist, Vegetable Crops Department, University of California, Davis, CA
3/ Extension Specialist and Research Assistant, respectively, Department of Crop and Soil Science, Oregon State University, Corvallis, OR.

**Acknowledgments:** Appreciation is expressed to potato breeding programs at Aberdeen, Idaho, North Dakota State University, and Colorado State University for providing breeding lines for evaluation, and to the Oregon Potato Commission, USDA-CREES, and USDA-ARS for partial funding of this program.

The site for all KES red-skinned potato trials was planted to spring cereals in 1995. The site was fumigated with Telone II applied at 18 gpa in October 1995. Single-hill selections were planted at 36-inch spacing in 32-inch rows with an assisted-feed, two-row planter on May 20. All fertilizer (1,000 lb/acre of 15-15-15) was banded at planting. Weed control measures included 3.0 lb ai/acre of Eptam and 0.0156 lb ai/acre of Matrix applied pre-emergence on June 3 and immediately incorporated with a rolling cultivator, and 0.0156 lb ai/acre of Matrix applied on July 3. Cultural practices, including irrigation, foliar fungicides, and insecticides were applied as described for variety trials (page 41). Vines were desiccated with Diquat applied at 1.0 pint/acre on September 6 and September 12. Tuber families were dug with a two-row, level-bed digger and displayed for selection on September 26.

### Results and Discussion

Approximately one-third of the tuberlings produced healthy plants with good tuber production. Rhizoctonia damage weakened a significant number of plants. Heat sprouts were noted in many plants in late July. Plant vigor was clearly influenced by size of tuberlings planted. Colorado clones generally had larger minitubers and produced more vigorous plants.

At harvest, 82 clones, representing about 1.5 percent, were selected for further evaluation. Tubers were stored under typical seed storage conditions. The selections were examined after three months in storage and 27 clones were retained for evaluation in 12-hill plots in 1997 (Table 1). Tubers of these selections were eye-indexed and planted in greenhouse culture to determine extent of virus infections. Virus-free tubers will be used for 1997 plantings.

## II. Multi-hill Observational Trials

### Procedures

Twenty-four clones selected from 1995 and 1994 KES single-hills, and 12 selections from the USDA-ARS Aberdeen, Idaho program were planted in 12-hill plots on May 20. Four clones from 1994 KES single-hills were planted in 50-hill plots. Plants were spaced at 8.7 inches in 32-inch rows. Cultural practices were the same as for single-hills in all other respects. Tubers from 12-hill plots were harvested with a one-row, digger-bagger on September 25. All tubers from each clone were saved and stored under standard conditions until mid-December. The 50-hill selections were dug with the level-bed digger and evaluated on September 26. Several third- and fourth-year KES selections were also grown in observational trials at Bakersfield and Tulelake, California.

### Results and Discussion

Seven 12-hill and two 50-hill selections were retained for further evaluation (Table 2). Thirty tubers from the 12-hill lines were eye-indexed and will be tested in greenhouse culture for virus content. Several virus-free tubers will be provided for seed increase at Powell Butte. None of the Idaho 12-hill selections were considered suitable for additional testing. NDO5108-1 and NDO4654-1 were included in 27-hill plots at Bakersfield, California. NDO5108-1 was selected for further testing at that site. NDO4592-3 was included in a replicated yield trial in Bakersfield. It produced moderate yields with larger than average tuber size for the trial. Both clones were selected from the KES 50-hill trial for further evaluation. About 200 pounds of seed of each of these lines produced at Powell Butte will be provided for replicated yield trials in Oregon, California, and Texas in 1997.

## III. Advanced Replicated Yield Trials

### Procedures

Three standard varieties and 11 selections were included in a replicated yield trial at KES. The experiment was a completely randomized block design with four replications of single row, 30-hill plots. Seed was hand-cut to 1.5 to 2 ounces, treated with Tops 5.0 fungicide, and stored at about 55 °F and 95 percent relative humidity for 10 days prior to planting. Seedpieces were planted at 8.7-inch spacing in 32-inch rows on May 23. Cultural practices were the same as described for single-hill plots. Emergence data were recorded on June 17, June 26, and July 9; vine vigor ratings were made on July 9; and vine maturity data were noted on September 2.

Vines were desiccated with Diquat applied at 1 pint/acre on September 6 and September 12. Tubers were harvested with a one-row digger-bagger on September 25. All tubers from each plot were stored and graded in late October. External tuber characteristics were noted for each replication at grading. A 10 pound sample of 6- to 10-ounce No.1 tubers from each replication was used to determine specific gravity by the weight-in-air, weight-in-water method. Ten large tubers from each plot were cut longitudinally and inspected for internal defects. Sub-samples of 6- to 8-ounce No.1 tubers were saved from one replication of each entry for evaluation of culinary quality in boiling, microwave baking, and oven baking preparation methods.

The Corvallis trial included most entries from the KES trial plus two additional KES selections. Standard cultural practices for the area were followed. Four replications of 30-hill plots in a randomized block design were planted on June 1. Seedpieces were spaced at 9 inches in 34-inch rows. Vines were desiccated with 1 pint/acre Diquat applied September 10. Tubers were harvested on September 27. All tubers were graded and evaluated as at KES, except culinary tests were not conducted.

### Results and Discussion

Plant and tuber characteristics from the KES trial are presented in Table 3. Emergence was less than 90 percent on several selections. Vine vigor was generally inversely related to vine maturity. Entries with early maturity tended to have larger vines in early July. The earliest maturity was observed in NDO2686-6R, NDO4615-1R, and Dark Red Norland. Tuber appearance ratings were consistent with previous observations on these selections and varieties. Red LaSoda had deep eyes, light skin color, an oval shape, and extensive skinning damage. Sangre had fairly deep eyes and serious skinning damage. All selections had better color ratings and shallower eyes than Red LaSoda. The only selection with a severe skinning problem was AD82706-2R. This was observed at most western regional trial locations in both 1995 and 1996. This selection is nearly as late in maturity as Sangre. The entry with the best overall appearance rating was NDO2686-6R.

Yields, grade, and tuber size distribution varied widely among entries (Table 4). Red LaSoda produced the highest total No.1 and total yield, but had excessive tuber size with 50 percent of total yield over 10 ounces. Dark Red Norland was among the lowest yielding entries, while Sangre was about average in yield of No.1s and total yield. AD82706-2R produced the highest yield of No.1s among numbered selections. Excluding culls and tubers over 10 ounces, and including Bs, which command premium prices, the highest marketable yield was observed for NDO2686-6R. This selection has consistently produced a high yield of small, attractive tubers. The selection has also been evaluated on a small scale in a commercial seed operation in the Stockton, California area, where excellent performance has been noted.

Tuber characteristics at Corvallis are shown in Table 5. A high incidence of growth cracks was observed in Dark Red Norland, COO86107-1R, and NDO4615-1R. Hollow heart was common in Sangre, DT6063-1R, and

NDO4588-5R. Appearance ratings at Corvallis were quite consistent with KES ratings. Serious skinning damage was observed in AD82706-2R and NDO3994-2R. All selections except DT6063-1R had higher color ratings than all standard varieties.

Yields and size distribution were generally similar at KES and Corvallis (Tables 4 and 6). Red LaSoda produced the highest yield of No.1s at both locations, but excessive tuber size. The highest yield of Bs and No.1s under 10 ounces was achieved by NDO2686-6R. The standard varieties and several selections produced relatively high yields of culls. The lowest yields of No.1s occurred in Dark Red Norland, NDO3994-2R, and NDO4615-1R.

AD82706-2R, CO86142-3, CO86218-2, and DT6063-1R were evaluated as formal entries in the western regional red-skinned trial conducted at eight sites. The AD82706-2R selection is believed to be the same as A82705-1, which may be released by Idaho. This selection will be dropped from the regional trial. CO86142-3 and CO86218-2 will continue in the regional trial for one more year. DT6063-1R has been grown in California as 'Cherry Red' for several years. It will be included in the regional trial for two more years and then will probably be formally released by California.

The other entries included in these trials, except for COO86107-1R, are KES selections in various stages of evaluation. COO86107-1R, NDO2438-6R, NDO2438-7R, and NDO2686-6R were evaluated in the regional trial previously. Limited seed supplies due to virus infection precluded their entry in the 1996 regional trial. The performance of these clones in the KES and Corvallis trials, and seed production experience in 1996 was similar to previous observations. COO86107-1R, NDO2438-6R, and NDO2686-6R will return to the regional red-skinned trial in 1997. NDO2438-7R is being discarded due to serious storage rot problems that have occurred several times.

The remaining selections were in replicated trials for the second time. NDO3994-2R was grown at several locations in 1994. It was not outstanding at any location in either year, received a low rating in culinary quality tests, and will be discarded. NDO4615-1R had excessive growth cracks at both KES and Corvallis in 1996 and was among the lowest yielding entries at Corvallis. NDO4323-2R produced a relatively high yield at Corvallis in 1995 and 1996, but has had excessive growth cracks and high yields of culls. Both selections are being discarded. NDO4300-1R and NDO4588-5R will be retained for further testing. NDO4300-1R is relatively early in maturity, has good color, shallow eyes, and consistently achieves good yields with acceptable tuber size. It was rated lowest of all entries in the 1996 culinary quality test, but was among the highest in 1995 culinary ratings. This clone is a good candidate for the regional trial if 1997 results are similar to previous experience.

**Summary**

A return of the seed production function to Powell Butte appears to have solved a virus infection problem in the Oregon red-skinned potato variety program. Tissue culture propagation in the Oregon clone bank has been established for NDO2438-6R, NDO2686-6R, and COO86107-1R. Nuclear minituber stocks of NDO2438-6R were produced in 1996 and will provide the first commercial production of this clone in 1997. The most promising KES red-skinned selection, NDO2686-6R, is on a fast track for rapid increase of nuclear seed stocks. The NDO4300-1R clone will be entered in the clone bank in 1997. With no further seed production problems, the first Oregon red-skinned potato variety release may occur before the year 2000.

Table 1. Single-hill red-skinned potato seedlings selected at Klamath Falls, OR, 1996.

| Family No. | Parents | | Number | Number selected | |
|---|---|---|---|---|---|
| | female | male | planted | fall | winter |
| NDO5863 | 4299-7R | 2050-1R | 80 | 3 | 1 |
| NDO6009 | Norland | 3574-5R | 82 | 1 | 1 |
| NDO6170 | 3530-13R | Bison | 134 | 1 | 1 |
| NDO6172 | 3530-13R | 4952-4R | 136 | 1 | 1 |
| NDO6173 | 3574-5R | NorDonna | 202 | 9 | 5 |
| NDO6183 | 3595-17R | 5084-3R | 70 | 1 | 1 |
| NDO6184 | 3630-17R | Bison | 40 | 3 | 1 |
| NDO6244 | 4254-7R | S. Kurtzianum | 36 | 2 | 1 |
| NDO Sub total | | | (2702)[1] | (40) | 12 |
| COO94019 | AC82706-2 | NDO4030-12 | 64 | 2 | 1 |
| COO94029 | AC88482-1 | ND1871-3 | 44 | 2 | 2 |
| COO94094 | ND1871-3 | NDO4030-1 | 164 | 9 | 2 |
| COO94095 | ND1871-3 | NDO4030-12 | 244 | 6 | 2 |
| COO94103 | NDO4030-1 | NDO2438-7 | 182 | 8 | 5 |
| COO94111 | NDO3849-12 | C086218-2 | 190 | 4 | 1 |
| COO94113 | NDO4030-12 | NDO4030-1 | 158 | 3 | 1 |
| COO94114 | TC1389-3 | NDO2050-1 | 24 | 1 | 1 |
| COO Sub total | | | (2354) | (42) | 15 |

[1]/numbers in parentheses are totals for all seedlings planted and selected in the fall.

Table 2. Potato clones selected from 1996 12-hill and 50-hill plots at Klamath Falls, OR.

| Selection | Parents | |
|---|---|---|
| | female | male |
| | 12-hill selections | |
| NDO5438-3 | 4339-10R | 4269-9R |
| NDO5465-2 | 4398-1R | 3904-6R |
| NDO5846-1 | 4253-3R | 2224-5R |
| NDO5846-5 | 4253-3R | 2224-5R |
| COO93025-1 | AC88482-1 | CO86142-3 |
| COO93037-3 | CO82177-9 | NDO4030-12 |
| AO93459-1 | COA87154-1 | A82705-1R |
| | 50-hill selections | |
| NDO4592-3 | Reddale | 3198-1R |
| NDO5108-1 | 4128-5R | 2225-1R |

Table 3. Plant and tuber characteristics of red-skinned potato varieties and selections in the western regional and advanced KES trial at Klamath Falls, OR, 1996.

| Variety/ selection | Percent stand | Vine vigor [1] | Vine maturity [2] | Appearance rating [3] | | | |
|---|---|---|---|---|---|---|---|
| | | | | color | eyes | shape | skinning |
| Dark Red Norland | 95 | 4.0 | 2.0 | 3.8 | 4.3 | 1.5 | 4.8 |
| Red LaSoda | 98 | 4.8 | 3.5 | 3.0 | 1.8 | 2.0 | 2.5 |
| Sangre | 93 | 2.3 | 4.3 | 4.3 | 2.5 | 1.8 | 2.3 |
| AD82706-2R | 87 | 2.0 | 4.0 | 4.8 | 4.0 | 1.3 | 1.5 |
| CO86142-3 | 88 | 3.8 | 2.3 | 4.0 | 4.0 | 1.5 | 4.3 |
| CO86218-2 | 93 | 2.3 | 3.3 | 4.0 | 4.0 | 1.8 | 3.8 |
| DT6063-1R | 93 | 3.3 | 3.0 | 4.3 | 3.3 | 1.3 | 5.0 |
| NDO2438-6R | 93 | 2.8 | 2.8 | 4.5 | 3.5 | 1.5 | 4.0 |
| NDO2438-7R | 92 | 3.3 | 2.8 | 4.0 | 3.8 | 1.5 | 4.0 |
| NDO2686-6R | 96 | 4.0 | 1.8 | 5.0 | 4.5 | 1.0 | 4.8 |
| NDO3994-2R | 81 | 2.8 | 3.5 | 4.3 | 4.0 | 1.0 | 3.3 |
| NDO4300-1R | 91 | 3.3 | 2.5 | 4.0 | 4.3 | 1.0 | 4.0 |
| NDO4588-5R | 86 | 2.8 | 2.3 | 4.5 | 4.0 | 1.0 | 4.8 |
| NDO4615-1R | 88 | 4.5 | 2.0 | 3.5 | 3.5 | 1.3 | 3.8 |
| Mean | 91 | 3.3 | 2.9 | 4.1 | 3.6 | 1.3 | 3.8 |

1/ Vine vigor: 1 - small, weak; 5 - large, robust

2/ Vine maturity: 1 - early; 5 - late

3/ Color: 1 - pale to pink; 5 - bright red

Eyes: 1 - deep; 5 - shallow

Shape: 1 - round; 2 - oval

Skinning: 1 - severe; 5 - none

Table 4. Yield, grade, size distribution, and specific gravity of regional and advanced KES red-skinned potato selections grown in replicated yield trials at Klamath Falls, OR, 1996.

| Variety/ | Yield U.S. No. 1s | | | | Yield | | | Specific |
|---|---|---|---|---|---|---|---|---|
| selection | 4 - 6oz. | 6-10 oz. | > 10 oz. | Total | Bs | Culls | Total | gravity |
| | ----------cwt/A---------- | | | | | | | |
| Dark Red Norland | 83 | 132 | 65 | 280 | 60 | 23 | 363 | 1.060 |
| Red La Soda | 53 | 160 | 321 | 534 | 35 | 75 | 643 | 1.073 |
| Sangre | 84 | 154 | 153 | 391 | 51 | 33 | 475 | 1.073 |
| AD82706-2R | 85 | 180 | 186 | 451 | 57 | 8 | 515 | 1.064 |
| CO86142-3 | 72 | 120 | 45 | 238 | 72 | 31 | 340 | 1.067 |
| CO86218-2 | 74 | 156 | 158 | 387 | 63 | 19 | 469 | 1.069 |
| DT6063-1R | 60 | 138 | 183 | 380 | 42 | 19 | 441 | 1.079 |
| NDO2438-6R | 74 | 154 | 189 | 416 | 36 | 23 | 475 | 1.058 |
| NDO2438-7R | 90 | 181 | 164 | 434 | 48 | 30 | 512 | 1.064 |
| NDO2686-6R | 119 | 135 | 46 | 300 | 98 | 2 | 400 | 1.066 |
| NDO3994-2R | 100 | 142 | 104 | 346 | 88 | 11 | 444 | 1.068 |
| NDO4300-1R | 100 | 144 | 88 | 332 | 78 | 23 | 433 | 1.061 |
| NDO4588-5R | 87 | 147 | 123 | 357 | 54 | 16 | 427 | 1.060 |
| NDO4615-1R | 87 | 148 | 184 | 418 | 39 | 66 | 523 | 1.074 |
| Mean | 83 | 149 | 143 | 376 | 58 | 27 | 461 | 1.067 |
| LSD (0.05) | 26 | NS | 87 | 98 | 20 | 35 | 107 | 0.005 |
| CV (%) | 22 | 21 | 42 | 18 | 24 | 91 | 16 | 0 |

Table 5. Tuber characteristics of red-skinned potato varieties and selections grown at Corvallis, OR, 1996.

| Variety/ selection | Growth cracks | Hollow heart | Appearance ratings [1] | | | |
|---|---|---|---|---|---|---|
| | | | color | eyes | shape | skinning |
| | ----------% | --------- | | | | |
| Dark Red Norland | 19 | 15 | 3.3 | 3.4 | 2.0 | 4.2 |
| Red La Soda | 6 | 3 | 2.4 | 2.6 | 2.0 | 3.0 |
| Sangre | 7 | 30 | 3.5 | 3.6 | 1.5 | 4.2 |
| AD82706-2R | 2 | 0 | 4.7 | 4.4 | 1.8 | 1.7 |
| CO86142-3 | 4 | 0 | 4.0 | 4.4 | 1.2 | 4.4 |
| CO86218-2 | 1 | 3 | 4.8 | 4.5 | 1.2 | 4.7 |
| DT6063-1R | 8 | 52 | 3.3 | 3.7 | 1.7 | 4.9 |
| NDO2438-7R | 4 | 2 | 4.8 | 4.7 | 1.2 | 4.0 |
| NDO2686-6R | 0 | 0 | 4.6 | 5.0 | 1.0 | 4.3 |
| COO86107-1R | 12 | 0 | 4.8 | 4.8 | 1.3 | 3.1 |
| NDO3994-2R | 1 | 0 | 4.7 | 4.7 | 1.2 | 2.1 |
| NDO4300-1R | 3 | 3 | 4.3 | 4.9 | 1.2 | 4.0 |
| NDO4323-2R | 6 | 0 | 4.6 | 4.5 | 1.3 | 4.3 |
| NDO4588-5R | 1 | 23 | 4.2 | 3.8 | 1.4 | 3.4 |
| NDO4615-1R | 12 | 2 | 4.4 | 4.2 | 1.0 | 4.3 |
| Mean | 6 | 9 | 4.1 | 4.2 | 1.4 | 3.6 |

[1]/ Color: 1 - pale to pink; 5 - bright red
Eyes: 1 - deep; 5 - shallow
Shape: 1 - round; 2 - oval
Skinning: 1 - severe; 5 - none

Table 6. Yield, grade, and size distribution of red-skinned potato varieties and selections grown in replicated yield trials at Corvallis, OR, 1996.

| Variety/ selection | Yield U.S. No. 1s | | | | Yield | | |
|---|---|---|---|---|---|---|---|
| | 4 - 6oz. | 6 - 10 oz. | > 10 oz. | Total | Bs | Culls | Total |
| | cwt/A | | | | | | |
| Dark Red Norland | 59 | 115 | 95 | 269 | 54 | 161 | 484 |
| Red La Soda | 42 | 134 | 267 | 443 | 35 | 132 | 610 |
| Sangre | 60 | 145 | 170 | 375 | 52 | 98 | 525 |
| AD82706-2R | 70 | 164 | 175 | 409 | 50 | 40 | 499 |
| CO86142-3 | 60 | 190 | 86 | 336 | 61 | 31 | 428 |
| CO86218-2 | 91 | 160 | 69 | 320 | 95 | 35 | 450 |
| DT6063-1R | 62 | 184 | 115 | 361 | 52 | 95 | 508 |
| NDO2438-7R | 58 | 153 | 120 | 331 | 67 | 52 | 450 |
| NDO2686-6R | 111 | 186 | 49 | 346 | 102 | 9 | 457 |
| COO86107-1R | 38 | 137 | 158 | 333 | 44 | 93 | 470 |
| NDO3994-2R | 104 | 139 | 55 | 298 | 80 | 13 | 391 |
| NDO4300-1R | 96 | 204 | 105 | 405 | 62 | 41 | 508 |
| NDO4323-2R | 76 | 192 | 74 | 342 | 62 | 58 | 462 |
| NDO4588-5R | 56 | 201 | 165 | 422 | 72 | 35 | 529 |
| NDO4615-1R | 63 | 134 | 89 | 286 | 47 | 86 | 419 |
| Mean | 70 | 163 | 119 | 352 | 62 | 65 | 479 |
| LSD (0.05) | 28 | 47 | 59 | 80 | 23 | 40 | 80 |
| CV (%) | 29 | 21 | 34 | 16 | 27 | 42 | 12 |

## Potato Cultivar Response to Plant Population

K.A. Rykbost and J. Maxwell[1]

### Introduction

Russet Burbank has declined to less than one-third of total potato production acreage in the Klamath Basin. Russet Norkotah currently is the variety of choice for fresh market and seed crops. High susceptibility to potato virus Y infection and annual occurrences of early senescence of some Russet Norkotah fields result in low yields, and keeps interest in alternative varieties at a high level. A number of potential new fresh market varieties are progressing through the regional variety development program. Since 1988, a systematic effort has been pursued at the KES to evaluate the response of potential new cultivars to a range of plant populations. Seed spacing is a very important factor determining tuber size distribution. Cultivars have a relatively wide range in stem and tuber numbers per plant. Cultivars that produce high tuber numbers, such as Russet Burbank, require low populations to produce adequate tuber size. Others such as Century Russet and Shepody produce few tubers and tend to achieve excessive size unless populations are much higher than the ideal population for Russet Burbank. In 1996, response to plant populations was evaluated for Russet Burbank and Russet Norkotah standards, and three advanced russet selections. AO85165-1, an Oregon fresh market selection, was included for the third year. Dual purpose Idaho selections A84118-3 and A8495-1 were included for the first and second year, respectively. Both of these selections have produced very attractive tubers in previous KES trials.

### Procedures

Seed of all selections was hand cut to 1.5 to 2 ounces/seedpiece, treated with Tops 5.0 fungicide, and suberized for two weeks prior to planting. The experiment was conducted as a split-plot with seed spacings of 6.8, 8.7, or 12.0 inches in 32-inch rows as main plots, the five selections as split-plots, with four replications. Individual plots were two rows, 30 feet long. Potatoes were planted with a two-row, assisted-feed planter on May 24. Cultural practices were the same as described for variety trials on page 41. Vines were desiccated with 1 pint/acre Diquat applied on September 12.

Potatoes were harvested with a one-row, digger-bagger on October 1. Field weights were determined for all tubers from both rows. Approximately 100-pound samples from each plot were stored and graded to USDA standards in late October. Specific gravity was determined by the weight-in-air, weight-in-water method on a 10-pound sample of 6- to 10-ounce No.1 tubers. Ten large tubers from each plot were cut longitudinally and inspected for internal defects.

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1/ Superintendent/Professor and Biological Sciences Research Technician III, respectively, Klamath Experiment Station, Klamath Falls, OR.

**Acknowledgments:** Partial funding from the Oregon Potato Commission and CREES is gratefully recognized.

## Results and Discussion

Emergence data were recorded on June 24, 31 days after planting. All selections had achieved at least 90 percent emergence. Final stands exceeded 95 percent in all treatments. Crop development was affected by heat stress in July and August. A high incidence of hollow heart was observed in AO85165-1 (43 percent) and Russet Norkotah (20 percent). However, most of the tubers inspected for internal defects were over one pound in weight.

Yield, grade, and tuber size distribution data are presented in Table 1. Russet Norkotah produced significantly higher No.1 yield than Russet Burbank, A8495-1, and A84118-3. AO85165-1 has consistently produced significantly higher yields than both Russet Burbank and Russet Norkotah in variety trials. Over 11 KES trial years, total No.1 yield averaged 50 percent more for AO85165-1 than for both standard varieties. The similar yields for AO85165-1 and Russet Norkotah in this trial are, therefore, surprising. Lower yields for A8495-1 and A84118-3 are consistent with previous experience with these selections.

A significant interaction was observed between selection and seed spacing for total No.1 and total yield. Russet Burbank, Russet Norkotah, and A8495-1 produced their highest yields at the lowest plant population. In each case, the increased yield was attributable to larger tuber size with more No.1s over 10 ounces, and fewer Bs. Yields declined for AO85165-1 and A84118-3 when seed spacing increased from 8.7 to 12 inches. Neither selection produced higher yields of large tubers or lower yields of Bs at the lowest population. The response to seed spacing over three years for AO85165-1, Russet Burbank, and Russet Norkotah is shown in Table 2. Effects of seed spacing on Russet Burbank and Russet Norkotah were the same, when averaged over three years, as results observed in 1996. Both varieties produce higher yields and larger tuber size at 12-inch seed spacing. However, Russet Norkotah produces excessive tuber size and a relatively high incidence of hollow heart in large tubers at 12-inch spacing. The intermediate population has been adopted as standard management for Russet Norkotah in commercial crops. AO85165-1 typically produces larger tuber size than Russet Norkotah and usually has a higher incidence of hollow heart in very large tubers. Results from three years of evaluation indicate a seed spacing of 7 to 8 inches will be required to avoid excessive tuber size in this selection.

In 1995, A8495-1 produced 365, 382, and 377 cwt/acre of No.1s at 6.8, 8.7, and 12 inches, respectively. Averaged over two years, there is little difference in yield between the seed spacings. This selection has not produced excessively large tubers at the low plant population and is not as susceptible to hollow heart as Russet Norkotah. This selection is being considered for release by Idaho. It is probably the most attractive russet in the regional variety development program. In spite of somewhat lower yields, it appears to be a good candidate for fresh market use in the Klamath Basin. It will be evaluated for one more year in this trial.

A84118-3 is also a very attractive russet from the Idaho program. It completed three years of evaluation in the western regional variety trial in 1996. Due to lower yield than many other advanced clones, this selection will not be pursued for release from the Idaho program. No further evaluations will be conducted at KES.

Table 1. Effect of seed spacing on yield, grade, and tuber size distribution of five varieties/ grown at Klamath Falls, OR, 1996.

| Variety/ Selection | Seed Spacing | Yield U.S. No. 1s | | | | Yield | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 4-6 oz. | 6-10 oz. | >10 oz. | Total | Bs | No.2s | | Total |
| | inches | cwt/A | | | | | | | |
| R. Burbank | 6.8 | 163 | 134 | 53 | 350 | 94 | 13 | 10 | 466 |
| | 8.7 | 130 | 152 | 60 | 341 | 86 | 12 | 13 | 451 |
| | 12.0 | 126 | 179 | 101 | 405 | 53 | 26 | 18 | 502 |
| R. Norkotah | 6.8 | 117 | 149 | 99 | 365 | 64 | 8 | 5 | 442 |
| | 8.7 | 102 | 136 | 160 | 398 | 51 | 9 | 8 | 465 |
| | 12.0 | 89 | 144 | 190 | 423 | 40 | 15 | 10 | 488 |
| A085165-1 | 6.8 | 98 | 132 | 147 | 377 | 48 | 14 | 14 | 452 |
| | 8.7 | 71 | 120 | 211 | 401 | 27 | 20 | 6 | 453 |
| | 12.0 | 62 | 106 | 199 | 366 | 23 | 18 | 5 | 411 |
| A8495-1 | 6.8 | 93 | 145 | 58 | 296 | 69 | 12 | 4 | 381 |
| | 8.7 | 101 | 133 | 89 | 322 | 58 | 10 | 5 | 395 |
| | 12.0 | 81 | 133 | 123 | 337 | 28 | 13 | 9 | 386 |
| A84118-3 | 6.8 | 125 | 101 | 39 | 264 | 91 | 9 | 5 | 369 |
| | 8.7 | 122 | 118 | 66 | 306 | 80 | 8 | 8 | 402 |
| | 12.0 | 106 | 98 | 32 | 235 | 82 | 4 | 4 | 324 |
| Variety Main Effect: | | | | | | | | | |
| R. Burbank | | 139 | 155 | 71 | 365 | 78 | 17 | 14 | 473 |
| R. Norkotah | | 103 | 143 | 150 | 395 | 52 | 11 | 7 | 465 |
| A085165-1 | | 77 | 119 | 186 | 381 | 33 | 17 | 8 | 439 |
| A8495-1 | | 92 | 137 | 90 | 318 | 51 | 12 | 6 | 387 |
| A84118-3 | | 118 | 106 | 45 | 268 | 84 | 7 | 6 | 365 |
| CV (%) | | 16 | 18 | 33 | 9 | 25 | 57 | 72 | 8 |
| LSD (0.05) | | 14 | 20 | 30 | 27 | 13 | 6 | 5 | 25 |
| Spacing Effect: | | | | | | | | | |
| | 6.8 | 119 | 132 | 79 | 330 | 73 | 11 | 7 | 422 |
| | 8.7 | 105 | 132 | 117 | 354 | 60 | 12 | 8 | 433 |
| | 12.0 | 93 | 132 | 129 | 353 | 45 | 15 | 9 | 422 |
| CV (%) | | 11 | 19 | 42 | 18 | 6 | 37 | 116 | 14 |
| LSD (0.05) | | 9 | NS | 35 | NS | 3 | NS | NS | NS |

Table 2. Three-year summary of effects of seed spacing on yield, grade, and tuber size distribution of Russet Burbank, Russet Norkotah, and A085165-1 grown at Klamath Falls, OR, in 1994-1996.

| Variety/ selection | Seed spacing | Yield U.S. No. 1s | | | | Yield | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 4-6 oz. | 6-10 oz. | >10 oz. | Total | Bs | No 2s | Culls | Total |
| | inches | cwt/A | | | | | | | |
| R. Burbank | 6.8 | 138 | 124 | 45 | 308 | 120 | 28 | 14 | 470 |
| | 8.7 | 114 | 127 | 69 | 309 | 90 | 41 | 31 | 470 |
| | 12.0 | 117 | 150 | 91 | 356 | 62 | 38 | 19 | 475 |
| | Mean | 123 | 134 | 68 | 324 | 91 | 36 | 21 | 472 |
| R. Norkotah | 6.8 | 104 | 158 | 122 | 384 | 67 | 11 | 7 | 469 |
| | 8.7 | 92 | 145 | 169 | 406 | 43 | 12 | 9 | 469 |
| | 12.0 | 71 | 152 | 213 | 436 | 32 | 14 | 10 | 491 |
| | Mean | 89 | 152 | 168 | 409 | 47 | 12 | 9 | 476 |
| A085165-1 | 6.8 | 93 | 162 | 201 | 456 | 52 | 13 | 10 | 530 |
| | 8.7 | 82 | 157 | 235 | 474 | 36 | 17 | 9 | 536 |
| | 12.0 | 66 | 130 | 270 | 466 | 27 | 21 | 14 | 527 |
| | Mean | 80 | 150 | 235 | 465 | 38 | 17 | 11 | 531 |

## Effect of Seedpiece Size on Performance of three Potato Varieties

K.A. Rykbost and J.Maxwell[1]

### Introduction

A survey of 19 commercial cut seed lots in 1994 and 1995 confirmed previous subjective observations of poor quality control in local potato seed cutting operations. Only two of the seed lots surveyed had more than 60 percent of seedpieces in the desired range of 1.5 to 2.5 ounces. Five lots had over 50 percent of seedpieces under 1.5 ounces. The average for all lots was 37 percent of seedpieces, on a number basis, less than 1.5 ounces. A study was established at KES in 1994 to evaluate response to seedpiece size under local conditions. The preliminary 1994 study with Russet Burbank was expanded in 1995 and 1996 to include Russet Norkotah and Century Russet.

### Procedures

Seed tubers of Russet Burbank, Russet Norkotah, and Century Russet were individually sized to 3, 5, 7, 9, and 11 ounces (within 1/4 ounce). This allowed appropriate size seed from four-cut pieces to plant four replications of one-row plots with 3/4, 1-1/4, 1-3/4, 2-1/4, and 2-3/4 ounce seedpieces. Russet Burbank plots were 30 hills at 12.0-inch seed spacing. Russet Norkotah and Century Russet plots were 42 hills at 8.7-inch seed spacing. Eight (Russet Burbank) or 11 (Russet Norkotah and Century Russet) tubers were used for each plot with two bud-end pieces discarded in each case. This ensured uniform numbers of bud-end and stem-end pieces in each plot. All seed lots were cut and treated with Tops 5.0 fungicide on May 9 and stored at approximately 55 °F and 95 percent relative humidity until planting on May 24.

Potatoes were planted with a one-row, assisted-feed planter in 32-inch rows. Plots were arranged in a split-plot design with variety as the main-plot and seedpiece size as the split-plot. All fertilizer (1,000 lb/acre 15-15-15) was banded at planting. Cultural practices were as described on page 41. Emergence data were recorded on June 17, June 24, and July 1. Stem counts were determined on 10 consecutive plants in each plot on September 9. Vines were desiccated with Diquat applied at 1.0 pint/acre on September 6. Potatoes were harvested with a one-row, digger-bagger on September 27. All tubers from each plot were stored and graded on October 21.

Economic interpretations of findings were based on the following assumptions:

1. Seed costs, including cutting and treating - $12/cwt;
2. 17,424 or 21,780 seedpieces/acre for 10- or 8-inch seed spacing in 36-inch rows;
3. Crop values: Bs and culls - $1.00/cwt; No.2s - $3.00/cwt; No.1s 4-8 ounce - $5.00/cwt; No.1s 8-12 ounce - $10.00/cwt; No.1s >12 ounce - $8.00/cwt.

[1] Superintendent/Professor and Biological Sciences Research Technician III, respectively, Klamath Experiment Station, Klamath Falls, OR.

**Acknowledgments:** Partial funding support was provided by the Oregon Potato Commission.

## Results and Discussion

As in 1995, Russet Burbank emerged earlier than the other varieties (Table 1). Russet Norkotah and Century Russet emergence was delayed for small seedpieces. In Russet Burbank and Century Russet, small seedpieces resulted in smaller and less vigorous plants. Russet Norkotah vines were less vigorous in general and were in advanced stages of senescence in early September, while Russet Burbank and Century Russet remained vigorous until vines were desiccated. Stem numbers were similar to those observed in 1995. Large seedpieces produced significantly more stems in each variety. Seedpiece size did not affect specific gravity.

There was a significant interaction between variety and seedpiece size only for yield of 4- to 8-ounce No.1s in 1996. There were; however, different effects of seedpiece size among varieties. Century Russet produced relatively small increases in total No.1 yield for each incremental increase in seed size (Table 2). In contrast, Russet Burbank experienced a large yield increase from 3/4 to 1-1/4 ounce, but no further benefit from larger seed size. Seed size did not significantly affect total No.1 yield in Russet Norkotah. Effects of tuber size were more pronounced and more consistent among varieties. Larger seedpieces resulted in reduced yields of large No.1s and increased yields of Bs and small No.1s. The yield of Bs produced from 2-3/4-ounce seedpieces was more than double the yields of Bs produced by 3/4-ounce seedpieces, in all varieties. Yield responses over three years for Russet Burbank and two years for Russet Norkotah and Century Russet are summarized in Table 3. Response trends are similar to those observed in 1996 for all varieties.

Gross crop values were calculated for each plot individually using the prices listed for various yield components. The highest gross returns in 1996 occurred for 1-1/4, 1-3/4, and 2-3/4 ounce seedpiece size for Russet Burbank, Russet Norkotah, and Century Russet, respectively (Table 4). When seed costs are considered, the economically optimum seedpiece sizes in 1996 were 1-3/4 ounces for all three varieties. When findings are averaged over years, economically optimum seedpiece sizes are 1-3/4, 1-1/4, and 2-1/4 ounces for Russet Burbank, Russet Norkotah, and Century Russet, respectively.

Effects of seedpiece size on performance of Russet Burbank and Century Russet are in general agreement with findings from research in other production areas. Larger seed resulted in earlier emergence, more stems/plant, more tubers/plant, increased yields, but a higher proportion of smaller tubers. Economic effects vary depending on prices assumed for components of yield and seed. The prices used in this analysis result in average returns of about $6.25/cwt on a total crop basis. The average price declines as seed size increases due to the higher proportion of small, less valuable tubers. This is less than returns for fresh market crops in good price years, but higher than mean prices for the 1994-1996 crops.

Russet Norkotah response to seedpiece size was similar to the other varieties in emergence and stem numbers in both years. Yields were not significantly affected by seedpiece size in either year. The reasons for this lack of response are not clear. Low Norkotah yields in 1995 were thought to be the result of early dying. The 1996 yields were equal to Russet Burbank and do not indicate an unusual condition in this variety. A third year of evaluation for all three varieties in 1997 may provide further insight in the discrepancy between varieties.

Table 1. Effect of seedpiece size on emergence, stem numbers, and specific gravity of Russet Burbank, Russet Norkotah, and Century Russet potatoes grown at Klamath Falls, OR, 1996.

| Variety | Seed size (oz.) | Emergence (%) 6/17 | 6/24 | 7/1 | Stems/ plant | Specific gravity |
|---|---|---|---|---|---|---|
| R. Burbank | 3/4 | 91 | 98 | 100 | 2.1 | 1.086 |
| | 1-1/4 | 94 | 100 | 100 | 2.5 | 1.085 |
| | 1-3/4 | 100 | 100 | 100 | 2.6 | 1.082 |
| | 2-1/4 | 98 | 100 | 100 | 3.2 | 1.083 |
| | 2-3/4 | 99 | 100 | 100 | 3.5 | 1.084 |
| R. Norkotah | 3/4 | 50 | 89 | 95 | 2.3 | 1.070 |
| | 1-1/4 | 67 | 97 | 99 | 2.4 | 1.069 |
| | 1-3/4 | 67 | 93 | 97 | 2.6 | 1.069 |
| | 2-1/4 | 64 | 88 | 96 | 3.3 | 1.072 |
| | 2-3/4 | 77 | 98 | 99 | 3.4 | 1.067 |
| Century R. | 3/4 | 64 | 88 | 94 | 2.1 | 1.084 |
| | 1-1/4 | 65 | 94 | 99 | 2.8 | 1.085 |
| | 1-3/4 | 81 | 95 | 97 | 3.0 | 1.084 |
| | 2-1/4 | 77 | 95 | 99 | 3.8 | 1.083 |
| | 2-3/4 | 78 | 98 | 99 | 3.5 | 1.084 |
| Variety main effect: | | | | | | |
| R. Burbank | | 96 | 100 | 100 | 2.8 | 1.084 |
| R. Norkotah | | 65 | 92 | 97 | 2.8 | 1.069 |
| Century R. | | 73 | 94 | 98 | 3 | 1.084 |
| CV (%) | | 10 | 4 | 2 | 20 | 0.2 |
| LSD (0.05) | | 6 | 3 | 2 | 0.4 | 0.002 |
| Seed size effect: | | | | | | |
| | 3/4 | 68 | 92 | 96 | 2.2 | 1.080 |
| | 1-1/4 | 75 | 97 | 99 | 2.6 | 1.079 |
| | 1-3/4 | 83 | 96 | 98 | 2.7 | 1.078 |
| | 2-1/4 | 80 | 94 | 98 | 3.4 | 1.079 |
| | 2-3/4 | 85 | 99 | 99 | 3.5 | 1.078 |
| CV (%) | | 8 | 4 | 3 | 12 | 0.3 |
| LSD (0.05) | | 5 | 3 | 2 | 0.3 | NS |

Table 2. Effect of seedpiece size on yield, grade, and tuber size distribution of Russet Burbank, Russet Norkotah, and Century Russet grown at Klamath Falls, OR, 1996.

| Variety | Seed size | Yield U.S. No. 1s | | | | Yield | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 4-8 oz. | 8-12 oz | >12 oz. | Total | Bs | No.2s | Culls | Total |
| | oz. | ---cwt/A--- | | | | | | | |
| R. Burbank | 3/4 | 108 | 97 | 50 | 255 | 45 | 33 | 28 | 360 |
| | 1-1/4 | 193 | 118 | 60 | 371 | 52 | 30 | 1 | 454 |
| | 1-3/4 | 187 | 113 | 39 | 339 | 66 | 27 | 5 | 437 |
| | 2-1/4 | 207 | 111 | 34 | 352 | 84 | 36 | 8 | 480 |
| | 2-3/4 | 199 | 99 | 28 | 326 | 104 | 17 | 15 | 461 |
| R. Norkotah | 3/4 | 126 | 119 | 77 | 322 | 27 | 11 | 18 | 377 |
| | 1-1/4 | 147 | 131 | 77 | 355 | 40 | 7 | 13 | 414 |
| | 1-3/4 | 172 | 136 | 64 | 371 | 55 | 12 | 6 | 444 |
| | 2-1/4 | 190 | 106 | 42 | 338 | 65 | 12 | 7 | 421 |
| | 2-3/4 | 175 | 133 | 61 | 369 | 72 | 14 | 2 | 457 |
| Century R. | 3/4 | 191 | 113 | 76 | 379 | 33 | 8 | 18 | 438 |
| | 1-1/4 | 217 | 130 | 62 | 408 | 57 | 8 | 13 | 486 |
| | 1-3/4 | 261 | 141 | 44 | 445 | 73 | 5 | 5 | 528 |
| | 2-1/4 | 272 | 135 | 50 | 456 | 73 | 11 | 9 | 549 |
| | 2-3/4 | 322 | 123 | 41 | 486 | 113 | 5 | 7 | 611 |
| Variety main effect: | | | | | | | | | |
| R. Burbank | | 179 | 108 | 42 | 328 | 70 | 28 | 11 | 438 |
| R. Norkotah | | 162 | 125 | 64 | 351 | 52 | 11 | 9 | 423 |
| Century R. | | 252 | 128 | 54 | 435 | 70 | 7 | 10 | 522 |
| CV (%) | | 18 | 13 | 29 | 10 | 26 | 24 | 127 | 9 |
| LSD (0.05) | | 28 | 14 | 12 | 29 | 13 | 3 | NS | 31 |
| Seed size effect: | | | | | | | | | |
| | 3/4 | 141 | 109 | 68 | 319 | 35 | 17 | 21 | 392 |
| | 1-1/4 | 186 | 126 | 66 | 378 | 50 | 15 | 9 | 451 |
| | 1-3/4 | 207 | 130 | 49 | 385 | 65 | 15 | 6 | 470 |
| | 2-1/4 | 223 | 117 | 42 | 382 | 74 | 19 | 8 | 483 |
| | 2-3/4 | 232 | 118 | 43 | 394 | 96 | 12 | 8 | 510 |
| CV (%) | | 13 | 22 | 53 | 12 | 26 | 35 | 102 | 10 |
| LSD (0.05) | | 21 | NS | 23 | 38 | 14 | 5 | 9 | 37 |

Table 3. Mean effect of seedpiece size on yield, grade, and tuber size distribution over three years for Russet Burbank, and two years for Russet Norkotah and Century Russet potatoes grown at Klamath Falls, OR, 1994 - 1996.

| Variety | Seed size | 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 Bs | Yield No.2s | Yield Culls | Yield Total |
|---|---|---|---|---|---|---|---|---|---|
| | oz. | cwt/A | | | | | | | |
| R. Burbank | | Three-year mean (1994 - 1996) | | | | | | | |
| | 3/4 | 110 | 105 | 55 | 269 | 32 | 25 | 24 | 349 |
| | 1-1/4 | 166 | 127 | 62 | 355 | 41 | 27 | 11 | 434 |
| | 1-3/4 | 171 | 138 | 63 | 371 | 52 | 27 | 6 | 456 |
| | 2-1/4 | 196 | 121 | 67 | 383 | 64 | 35 | 12 | 493 |
| | 2-3/4 | 210 | 115 | 34 | 358 | 75 | 27 | 25 | 485 |
| R. Norkotah | | Two-year mean (1995 - 1996) | | | | | | | |
| | 3/4 | 103 | 108 | 63 | 272 | 24 | 7 | 14 | 316 |
| | 1-1/4 | 125 | 112 | 55 | 290 | 41 | 9 | 12 | 351 |
| | 1-3/4 | 139 | 105 | 49 | 292 | 50 | 9 | 10 | 360 |
| | 2-1/4 | 144 | 106 | 44 | 292 | 50 | 10 | 13 | 363 |
| | 2-3/4 | 144 | 114 | 51 | 308 | 58 | 9 | 3 | 378 |
| Century R. | | Two-year mean (1995 - 1996) | | | | | | | |
| | 3/4 | 128 | 128 | 108 | 364 | 26 | 9 | 13 | 412 |
| | 1-1/4 | 165 | 180 | 97 | 442 | 52 | 6 | 9 | 508 |
| | 1-3/4 | 211 | 186 | 80 | 477 | 58 | 5 | 12 | 552 |
| | 2-1/4 | 218 | 206 | 104 | 528 | 59 | 8 | 9 | 604 |
| | 2-3/4 | 281 | 178 | 84 | 543 | 86 | 8 | 10 | 647 |

Table 4. Effect of seedpiece size on gross crop value, seed costs, and gross value less seed cost for Russet Burbank, Russet Norkotah, and Century Russet potatoes grown at Klamath Falls, OR, 1994 - 1996.

| Variety | Seed size | Gross Value | | | | Seed cost | Gross value less seed cost | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1994 | 1995 | 1996 | Mean | | 1994 | 1995 | 1996 | Mean |
| | oz. | ---------------------------------------------------------------/acre------------------------------------------ | | | | | | | | |
| R. Burbank | 3/4 | 2490 | 1960 | 2080 | 2180 | 120 | 2370 | 1840 | 1960 | 2060 |
| | 1-1/4 | 3170 | 2240 | 2770 | 2730 | 200 | 2970 | 2040 | 2570 | 2530 |
| | 1-3/4 | 3460 | 2620 | 2530 | 2870 | 280 | 3180 | 2340 | 2250 | 2590 |
| | 2-1/4 | 3010 | 3070 | 2570 | 2880 | 350 | 2660 | 2720 | 2220 | 2530 |
| | 2-3/4 | 3160 | 2400 | 2370 | 2640 | 430 | 2730 | 1970 | 1940 | 2210 |
| R. Norkotah | 3/4 | - | 1770 | 2510 | 2140 | 150 | - | 1620 | 2360 | 1990 |
| | 1-1/4 | - | 1760 | 2730 | 2250 | 250 | - | 1510 | 2480 | 2000 |
| | 1-3/4 | - | 1610 | 2820 | 2220 | 340 | - | 1270 | 2480 | 1880 |
| | 2-1/4 | - | 1960 | 2450 | 2210 | 440 | - | 1520 | 2010 | 1770 |
| | 2-3/4 | - | 1880 | 2810 | 2350 | 540 | - | 1340 | 2270 | 1810 |
| Century | 3/4 | - | 2940 | 2760 | 2850 | 150 | - | 2790 | 2610 | 2700 |
| | 1-1/4 | - | 3990 | 2960 | 3480 | 250 | - | 3740 | 2710 | 3230 |
| | 1-3/4 | - | 4050 | 3160 | 3610 | 340 | - | 3710 | 2820 | 3270 |
| | 2-1/4 | - | 4940 | 3210 | 4080 | 440 | - | 4500 | 2770 | 3640 |
| | 2-3/4 | - | 4630 | 3300 | 3970 | 540 | - | 4090 | 2760 | 3430 |
| LSD (0.05) | (Size) | 580 | 340 | 310 | - | - | - | - | - | - |

## Effect of Potato Virus Y on Performance of Russet Norkotah

K.A. Rykbost[1], P. Hamm[2], D. Hane[2], R. Voss[3], and D. Kirby[3]

### Introduction

Mild potato virus Y (PVY) symptom expression in Russet Norkotah and other varieties results in difficulty in detecting, and therefore removing, diseased plants in seed production. The implications of the problem in Russet Norkotah were very evident in 1995 seed crops in central and southern Oregon. Several Russet Norkotah seed lots that had passed two field inspections were found to have high levels of PVY infection in winter greenhouse tests. The infected lots presented a dilemma for prospective buyers in the Klamath Basin. The rejection of seed with high PVY levels from late-blight-free local sources, would require purchasing seed from other production areas where late blight infection was a possibility.

Preliminary research in the Columbia Basin in 1994 and 1995 demonstrated a significant reduction in yield and tuber size in Russet Norkotah produced from PVY infected seed. These studies evaluated individual infected and disease free plants in commercial fields. In both years, Norkotah plants grown from PVY infected seed experienced yield reductions of nearly 50 percent compared to nearby disease-free plants. Research trials were established at three locations in 1996 to: 1) compare greenhouse PVY test results with field grown crops; 2) determine the extent of disease spread during the growing season under variable climatic conditions; 3) evaluate effects of seed-borne PVY infection on emergence rate, final stands, yield, grade, tuber size distribution, and specific gravity, and 4) evaluate the economic consequences of seed-borne PVY infection.

### Procedures

Two Russet Norkotah seed lots were obtained from Klamath County seed growers. Both lots were derived from generation II seed produced in Montana in 1994, and grown to produce generation III seed in Oregon in 1995. One seed lot had a greenhouse test of 48.9 percent PVY. The other seed lot was found to be free of PVY infection in the greenhouse test. Quantities of both lots were distributed to the Hermiston Agricultural Research and Extension Center (HAREC), the Intermountain Research and Extension Center (IREC), and the Klamath Experiment Station (KES) in mid-March.

1/ Superintendent/Professor, Klamath Experiment Station, Klamath Falls, OR.
2/ Associate Professor and Instructor, respectively, Hermiston Agricultural Research and Extension Center, Hermiston, OR.
3/ Extension Specialist, Department of Vegetable Crops, University of California, Davis, and Research Associate, Intermountain Research and Extension Center, Tulelake, CA, respectively.

**Acknowledgments:** Funding support from the Oregon Potato Commission and the Klamath Basin Potato Growers Association, and seed lots donated by Cheyne Brothers and Rajnus Brothers Seed are gratefully recognized.

At each location, seed was hand cut to 1.5 to 2.0 ounces/seedpiece about 10 days prior to planting. Isolation of seed lots was maintained until just prior to planting to prevent contact and potential spread of PVY. At HAREC, seed knives were disinfected between individual tubers in the lot with PVY infection, but not at KES and IREC.

The experimental arrangement at each location included 2-row plots with 60 hills/plot, 2 border rows between plots planted with virus-free seed, 5 replications, and 5 treatments with the following blend of seed lots: 1) 60 seedpieces from the clean lot (lot #1); 2) 45 seedpieces from lot #1 and 15 seedpieces from lot #2 (PVY infected); 3) 30 seedpieces from each lot; 4) 15 seedpieces from lot #1 and 45 seedpieces from lot #2; and 5) 60 seedpieces from lot #2. Treatments were arranged in a randomized complete block design.

Potatoes were planted on April 5, May 8, and May 24 at HAREC, IREC, and KES, respectively. Standard cultural practices, including insect control measures, were followed at each site. KES cultural practices are described on page 41. When most plants were 6 to 8 inches high, 30 plants from each plot were individually sampled and tested serologically for PVY infection. These samples were obtained in late May at HAREC, late June at IREC, and early July at KES. A second set of samples was obtained at early senescence at each site. Sampling times were late July at HAREC, late August at IREC, and early September at KES. All samples were ELISA tested for PVY infection at HAREC. Crops were harvested on August 20 at HAREC, September 23 at IREC, and September 24 at KES.

Standard grading procedures were used to determine grade and tuber size distribution. At each site, all tubers from each plot were graded. Specific gravity was measured by the weight-in-air, weight-in-water method at KES and HAREC.

**Results and Discussion**

Emergence rates and final stands were not affected by seed-borne PVY infection (Table 1). At KES, emergence ranged from 90 to 92 percent on June 24, and from 94 to 97 percent on July 1. At HAREC, emergence on June 1 ranged from 94 to 98 percent. At the time of early season sampling for PVY, infected plants were not visually distinguishable from healthy plants at KES. Plant population, emergence rates, and early season plant vigor were not a factor in yield, grade, or tuber size distribution. At time of senescence, plants in treatments with low virus content were clearly more vigorous than plants in treatments with high virus content. Nearly dead plants in KES plots with high PVY infection levels could not be tested serologically. Therefore, valid data could not be obtained from KES treatments 4 and 5 at the late season sampling.

Levels of PVY infection soon after emergence were quite similar at all locations and were in general agreement with expectations based on greenhouse tests for the two seed lots (Table 1). The lot testing free of PVY in the greenhouse was nearly virus-free at each site. The lot with a greenhouse reading of 48.9 percent PVY had early season infection levels of 56, 60, and 79 percent at HAREC, IREC, and KES, respectively. Treatments derived from blending of seed lots were predictably intermediate in infection levels. The differences between locations may be due to virus spread during seed cutting at KES and IREC, or differences in the virus content of three subsamples from the seed lot. Virus spread from the infected lot to the virus free lot before or during planting was unlikely due to seed being well suberized at the time seed lots were blended and planted. Plant to plant contact and virus spread prior to the first sampling was unlikely due to small plants.

The degree of virus spread between sampling times was site-specific. At HAREC, nearly all plants, including 79 percent of plants in the treatment that was virus-free initially, were infected with PVY in late July (Table 1). At IREC and KES, virus spread was similar for the three treatments with low virus levels, and late season infection levels were much less than at HAREC. The KES PVY levels for treatments 4 and 5 were probably also similar to those measured at IREC. The reasons for greater virus spread at HAREC may include greater insect activity in the warmer climate and more plant to plant contact due to frequent windy conditions in Hermiston compared to Klamath Basin conditions. It is also probable that the spread of PVY occurred at earlier growth stages at HAREC than at IREC or KES.

Effects of PVY infection on yield and tuber size distribution were also site-specific (Table 2). Total yield of U.S. No.1s declined from 433 cwt/acre for treatment 1 to 255 cwt/acre for the treatment 5. This 40 percent yield reduction is similar to findings from commercial fields in Hermiston in 1994 and 1995 studies. Differences in yield between treatments 1 and 2, and treatments 4 and 5 were statistically significant. Large yield reductions were found in each size class of No.1s. The PVY infection level did not affect yield of B size, or No.2s, or culls at any location.

The reduction in total U.S. No.1 yield as levels of PVY infection increased at IREC, was 82 cwt/acre, about 20 percent, compared to 40 percent at HAREC. The major yield loss experienced at IREC was in tubers over 12 ounces. Differences in smaller No.1 yields were not significant at IREC.

At KES, virus infection levels did not significantly affect any of the yield parameters. The range in total yield of No.1s was from 361 to 402 cwt/acre. A trend for fewer 12-ounce tubers at higher PVY infection levels was the only indication that PVY affected performance at this site. The fact that very small effects were observed at KES, argues against the possibility that yield differences at other sites were attributable to seed lot differences other than virus content.

Level of PVY infection did not affect specific gravity at HAREC or KES. The range at HAREC was from 1.070 to 1.072, and at KES it was from 1.066 to 1.068. Length to width ratios were measured at HAREC. A slight increase, from 1.80 to 1.90 was found with longer tubers at higher PVY infection levels. The differences were not significant.

Analyses of yield data over locations found significant interactions between treatment and location for 8- to 12-ounce No.1s, total No.1s, and total yield. This confirms the fact that yield response to level of tuber-perpetuated PVY was site-specific in this study. Incomplete data for KES prevented an analysis of late season PVY infection levels over location, but the available data clearly shows greater virus spread at HAREC than at Klamath Basin sites. Early season virus levels were similar at all sites.

**Summary**

Although only one year of data is available, the results provide support for the following observations: 1) the greenhouse virus readings were in good agreement with data from early season field tests; 2) virus spread during the season was significant at all locations, but spread was greater and probably more rapid at HAREC; and 3) yield reductions due to seed-borne PVY infection were much higher in the warm season environment at Hermiston. An economic analysis was not made, but the loss in crop value for fresh market crops would closely follow the reduction in U.S. No.1 yields.

Table 1. Comparison of emergence and early and late season PVY infection levels for Russet Norkotah potato seed lot treatments grown at three locations, 1996.

| | Emergence (%) | | | | PVY Infection (%) | |
|---|---|---|---|---|---|---|
| | KES | | | HAREC | Early | Late |
| Treatment | 6/17 | 6/24 | 7/1 | 6/1 | season | season |
| | | | KES | | | |
| 1 | 73 | 90 | 94 | | 1 | 21 |
| 2 | 70 | 91 | 97 | | 21 | 45 |
| 3 | 75 | 91 | 95 | | 39 | 65 |
| 4 | 75 | 92 | 94 | | 51 | - |
| 5 | 80 | 91 | 94 | | 79 | - |
| Mean | 75 | 91 | 95 | | 38 | - |
| | | | HAREC | | | |
| 1 | | | | 96 | 0 | 79 |
| 2 | | | | 94 | 20 | 97 |
| 3 | | | | 95 | 38 | 98 |
| 4 | | | | 98 | 53 | 100 |
| 5 | | | | 94 | 60 | 99 |
| Mean | | | | 95 | 34 | 95 |
| | | | IREC | | | |
| 1 | | | | | 3 | 21 |
| 2 | | | | | 16 | 52 |
| 3 | | | | | 30 | 67 |
| 4 | | | | | 62 | 81 |
| 5 | | | | | 56 | 85 |
| Mean | | | | | 33 | 61 |

Table 2. Yield, grade, and size distribution response to seed-borne PVY infection in Russet Norkotah grown at three locations, 1996.

| Treatment | Yield U.S. No. 1s (cwt/A) | | | | Yield (cwt/A) | | |
|---|---|---|---|---|---|---|---|
| | 4-8 oz. | 8-12 oz. | >12 oz. | Total | Bs | No.2s+ Culls | Total |
| | | | | KES | | | |
| 1 | 121 | 112 | 154 | 387 | 34 | 40 | 462 |
| 2 | 128 | 125 | 150 | 402 | 30 | 46 | 478 |
| 3 | 127 | 132 | 135 | 394 | 30 | 50 | 473 |
| 4 | 118 | 121 | 135 | 375 | 27 | 34 | 436 |
| 5 | 118 | 121 | 122 | 361 | 25 | 30 | 417 |
| CV (%) | 22 | 16 | 24 | 11 | 25 | 29 | 10 |
| LSD (0.05) | NS | NS | NS | NS | NS | NS | NS |
| | | | | HAREC | | | |
| 1 | 143 | 165 | 124 | 433 | 64 | 12 | 515 |
| 2 | 137 | 128 | 103 | 369 | 75 | 11 | 449 |
| 3 | 115 | 122 | 87 | 324 | 69 | 8 | 400 |
| 4 | 125 | 106 | 90 | 322 | 70 | 8 | 400 |
| 5 | 94 | 84 | 78 | 255 | 66 | 7 | 328 |
| CV (%) | 15 | 17 | 18 | 11 | 12 | 77 | 10 |
| LSD (0.05) | 25 | 27 | 23 | 50 | NS | NS | 56 |
| | | | | IREC | | | |
| 1 | 100 | 145 | 171 | 416 | 47 | 55 | 518 |
| 2 | 114 | 134 | 147 | 395 | 45 | 33 | 473 |
| 3 | 94 | 133 | 143 | 369 | 47 | 29 | 445 |
| 4 | 108 | 149 | 125 | 381 | 40 | 25 | 446 |
| 5 | 112 | 118 | 105 | 334 | 47 | 39 | 420 |
| CV (%) | 12 | 16 | 17 | 10 | 17 | 51 | 7 |
| LSD (0.05) | NS | NS | 31 | 49 | NS | NS | 45 |

# Control of Nematodes and Related Diseases in Potatoes

K.A. Rykbost[1], J. Maxwell[1], and R.E. Ingham[2]

## Introduction

Root-knot nematodes (*Meloidogyne chitwoodi*) and corky ringspot disease (CRS), caused by tobacco rattle virus and vectored by the stubby-root nematode (*Paratrichodorus allius*), remain among the most costly pests for potato production in the local area and in the Pacific Northwest. Crops seriously infected by either of these problems are reduced to the status of culls. In each of the past five years, crops in fields with no history of CRS have become infected, inflicting substantial economic losses on growers. Fields in several areas of the northwest have been abandoned for potato production due to the presence of stubby-root nematodes and the lack of satisfactory control options.

The choice of control measures for root-knot nematodes depends on nematode populations, climatic conditions, soil conditions (organic or mineral soils), and crop rotation alternatives. Chemical control options range from an application of Mocap (ethoprop) at low population levels, at a cost of about $150/acre, to the extreme case of Mocap plus Vapam (metham sodium) at about $300/acre.

Mocap, Vapam, and Telone II (1-3, dichloropropene), which are all somewhat effective in controlling root-knot nematodes, have not provided acceptable control of stubby-root nematode and CRS in previous research. The most effective control for CRS, Temik (aldicarb) was reinstated for use on potatoes in the Pacific Northwest in 1996. However, a restriction of 150 days-to-harvest was imposed for its use. This effectively limits the use of Temik to late maturing varieties in long season production areas.

Research in the Columbia Basin continues to evaluate combinations and application rates of products in an attempt to identify lower cost control options for both pest problems. With the possibility that Temik may become available with a less restrictive days-to-harvest interval, a study was conducted at the Klamath Experiment Station in 1996 to evaluate the efficacy of Mocap, Telone II, and Temik, alone or in combinations, in a field with fairly high nematode populations.

## Procedures

The experimental site was a Poe fine sandy loam soil that has been in a barley/potato rotation for over 10 years. The site has been used for nematode research in alternate years since 1990. Relatively high populations of stubby-root and root-knot nematodes occur throughout the field. Plot areas were established in October 1995 to accommodate six treatments and four replications in a randomized complete block design. Individual plots were 16 feet (6 rows) wide and 42 feet long. Three plots in each replication received 15 gpa of Telone II shanked in on 18-inch spacing at 16-inch depth with a V-ripper on October 24. The field was plowed in mid-November.

[1]/ Superintendent/Professor and Biological Sciences Research Technician III, respectively, Klamath Experiment Station, Klamath Falls, OR.

[2]/ Associate Professor, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR.

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Soil depths of 0 to 8 inches and 8 to 16 inches were sampled in each plot on April 4. Samples were composites from about 15 probes/plot. A second set of samples was obtained from all plots on October 7, 5 days after potatoes were harvested. These samples were from the top foot of soil. All soil samples were sieved and a 250 g soil sample was extracted with wet sieving-sucrose centrifugation by personnel in the nematology laboratory at the OSU Department of Botany and Plant Pathology.

Mocap EC was applied at 12 lb ai/acre with a conventional ground sprayer and incorporated in the top 8 inches of soil with a disc on May 3. Two plots in each replication were treated with Mocap. Temik was applied in the seed furrow to the four center rows of designated plots at a rate of 3.0 lb ai/acre during planting on May 23. Russet Burbank potatoes were planted at 12-inch seed spacing in 32-inch rows with a two-row, assisted-feed planter. No granular insecticides were applied to non-Temik treatments at planting.

Standard cultural practices were followed except for nematode control measures. Vines were desiccated with Diquat applied at 1.0 pint/acre on September 12. All tubers from 30 feet of the center two rows of each plot were harvested with a one-row, digger-bagger on October 2 and stored until grading on October 30. All tubers with visible root-knot nematode blemish were classified blemished, regardless of size or other grade considerations. Twenty tubers from each plot were cut into quarters and cut surfaces were inspected for CRS symptoms. Any evidence of CRS, regardless of severity, constituted a positive CRS determination. Yields were recorded by size and grade for unblemished tubers. CRS infection did not result in downgrading tubers otherwise classified as No.1s.

## Results and Discussion

Fall applied Telone II greatly reduced the population of both root-knot and stubby-root nematodes (Table 1). Populations of root-knot nematodes in April were highly variable in plots not treated with Telone II, ranging from 0 to over 700/250 g dry soil in individual plots. The distribution between soil layers indicated higher populations in the top 8 inches in plots not treated with Telone II. Stubby-root nematode populations ranged from 0 in 5 treated plots to about 100/250 g dry soil in one untreated plot. Stubby-root nematodes appeared to be uniformly distributed in the top 16 inches of soil.

Populations of root-knot nematodes after harvest were much higher than have been observed in previous research at this site. The very warm weather in July and August may have resulted in an additional nematode generation compared with a cooler season. The mean population for the control treatment was five times greater than the highest population observed in a 1994 study conducted in the same field. All plots treated with Telone II had significantly fewer root-knot nematodes than the untreated control. Stubby-root nematode populations were lower in October than in April samples. In Temik treatments, no stubby-root nematodes were found in five of the eight plots. No CRS symptoms were observed in samples from any of these plots. However, no stubby-root nematodes were found in two replications of the control treatment, while CRS infection in these plots was over 60 percent.

Crop development appeared normal through the season, with no apparent effect of treatments on foliage. Total yields were very uniform across treatments (Table 2). Differences in grade between treatments were mainly due to the level of root-knot nematode blemish. In three out of four replications, all tubers in untreated control plots were blemished. Root-knot nematode populations in post-harvest samples ranged from 1,500 to

3,350/250 g dry soil in these plots. About 37 percent infection was observed in the fourth replication where the population was 390/250 g dry soil. The extent of blemish was also variable in other treatments. For example, blemish in Mocap treated plots was 4, 8, 38, and 100 percent in the four replications. The corresponding populations were 82, 54, 2,032, and 1,602/250 g, respectively. While large differences were found between treatments in the percent of blemished tubers, the only statistically significant difference was between the control and all other treatments. The average blemish in treatments was in good agreement with post-harvest root-knot nematode populations.

Nematode blemish data show trends that are consistent with results observed in previous research at the same location. Mocap was not as effective as Telone II in reducing blemish. The combination of Telone II and Mocap did not improve control compared with Telone II applied alone. Temik appeared to be slightly more effective than Mocap, either alone or in combination with Telone II. It should be noted that the application rate for Telone II was less than would normally be applied for the root-knot nematode populations found at this site. However, the lower rate was selected specifically to determine whether it would be adequate when used in combination with Mocap.

CRS infection levels were also highly variable in most treatments (Table 2). Mocap did not provide any reduction in CRS. The fall samples show higher stubby-root nematode populations in plots treated with Mocap than in the untreated plots. Telone II reduced the incidence of CRS by about one-third, but not significantly. Stubby-root populations in fall samples were the same in Telone II treated plots as in the control. Temik, alone or in combination with Telone II, significantly reduced CRS compared to control and Mocap treatments.

## Summary

The only treatment that provided commercially acceptable control of both root-knot nematode blemish and CRS infection was the combination of Telone II and Temik. Mocap reduced blemish and root-knot nematode population by about 50 percent, but was ineffective in controlling stubby-root nematodes or CRS infection. Based on previous research, Telone II would probably have achieved acceptable control of tuber blemish at 20 or 25 gpa application rates. As in previous trials, Telone II did not control CRS even though it appeared to control stubby-root nematodes based on populations observed in spring samples.

The study once again demonstrated the efficacy of Temik for CRS control. The 150 days-to-harvest restriction precludes use of Temik for most crops in the Klamath Basin. Crops planted in mid-May could not be harvested prior to mid-October. If the pre-harvest interval is reduced to 120 days, Temik will return as the best, if not the only, feasible control measure for CRS caused by tobacco rattle virus and vectored by stubby-root nematodes.

Table 1. Effect of fumigation and nematicide treatments on population of root-knot and stubby-root nematodes at Klamath Falls, OR, 1996.

| | Root-knot | | | Stubby-root | | |
|---|---|---|---|---|---|---|
| | April 4 | | Oct. 7 | April 4 | | Oct. 7 |
| Treatment [1] | 0-8" | 8-16" | 0-12" | 0-8" | 8-16" | 0-12" |
| | ---nematodes/250 g dry soil--- | | | | | |
| Control | 209 | 112 | 1886 | 23 | 39 | 5 |
| Mocap | 206 | 167 | 943 | 28 | 25 | 14 |
| Temik | 80 | 38 | 870 | 26 | 19 | 2 |
| Telone II | 0 | 2 | 308 | 1 | 1 | 7 |
| Telone II + Mocap | 6 | 5 | 100 | 1 | 1 | 5 |
| Telone II + Temik | 0 | 0 | 58 | 0 | 2 | 1 |
| Mean | 84 | 54 | 694 | 13 | 14 | 6 |
| CV (%) | 251 | 271 | 103 | 120 | 149 | 143 |
| LSD (0.05) | NS | NS | 1077 | 24 | NS | 12 |

[1]/ Mocap: applied at 12 lb. ai/acre May 3
Temik: applied at 3.0 lb. ai/acre May 23
Telone II: applied at 15 gallons/acre October 24, 1995

Table 2. Effect of fumigation and nematicides on yield, grade, root-knot nematode blemish, and corky ringspot infection of Russet Burbank at Klamath Falls, OR, 1996.

| | Yield U.S. No. 1s | | | Yield | | | | | Infection level | |
|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | 4-12 oz. | >12 oz. | Total | Bs | No. 2s | Culls | Blemish | Total | Blemish | CRS |
| | cwt/A | | | | | | | | % | |
| Control | 40 | 5 | 45 | 10 | 7 | 4 | 282 | 347 | 82 | 56 |
| Mocap | 145 | 10 | 155 | 30 | 19 | 14 | 149 | 366 | 38 | 60 |
| Temik | 182 | 18 | 200 | 44 | 23 | 19 | 84 | 368 | 22 | 1 |
| Telone II | 217 | 18 | 235 | 51 | 13 | 12 | 61 | 370 | 16 | 34 |
| Telone II + Mocap | 197 | 15 | 212 | 46 | 25 | 11 | 41 | 334 | 12 | 34 |
| Telone II + Temik | 236 | 23 | 259 | 61 | 24 | 18 | 11 | 373 | 3 | 6 |
| Mean | 169 | 15 | 184 | 40 | 18 | 13 | 105 | 360 | 29 | 32 |
| CV (%) | 39 | 84 | 40 | 34 | 69 | 82 | 93 | 8 | 88 | 80 |
| LSD (0.05) | 99 | NS | 112 | 20 | NS | NS | 147 | NS | 38 | 38 |

## Screening Potato Selections for Resistance to Corky Ringspot Disease

K.A. Rykbost and J. Maxwell[1]

### Introduction

Corky ringspot disease (CRS) in potatoes occurs in isolated locations, scattered around the potato production areas of the Pacific Northwest. Since Temik use on potato crops was suspended in 1990, CRS is occurring in new locations in the northwest. Several samples of CRS infected tubers are submitted to KES personnel for evaluation each year. The reinstatement of Temik for use on potatoes in the Pacific Northwest will allow control of this disease in late maturing varieties in long-season environments. A restriction of 150 days-to-harvest will preclude the use of Temik in many areas, including most crops in the Klamath Basin. With no other reliable options for control of the vector of CRS, the stubby-root nematode (*Trichodorus spp.*), variety resistance or tolerance is an increasingly important approach to management of this disease.

Varietal response to the causal pathogen of CRS, tobacco rattle virus, varies widely. The Aberdeen, Idaho USDA-ARS potato breeding program has directed a small portion of the effort toward development of selections resistant to or tolerant of CRS. The Aberdeen breeding and selection team has screened varieties for response to CRS but they do not have sufficient populations of virus infected stubby-root nematodes to produce consistent infections in susceptible standard varieties. A KES field with a history of CRS infections and root-knot nematode blemish was offered to supplement the Aberdeen program in 1994 and 1996.

### Procedures

The site for the study is a Poe fine sandy loam soil type. No fumigants or nematicides have been applied at this site since 1988. Composite soil samples were collected from each half of the trial site at depths of 0 to 8 and 8 to 16 inches on April 4, and 0 to 12 inches on October 7, 1996, to determine nematode population density. Twenty-seven varieties or selections were screened in three replications of 20 hills each, arranged in a modified randomized complete block design. Each plot was paired with a Russet Burbank standard in an adjacent row. Seed was planted at 8.7-inch spacing in 32-inch rows on May 23. Standard cultural practices were followed as described for other experiments (page 41), except that no nematode control measures were applied. Vines were desiccated with Diquat applied at 1.0 pint/acre on September 12 and all tubers from each plot were harvested with a one-row digger-bagger on October 3 and stored until grading on October 29.

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1/ Superintendent/Professor and Biological Sciences Research Technician III, respectively, Klamath Experiment Station, Klamath Falls, OR.

**Acknowledgments:** OSU Nematology Program personnel in the Department of Botany and Plant Pathology provided analysis of soil samples for nematode identification and counts, Dr. Stephen Love, University of Idaho, provided selections for evaluation, and the Oregon Potato Commission, USDA-ARS, and USDA-CREES provided funding for the study.

Intact tubers were visually inspected for root-knot nematode (*Meloidogyne chitwoodi*) blemish symptoms. Samples ranged from no visible symptoms to severe blemish on all tubers. Tubers from each individual plot were scored as 0, 25, 50, 75, or 100 percent root-knot nematode blemished. Twenty-five tubers from each plot were cut into quarters and exposed surfaces were inspected for CRS symptoms. Each tuber was scored as follows:

1) no symptoms observed - no damage;
2) 1 to 5 percent damage (slight) - not more than one 1/8-inch diameter or larger diffuse brown spot per 1/2-inch tuber length;
3) 6 to 10 percent damage (moderate) - not more than two 1/8-inch diameter or larger diffuse brown spots per 1/2-inch tuber length;
4) >10 percent damage (severe) - more than two 1/8-inch diameter or larger spots per 1/2-inch tuber length.

A CRS Rating Index (RI) was calculated as: RI = (1.0 X number of tubers with no damage + 2.0 X number of tubers with slight damage + 3.0 X number of tubers with moderate damage + 4.0 X number of tubers with severe damage)/25 (total number of tubers). On this basis, scores range from 1.0 for a clean sample with no CRS symptoms, to 4.0 for a sample with all tubers having severe symptoms.

## Results and Discussion

April soil samples indicated populations of root-knot nematodes were 40 to 60/250 g dry soil, and stubby-root populations ranged from 30 to 80/250 g dry soil. Two composite samples collected after harvest measured root-knot populations at 30 and 193/250 g, and stubby-root populations at 4 and 7/250 g dry soil. Compared with populations measured in several plots of the nematode control study described in the previous section of this report, these were moderate populations for both nematode species.

Stubby-root nematode populations were apparently quite uniform throughout the study area. CRS symptoms were observed in each of the 54 Russet Burbank control samples. Severity ratings for Russet Burbank were consistently in the slight to moderate range, a level that would be unacceptable for processing or fresh market use (Table 1). No CRS symptoms were observed in any tubers in Brador, Gemchip, A8793-6, TX1385-12 Ru, or NZA8904-2. Several other selections with RI less than 1.3 appear to be only mildly susceptible to CRS damage. Previous experience has shown that Russet Norkotah has a lower incidence and very mild CRS symptoms in situations where Russet Burbank and Century Russet express much greater damage. Results in this study indicate a similar low incidence in TXNS112, which is a Texas line selection of Russet Norkotah.

Root-knot nematode populations were not uniform in the study area. Blemish was observed in about one-third of the Russet Burbank control plots, and two-thirds of samples from selections. Interpretations of tuber blemish data must be made with care. For example, the data show no infection in A8787-2, but little infection in the adjacent Russet Burbank either. On the other extreme, Russet Burbank adjacent to TXAV657-27 had 100 percent blemish, while no blemish was observed in TXAV657-27. Several other selections had considerably less tuber blemish than adjacent Russet Burbank samples, including the two Russet Norkotah selections, TXNS112 and TXNS278.

Table 1. Corky ringspot (CRS) infection by severity classification, CRS rating index (RI), and root-knot nematode blemish for potato selections and adjacent Russet Burbank controls grown at Klamath Falls, OR, 1996.

| Variety / Selection | CRS Severity | | | | CRS RI | | Nematode blemish | |
|---|---|---|---|---|---|---|---|---|
| | none | slight | moderate | severe | Selection | Burbank | Selection | Burbank |
| | -----%----- | | | | | | -----%----- | |
| Brador | 100 | 0 | 0 | 0 | 1.0 | 2.6 | 33 | 58 |
| Chipeta | 91 | 7 | 0 | 2 | 1.2 | 2.8 | 33 | 67 |
| Gemchip | 100 | 0 | 0 | 0 | 1.0 | 2.6 | 33 | 25 |
| White Rose | 58 | 42 | 0 | 0 | 1.4 | 2.1 | 33 | 50 |
| A82360-7 | 45 | 47 | 8 | 0 | 1.7 | 2.4 | 17 | 75 |
| A8495-1 | 40 | 30 | 27 | 3 | 2.0 | 2.6 | 67 | 33 |
| A84118-3 | 55 | 43 | 2 | 0 | 1.5 | 2.4 | 33 | 33 |
| A86102-6 | 45 | 52 | 3 | 0 | 1.5 | 2.2 | 58 | 58 |
| A8787-2 | 73 | 27 | 0 | 0 | 1.3 | 2.1 | 0 | 25 |
| A8787-26 | 33 | 39 | 15 | 13 | 2.1 | 2.7 | 42 | 33 |
| A8792-1 | 28 | 40 | 19 | 13 | 2.2 | 2.6 | 25 | 100 |
| A8793-6 | 100 | 0 | 0 | 0 | 1.0 | 2.1 | 58 | 58 |
| A87295-3 | 85 | 13 | 2 | 0 | 1.2 | 2.6 | 33 | 33 |
| A89241-6 | 40 | 30 | 30 | 0 | 1.9 | 2.5 | 17 | 83 |
| A89244-3 | 72 | 28 | 0 | 0 | 1.3 | 2.4 | 67 | 50 |
| A90550-3 | 80 | 17 | 3 | 0 | 1.3 | 2.3 | 0 | 58 |
| A91164-5 | 42 | 35 | 18 | 5 | 1.9 | 2.3 | 0 | 17 |
| A91319-1 | 85 | 13 | 2 | 0 | 1.2 | 2.2 | 17 | 25 |
| A91550-1 | 20 | 30 | 38 | 12 | 2.4 | 2.5 | 0 | 42 |
| AO85165-1 | 25 | 48 | 15 | 12 | 2.2 | 2.8 | 33 | 58 |
| CO85026-4 | 57 | 43 | 0 | 0 | 1.4 | 2.7 | 67 | 67 |
| TX1229-2RU | 47 | 43 | 10 | 0 | 1.6 | 2.7 | 50 | 67 |
| TX1385-12RU | 100 | 0 | 0 | 0 | 1.0 | 2.3 | 33 | 50 |
| TXAV657-27 | 75 | 23 | 2 | 0 | 1.3 | 2.5 | 0 | 100 |
| TXNS112 | 83 | 10 | 7 | 0 | 1.2 | 2.6 | 0 | 67 |
| TXNS278 | 57 | 25 | 15 | 3 | 1.7 | 2.7 | 8 | 92 |
| NZA8904-2 | 100 | 0 | 0 | 0 | 1.0 | 2.6 | 0 | 42 |
| Mean | 65 | 25 | 8 | 2 | 1.5 | 2.5 | 28 | 54 |

# Hybrid Poplar Research

S. Leavengood[1], J. Dahm[2], K.A. Rykbost[3]

## 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. Hybrids are produced by cross-fertilizing plants of different species, such as eastern cottonwood and black cottonwood. Hybrids can be produced to increase growth and to improve tolerance to environmental extremes. In the Pacific Northwest, hybrid poplar have grown 60 to 70 feet in height and 10 to 15 inches in diameter in just 7 years.

The ability of hybrid poplars to achieve very rapid growth and the decline in availability of federal timber in the northwest have stimulated great interest in hybrid poplar production. Within the last several years, four Oregon pulp and paper companies have established hybrid poplar plantations to help supply their paper mills. There is also interest in the wood products industry (e.g., sawmills, plywood mills, door and window manufacturers, etc.) to assess the suitability of poplar wood for wood products.

Growers and the wood products industry in the Klamath Basin have expressed interest in determining if hybrid poplar can be grown economically in the basin, and if so, which of the many hybrid clones available are best suited to local climatic conditions.

## Procedures

Mt. Jefferson Farms of Salem, Oregon provided 560 poplar cuttings ("sticks") representing eight different clones (70 trees of each clone). Seven clones (49-177, 52-225, 15-29, 50-194, 50-197, 288-64, and 184-411) were derived from parent stock involving crossing of *Populus trichocarpa* (black cottonwood) and *Populus deltoides* (eastern cottonwood). The other clone (OP-367) was from a cross of *Populus deltoides* (eastern cottonwood) and *Populus nigra* (European black poplar).

A field at the Klamath Experiment Station (KES) with Fordney fine sandy loam soil was selected as the research site. Previous crop history included spring barley or oats in the past four years preceeded by grass and legume forage crops. One potato crop and one sugarbeet crop was grown at the site in the past 10 years. Soil samples were collected and analyzed in the spring of 1996. An area of approximately 200 feet square was prepared for planting on June 11 and 12.

The field was ripped, with shanks spaced 18 inches apart, to a depth of 18 inches. A broadcast application of 500 lb/acre of 16-20-0-13S was incorporated by rototilling to a depth of 10 inches, followed by moderate compaction with a Brillion roller. A preplanting irrigation provided slightly less than field capacity in the top foot of soil. Poplar sticks were planted at 7-foot spacing in 10-foot rows on June 13. Individual plots (16 trees) consisted of 4 trees in 4 rows and were arranged in a randomized complete block design with three replications.

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1/ Southern Oregon Cooperative Extension Wood Products Agent, Klamath Falls, OR.
2/ President, Whiskey Creek Timber Company, Klamath Falls, OR.
3/ Superintendent/Professor, Klamath Experiment Station, Klamath Falls, OR.

The plot area was surrounded by two border rows of trees on all sides. Border trees were the same hybrid clones as in adjacent plots. Irrigation was provided with solid-set sprinklers arranged on a 40- by 40-foot spacing equipped to apply 0.25 inches/hour. The total irrigation for the 1996 season was approximately 30 inches.

Excellent weed control was achieved by cultivating between rows in both directions with a small harrow pulled with a four-wheel-drive ATV. The field was cultivated at about two week intervals. Nutrient deficiency symptoms evident during early foliage development prompted applications of elemental sulfur at 1,000 lb/acre on August 13, and four applications of a fertilizer blend containing 6 percent nitrogen, 5 percent sulfur, 6 percent iron, 2 percent manganese, and 1 percent zinc. The first application was made with a conventional ground sprayer at 5 gallons/acre in 30 gallons/acre of solution on July 23. Applications were made by drenching each tree individually with the concentrated solution applied with a backpack sprayer on August 10, August 16, and August 24. A total of 2 gallons of product was applied in the three applications. Height growth was measured on all trees on September 16. Height data was subjected to analysis of variance.

### Results and Discussion

Soil analyses indicated a potential for nutritional deficiencies and a need for soil amendments. Soil pH ranged from 7.9 to 8.8 with the gradient in the direction of replications such that replication 1 was positioned at the highest pH, and replication 3 at the lowest pH. Soil test results are presented in Table 1. Major elements and micronutrients were generally low. Exchangeable sodium was quite high, particularly in the area with high pH.
Due to limited experience with poplar production, and little information on how trees might respond to the soil conditions, use of soil amendments was delayed to observe crop response to the site.

Buds broke dormancy within about five days of planting and leaf development was evident within two weeks. As soon as expanded leaves were present the effects of high pH, high sodium content, and other nutritional stresses became evident. The trees in the area of highest pH and highest salt content exhibited severe bronzing to nearly purple color in leaves. At the lowest pH area, leaves appeared normal in color and growth was more rapid. The first application of the micronutrient mix did not result in noticeable improvement in leaf color or growth of the foliage. Some improvement in color and growth was observed after the application of elemental sulfur. The hand applications of nutrient during August also appeared to be beneficial. However, trees in the highest pH area continued to appear stressed throughout the season.

Some mortality was experienced in most clones in the first season. All trees survived in the OP-367 and 50-197 clones. Clones 49-177 and 52-225 each had one mortality out of 64 trees. Losses of 2, 3, 4, and 4 trees were experienced by clones 50-194, 15-29, 184-411, and 288-64, respectively.

Tree height measurements indicated significant differences between clones and a clear correlation between pH and tree growth (Figures 1 and 2). The OP-367 clone, which was the only clone derived from an eastern cottonwood - European black cottonwood cross, had an average height of 48 inches. This was significantly taller than the group including 50-197, 50-194, 15-29, and 49-177, which ranged in height from 37 to 34 inches. Clones 288-64 and 184-411 produced significantly shorter trees than all other clones, at about 26 inches.

The effects of high pH, high sodium levels, and related nutrient problems were also documented to some degree by the tree height measurements. Averaged over all clones, the heights ranged from 40 inches in the replication with lower pH to 33 inches in the middle replication and 30 inches in the highest pH replication. The superior performance of the

OP-367 clone seemed to be partially a tolerance to high pH and related soil conditions. It was more vigorous than other clones in each replication.

The limitations of this site for hybrid poplar production were recognized prior to planting the experiment. However, alternative sites were not offered within a limited time frame. It was also expected that the site could provide some insight into the opportunity to correct soil limitations. Further efforts in correcting soil limitations will be explored in 1997.

In the Columbia Basin and other long season areas, reports of tree heights of 7 to 10 feet in the first season are common. Much earlier planting is a major factor in this greater growth potential.

A small planting of the OP-367 clone was made at the Klamath County Extension Office site on May 31. Leaf growth was starting within 5 days after planting. A frost was experienced at the site on June 10 although the minimum temperature recorded at KES was 34°F. A lower temperature occurred on June 18 when the minimum recorded at KES was 30°F. These frosts resulted in 25 percent mortality in the trees planted at the extension office site, with no recovery. This is not an unusual event in the Klamath Basin, and suggests that early planting of hybrid poplars in the Klamath Basin would be very risky. The fact that the clone which performed best at KES was the one used at the extension office site may also be significant. Survival of other clones might have been even less.

One of the major problems experienced in poplar production has been controlling weed competition. The use of an ATV with a small cultivator was very satisfactory and cost effective. The ATV could drive over three-inch irrigation laterals with no damage and no need to disassemble the irrigation system. It is anticipated that this equipment will be able to maneuver through the plantation in the second year. By the third year, shading should provide adequate competition for weed control.

Overhead sprinkler irrigation is not widely used in hybrid poplar production. The system was very satisfactory in the first year, with no evidence of damage to leaves. In the first year, sprinkler heads were mounted on 36-inch risers. Taller risers may be required in the second year if leaf damage is observed. When trees reach fuller canopy conditions, other irrigation options may be required. The use of drip irrigation is probably not feasible in land irrigated with Klamath Project water due to algae growth, which would present filtering problems. Gated pipe and furrow irrigation will probably be the most practical approach in commercial scale situations.

The planting was made on the standard population of 70 square feet/tree used for pulp production. Slower growth rates in short-season climatic zones may require lower tree density to achieve adequate size in 10 years. Use of hybrid poplar for wood products will require larger diameter trees than necessary for pulp production. The preliminary plan for this study was to thin the stand after several years to provide more space and greater growth potential. In view of the poor growth due to adverse soil conditions, this site will not provide a good estimation of the potential for hybrid poplar to produce pulp or wood products. However, the experience gained has provided valuable information on adaptability of clones, effects of early season frost risk, irrigation and weed management options for first year establishment, and may, in the second year, demonstrate the ability to correct soil limitations.

Table 1. Soil test data for the hybrid poplar research site at the Klamath Experiment Station, Klamath Falls, OR, 1996.

| Parameter | | Quadrant NE | NW | SE | SW |
|---|---|---|---|---|---|
| pH | | 8.3 | 8.0 | 8.8 | 7.9 |
| Organic matter | (%) | 1.0 | 0.7 | 0.9 | 0.8 |
| Phosphorus | ppm | 6.0 | 6.4 | 5.6 | 7.0 |
| Sulfur | ppm | 4.5 | 3.0 | 2.5 | 8.5 |
| Potassium | ppm | 463 | 187 | 422 | 228 |
| Calcium | ppm | 3890 | 2700 | 4050 | 2950 |
| Magnesium | ppm | 492 | 298 | 673 | 271 |
| Sodium | ppm | 163 | 85 | 432 | 91 |
| Cation exchange | mEQ | 14.9 | 11.4 | 15.4 | 11.0 |
| Base saturation | % | 171 | 147 | 187 | 163 |
| Zinc | ppm | 1.1 | 0.9 | 0.9 | 0.9 |
| Iron | ppm | 2.1 | 3.7 | 1.0 | 4.0 |
| Manganese | ppm | 7 | 5 | 5 | 7 |
| Copper | ppm | 0.4 | 0.2 | 0.7 | 0.2 |
| Soluable salts | EC | 0.35 | 0.48 | 0.40 | 0.46 |

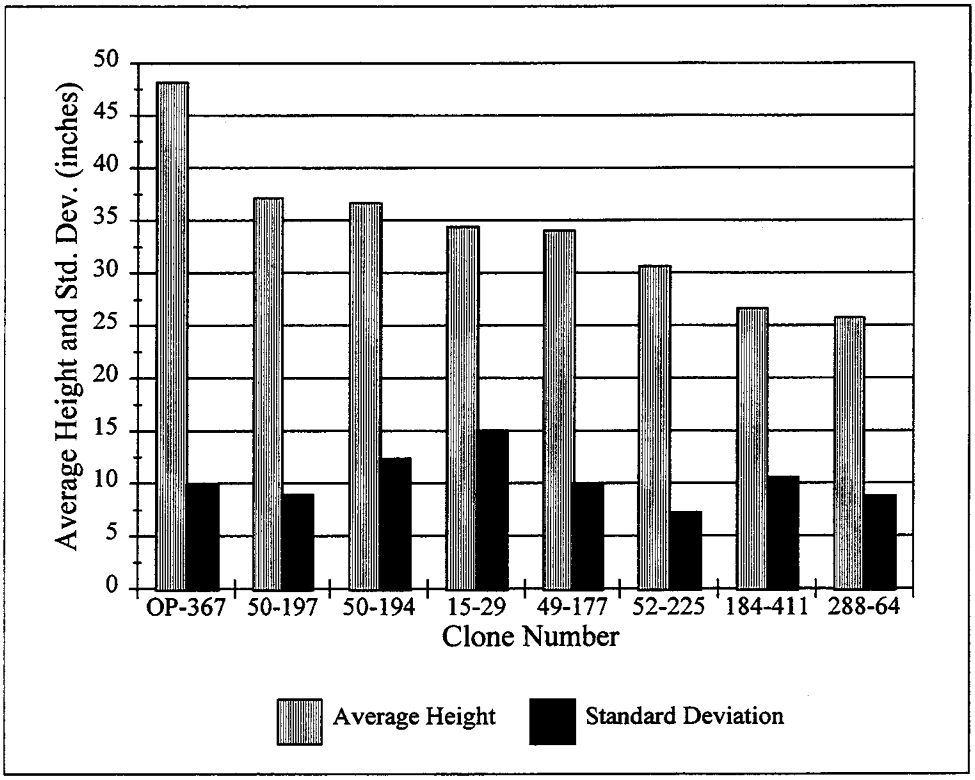


**Figure 1**. Average height for the 8 hybrid poplar clones, grown at the Klamath Experiment Station in 1996.

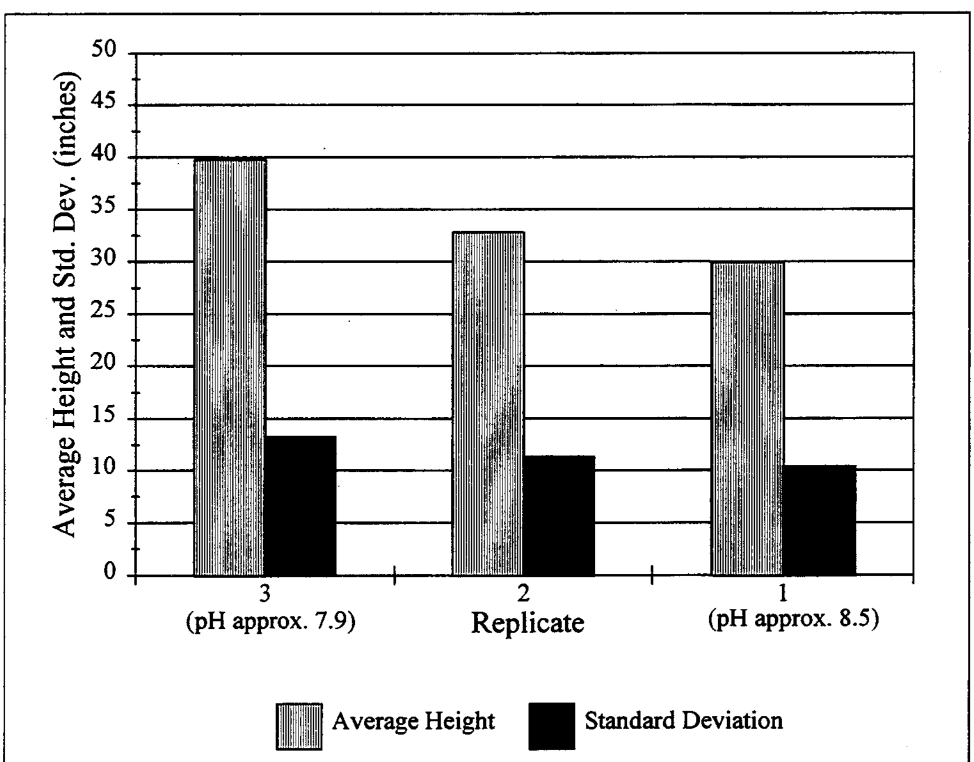


**Figure 2**. Average height (across all clones) for the 3 replicates, grown at the Klamath Experiment Station in 1996.

# Spring Barley Variety Screening, 1996

R.L. Dovel[1], R.S. Karow[2], and G. Chilcote[1]

## Introduction

Spring barley accounts for about 80 percent of cereal crops grown on over 100,000 acres in the Klamath Basin. Both feed and malting types are important in the region. Barley variety trials planted at the Klamath Experiment Station (KES) in 1996 included entries in the Western Regional Spring Barley trial done in cooperation with western states plant breeders and a collection of new lines from the Oregon State University (OSU) barley breeding program. The trial, in cooperation with OSU, was planted at KES and at two sites in the Lower Klamath Lake area. Screening of early selections from Idaho, Montana, and Washington breeding programs was also conducted in non-replicated trials.

## Procedures

All small grain variety trials at the KES were planted on land that was cropped in potatoes the previous year. Soils at the station include Poe, Fordney, and Hosley series, all of which have a fine-loamy to sandy texture, and are moderately deep and somewhat poorly drained. The off-station trials were on very deep, poorly drained, lake bottom soils with high organic matter content. These fields are cropped in spring cereals continuously. All plots at KES were sprinkler irrigated. Only one organic soil site was irrigated.

All trials were arranged in a randomized complete block design with four replications. Crops at the KES were planted on May 7 and 8. Unirrigated and irrigated organic soil sites were planted on May 2 and 30, respectively. Seed was planted to a depth of one inch at a seeding rate of 100 lb/acre. All plots were fertilized with 20 lb N, 12 lb $P_2O_5$, and 9 lb S/acre at time of seeding. Additional fertilizer was broadcast prior to planting at 80 lb N, 48 lb $P_2O_5$, and 35 lb S/acre. Plots measured 5 x 20 feet with a row spacing of 6 inches (10 rows). At KES, bromoxynil and MCPA were applied at labeled rates to control broadleaf weeds. Weed control at organic soil sites was achieved with a mixture of 2,4-D and Banvel. Plots were harvested in mid to late September using a plot combine with a 5-foot wide header. Grain yield was recorded for all plots. Test weight, percent plumps, and percent thins were measured in only one replication.

## Results and Discussion

### OSU Spring Barley Trials

#### Mineral Soil Site

Average yield was similar to that in 1995 but lower than in 1994. A late season infestation of barley stripe rust (BSR) reduced yields slightly.

Stander was the highest yielding entry in the trial in 1996 (Table 1). It produced significantly higher yields than eight entries in the trial, including Steptoe. Due to high variability in the trial, more precise mean separation was

[1]/ Associate Professor, and Research Technician, respectively, Klamath Experiment Station, Klamath Falls, OR.

[2]/ Professor, Crop and Soil Sciences Department, Oregon State University, Corvallis, OR.

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not possible. Other varieties in the trial that produced in excess of 5,000 lb/acre included BA 1202, Ab-2317, Baronesse, Foster, Maranna, and Galena. Test weight averaged 50.9 lb/bu at this site. Both WPB BZ489-74 and WA 11045-87 had exceptionally high test weights, but lower than average yields. Crest, BA 1202, and Baronesse had 25, 12, and 3 percent lodging compared to 15 percent for Steptoe. Serious lodging was observed in three experimental lines (Table 1). Other high yielding lines did not lodge.

When yield is averaged over the last two years, Baronesse is the highest yielding entry, followed by Stander, Maranna, and Colter (Table 2). Over a three-year period Maranna is the highest yielding entry followed by Baronesse, Colter, and Russell. Colter is extremely susceptible to BSR. Its yields and relative ranking have declined since the disease was introduced into the area in 1995.

Two hulless lines, WPB BZ489-74 and Waxbar, had significantly higher grain protein concentrations than other trial entries.

**Irrigated Organic Soil Site**

Gus was the highest yielding entry at this site in 1996 (Table 3), followed closely by UCD 92-10591R-117, a BSR resistant line. Both of these entries produced significantly higher yields than Steptoe. Four European lines, Alexis, Tyne, Optic, and Chariot, were included in the organic soil sites and in a separate trial at KES. These late maturing two row lines were as susceptible to BSR as domestic spring barley varieties. Due to later maturity, these varieties had lower than average yields.

Several varieties produced low test weights. The hulless variety, Bear, was highest in test weight due to the absence of hulls, but also had fewer plumps for the same reason. Similar results were observed at all three sites.

The top yielding varieties at this site over the last two years were Colter, Gus, Stander, and Russell (Table 4). Colter produced the highest yield at this site over three years.

**Unirrigated Organic Soil Site**

For the second year in a row, a severe frost in mid-August damaged heads in the early stages of grain fill, resulting in low test weights and yields. The trial was not harvested in 1995, but damage was less severe in 1996 and data were collected. The average yield was only 1,650 lb/acre and average test weight was 46.9 lb/bu (Table 5). The highest yielding entry in the trial, Baronesse, produced 2,970 lb/acre and was second highest in percent plump kernals. Colter and Russell produced yields that were not significantly different than Baronesse. Yields of later maturing varieties were especially low.

Steptoe treated with Vitivax and Steptoe treated with Baytan were included in all trials. Baytan treatment resulted in substantially higher yields at the mineral soil site, similar yields at the unirrigated organic soil site, and slightly lower yields at the irrigated organic soil site. Similarly inconclusive results were obtained from field scale and small plot studies at three sites in the Klamath Basin. It appears that late season BSR infestation occured after the window of protection provided by this fungicide had passed in 1996.

**Western Regional Spring Barley Nursery**

Yields were low and variability was high in the 1996 trial (Table 6). The trial average yield was the lowest since 1989, when common root rot severely reduced yields. Common root rot and BSR were present in 1996. Although barley stripe rust infestation occurred late in the season, the combination of both diseases reduced yields to 60 percent of expected levels.

High producing entries that were in the trial the previous two years also produced relatively higher yields in 1996, but mean separation was not possible due to high variability in the trial. Top yielding varieties over the last three years include BA 2B91-4947, MT 890008, BA 2B89-4311, and ND 11055 (Table 7).

Table 1. 1996 OSU Spring Barley Trial ( Irrigated mineral soil site).
Grain yield, test weight, and percent thins of spring barley lines planted in the 1996 Statewide Variety Testing Program. Plots were established on May 8 on irrigated mineral soil, at Klamath Experiment Station in Klamath County, OR.

| Entry | Variety | Row | Use | Yield | Test Wt | Protein | Lodge | Height | 50% Heading |
|---|---|---|---|---|---|---|---|---|---|
| | | | | lb/A | lb/bu | % | % | inches | julian |
| 1 | Baronesse | 2 | F | 5150 | 52.2 | 11.2 | 3 | 26 | 193 |
| 2 | Colter | 6 | F | 4690 | 50.8 | 9.8 | 0 | 30 | 186 |
| 3 | Crest | 2 | M | 4530 | 52.2 | 11.8 | 25 | 30 | 193 |
| 4 | Galena | 2 | M | 5120 | 52.2 | 10.9 | 0 | 30 | 193 |
| 5 | Idagold | 2 | F | 4860 | 51.2 | 11.8 | 0 | 25 | 197 |
| 6 | Maranna | 6 | F | 5130 | 49.5 | 11.0 | 0 | 25 | 193 |
| 7 | Payette | 6 | F | 4220 | 50.2 | 11.3 | 0 | 24 | 194 |
| 8 | Russell | 6 | M | 4420 | 51.3 | 10.7 | 0 | 31 | 186 |
| 9 | Steptoe | 6 | F | 3930 | 49.1 | 10.1 | 15 | 30 | 186 |
| 10 | Steptoe + Baytan | 6 | F | 5060 | 49.2 | 10.0 | 3 | 31 | 186 |
| 11 | Ab-2317 | 2 | F | 5390 | 52.8 | 11.7 | 0 | 34 | 193 |
| 12 | Bear (WA 11045-87) | 6 | H | 4210 | 56.8 | 12.2 | 38 | 31 | 193 |
| 13 | Washford (WA 97999-98) | 6 | Hd | 3480 | 38.8 | 11.9 | 20 | 37 | 192 |
| 14 | Waxbar | 6 | H | 2940 | 50.8 | 13.7 | 82 | 33 | 197 |
| 15 | WPB BZ489-74 | 6 | H | 3120 | 59.2 | 14.1 | 0 | 27 | 197 |
| 16 | Stander | 6 | M | 5860 | 52.3 | 11.4 | 0 | 37 | 187 |
| 17 | Foster (ND 11-055) | 6 | F | 5130 | 52.5 | 10.7 | 0 | 37 | 186 |
| 18 | Gustoe | 6 | F | 4460 | 47.2 | 11.1 | 0 | 20 | 193 |
| 19 | BA 1202 | 2 | M | 5410 | 52.5 | 11.8 | 12 | 33 | 193 |
| 20 | Gus | 6 | F | 4210 | 46.7 | 10.8 | 0 | 23 | 190 |
| 21 | 78Ab10274 | 2 | F/M | 4270 | 51.5 | 11.3 | 48 | 32 | 193 |
| Mean | | | | 4550 | 50.9 | 11.4 | 12 | 30 | 191 |
| LSD (0.05) | | | | 1080 | 1.9 | 0.6 | 26 | 11 | 2 |
| CV (%) | | | | 14 | 2 | 3 | 133 | 9 | 0 |

1/ F denotes a feed barley variety, M= a malting line, H = a hulless barley, Hd =hooded.

Table 2. Three-Year Summary of OSU Spring Barley Trial (Irrigated Mineral Soil Site). 1994-1996 grain yield of spring barley in the Statewide Variety Testing Program. Plots were established at Klamath Experiment Station in Klamath Co., OR.

| Variety | Row | Use | 1996 Yield | 1995 Yield | 1994 Yield | 2-year Average Yield | 2-year Average Rank | 3-year Average Yield | 3-year Average Rank |
|---|---|---|---|---|---|---|---|---|---|
| | | | lb/A | lb/A | lb/A | lb/A | | lb/A | |
| Baronesse | 2 | F | 5150 | 5150 | 6010 | 5150 | 1 | 5440 | 2 |
| Colter | 6 | F | 4690 | 4610 | 6410 | 4650 | 4 | 5240 | 3 |
| Maranna | 6 | F | 5130 | 4740 | 8620 | 4930 | 3 | 6160 | 1 |
| Russell | 6 | M | 4420 | 3810 | 7340 | 4110 | 11 | 5190 | 4 |
| Steptoe | 6 | F | 3930 | 4710 | 5040 | 4320 | 9 | 4560 | 5 |
| Crest | 2 | M | 4530 | 4240 | | 4390 | 6 | | |
| Payette | 6 | F | 4220 | 4010 | | 4120 | 10 | | |
| WPB BZ 489-74 | 6 | W | 3120 | 3480 | | 3300 | 12 | | |
| Stander | 6 | M | 5860 | 4180 | | 5020 | 2 | | |
| Gustoe | 6 | F | 4460 | 4230 | | 4350 | 8 | | |
| Gus | 6 | F | 4210 | 4500 | | 4350 | 7 | | |
| 78Ab10274 | 2 | F/M | 4270 | 4940 | | 4610 | 5 | | |
| Mean | | | 4520 | 4330 | 6680 | 4430 | | 5320 | |

1/ F denotes a feed barley variety, M= a malting line, H = a hulless barley, Hd =hooded.

Table 3. 1996 OSU Spring Barley Trial ( Irrigated organic soil site).
Grain yield, test weight, and percent thins of spring barley lines planted in the 1996 Statewide Variety Testing Program. Plots were established on May 30 on irrigated organic soil, in Klamath County, OR.

| Entry | Variety | Row | Use[1] | Yield | Test wt | Thins 6/64 | Thins 5.5/64 | Thins Pan |
|---|---|---|---|---|---|---|---|---|
| | | | | lb/A | lb/bu | % | % | % |
| 1 | Baronesse | 2 | F | 4430 | 50.0 | 92.5 | 4.7 | 2.8 |
| 2 | Colter | 6 | F | 4840 | 46.5 | 71.3 | 18.1 | 10.6 |
| 3 | Crest | 2 | M | 3680 | 48.0 | 90.1 | 6.8 | 3.1 |
| 4 | Alexis | 2 | M | 4210 | 48.0 | 82.7 | 10.4 | 6.8 |
| 5 | Tyne | 2 | M | 3890 | 50.5 | 87.9 | 7.7 | 4.4 |
| 6 | Maranna | 6 | F | 4650 | 43.0 | 75.5 | 15.2 | 9.3 |
| 7 | Cominant | 2 | M | 4240 | 47.5 | 75.3 | 13.3 | 11.4 |
| 8 | Russell | 6 | M | 5010 | 48.5 | 79.6 | 14.6 | 5.8 |
| 9 | Steptoe | 6 | F | 4520 | 47.0 | 92.2 | 5.0 | 2.9 |
| 10 | Steptoe + Baytan | 6 | F | 4000 | 46.5 | 87.9 | 7.7 | 4.4 |
| 11 | Ab-2317 | 2 | F | 4130 | 51.0 | 91.9 | 4.9 | 3.2 |
| 12 | Bear (WA 11045-87) | 6 | H | 3140 | 54.0 | 25.8 | 26.7 | 47.5 |
| 13 | Ab-88Y394 | -- | -- | 3330 | 50.0 | 78.4 | 12.0 | 9.5 |
| 14 | Optic | 2 | M | 4280 | 48.0 | 78.6 | 11.8 | 9.7 |
| 15 | Chariot | 2 | M | 3990 | 46.5 | 80.1 | 11.0 | 8.8 |
| 16 | Stander | 6 | M | 4710 | 50.0 | 93.2 | 4.2 | 2.6 |
| 17 | Foster (ND 11-055) | 6 | F | 4020 | 43.5 | 90.3 | 6.6 | 3.1 |
| 18 | Gustoe | 6 | F | 4520 | 44.0 | 83.3 | 11.5 | 5.2 |
| 19 | BA 1202 | 2 | M | 4210 | 51.0 | 92.3 | 5.1 | 2.6 |
| 20 | Gus | 6 | F | 5460 | 48.0 | 87.1 | 8.3 | 4.7 |
| 21 | 78Ab10274 | 2 | F/M | 2680 | 46.0 | 82.0 | 10.5 | 7.5 |
| 22 | UC 937-147 | 6 | F | 4860 | 43.0 | 89.0 | 8.0 | 3.0 |
| 23 | UCD 92-10591R-117 | 6 | F | 5450 | 45.0 | 84.2 | 8.4 | 4.2 |
| | Mean | | | 4270 | 47.6 | 82.2 | 10.1 | 7.5 |
| | LSD (0.05) | | | 840 | | | | |
| | CV (%) | | | 12 | | | | |

[1] F denotes a feed barley variety, while M denotes a malting line.

Table 4. Three-Year Summary of OSU Spring Barley Trial (Irrigated Organic Soil Site). 1994-1996 grain yield of spring barley in the Statewide Variety Testing Program. Plots were established on irrigated organic soil in Klamath Co., OR.

| Variety | Row | Use | 1996 Yield | 1995 Yield | 1994 Yield | 2-year Average Yield | 2-year Average Rank | 3-year Average Yield | 3-year Average Rank |
|---|---|---|---|---|---|---|---|---|---|
| | | | lb/A | lb/A | lb/A | lb/A | | lb/A | |
| Baronesse | 2 | F | 4430 | 2570 | 5450 | 3500 | 8 | 4150 | 6 |
| Colter | 6 | F | 4840 | 4520 | 6770 | 4680 | 1 | 5380 | 1 |
| Crest | 2 | M | 3680 | 2390 | 6900 | 3030 | 10 | 4320 | 5 |
| Maranna | 6 | F | 4650 | 3060 | 5310 | 3850 | 6 | 4340 | 4 |
| Russell | 6 | M | 5010 | 3640 | 6000 | 4320 | 4 | 4880 | 2 |
| Steptoe | 6 | F | 4520 | 3480 | 6570 | 4000 | 5 | 4860 | 3 |
| Stander | 6 | M | 4710 | 4400 | | 4550 | 3 | | |
| Foster (ND 11-055) | 6 | F | 4020 | 2920 | | 3470 | 9 | | |
| Gustoe | 6 | F | 4520 | 3180 | | 3850 | 7 | | |
| Gus | 6 | F | 5460 | 3780 | | 4620 | 2 | | |
| 78Ab10274 | 2 | F/M | 2680 | 1960 | | 2320 | 11 | | |
| Mean | | | 4410 | 3260 | 6170 | 3840 | | 4650 | |

[1/] F denotes a feed barley variety, while M denotes a malting line.

Table 5. 1996 OSU Spring Barley Trial (Unirrigated organic soil site).
Grain yield, test weight, and percent thins of spring barley lines planted in the 1996 Statewide Variety Trial Testing Program. Plots were established on May 2 on unirrigated organic soil, in Klamath County, OR.

| Entry | Variety | Row | Use[1] | Yield | Test wt | Thins 6/64 | Thins 5.5/64 | Thins Pan |
|---|---|---|---|---|---|---|---|---|
| | | | | lb/A | lb/bu | ------------- | % | ------------- |
| 1 | Baronesse | 2 | F | 2970 | 47.0 | 83.1 | 9.7 | 7.2 |
| 2 | Colter | 6 | F | 2470 | 47.5 | 69.4 | 17.7 | 12.8 |
| 3 | Crest | 2 | M | 2270 | 50.0 | 77.9 | 14.2 | 7.9 |
| 4 | Alexis | 2 | M | 1520 | 48.0 | 73.0 | 17.3 | 9.8 |
| 5 | Tyne | 2 | M | 1630 | 46.5 | 61.8 | 21.8 | 16.4 |
| 6 | Maranna | 6 | F | 1440 | 44.0 | 57.4 | 22.6 | 20.0 |
| 7 | Cominant | 2 | M | 1460 | 47.0 | 57.2 | 26.4 | 16.5 |
| 8 | Russell | 6 | M | 2470 | 50.5 | 72.3 | 16.6 | 11.2 |
| 9 | Steptoe | 6 | F | 2320 | 43.5 | 85.7 | 8.8 | 5.6 |
| 10 | Steptoe + Baytan | 6 | F | 2470 | 44.0 | 79.0 | 12.3 | 8.8 |
| 11 | Ab-2317 | 2 | F | 1400 | 46.5 | 74.0 | 16.0 | 10.0 |
| 12 | Bear (WA 11045-87) | 6 | H | 1520 | 56.0 | 14.2 | 42.7 | 43.0 |
| 13 | Ab-88Y394 | - | - | 720 | 47.5 | 78.6 | 11.9 | 9.6 |
| 14 | Optic | 2 | M | 720 | 47.0 | 65.5 | 22.1 | 12.5 |
| 15 | Chariot | 2 | M | 750 | 45.5 | 76.9 | 14.4 | 8.7 |
| 16 | Stander | 6 | M | 1530 | 48.0 | 77.3 | 11.6 | 11.1 |
| 17 | Foster (ND 11-055) | 6 | F | 1590 | 46.5 | 79.9 | 11.6 | 8.5 |
| 18 | Gustoe | 6 | F | 980 | 43.5 | 73.5 | 14.4 | 12.1 |
| 19 | BA 1202 | 2 | M | 1580 | 47.0 | 76.1 | 14.3 | 9.6 |
| 20 | Gus | 6 | F | 720 | 40.0 | 60.4 | 19.8 | 19.8 |
| 21 | 78Ab10274 | 2 | F/M | 2090 | 48.5 | 80.2 | 9.9 | 9.9 |
| | Mean | | | 1650 | 46.9 | 70.2 | 17.0 | 12.9 |
| | LSD (0.05) | | | 540 | | | | |
| | CV (%) | | | 20 | | | | |

[1/] F denotes a feed barley variety, while M denotes a malting line.

Table 6. 1996 Western Regional Spring Barley Nursery. Grain yield, test weight, percent thins, lodging, plant height, and date of 50% heading in Julian days (Number of days after January 1) of spring barley lines planted in the 1996 Western Regional Spring Barley Nursery. Plots were established on May 7 at Klamath Experiment Klamath County, OR.

| Entry | Variety | Row | Use[1] | Yield | Test wt | Thins 6/64 | Thins 5.5/6 | Thins Pan | Lodge | Height | 50% Heading |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | lb/A | lb/bu | -------- % | -------- | -------- | % | inches | Julian |
| 1 | Steptoe | 6 | F | 3740 | 51.0 | 88.1 | 7.7 | 4.2 | 0 | 24 | 189 |
| 2 | Klages | 2 | M | 3740 | 55.0 | 87.2 | 8.8 | 4.0 | 0 | 28 | 193 |
| 3 | Morex | 6 | M | 3220 | 52.5 | 88.8 | 8.4 | 2.8 | 0 | 28 | 187 |
| 4 | Stander | 6 | M | 4890 | 55.0 | 92.6 | 5.4 | 2.0 | 0 | 30 | 185 |
| 5 | Harrington | 2 | M | 3320 | 55.5 | 93.3 | 4.3 | 2.5 | 0 | 28 | 192 |
| 6 | MT 890008 | 2 | F | 3870 | 52.5 | 86.2 | 9.3 | 4.5 | 0 | 26 | 194 |
| 7 | BA 2B89-4311 | 2 | M | 3890 | 53.0 | 88.2 | 7.7 | 4.1 | 0 | 30 | 192 |
| 8 | BA 2B91-4947 | 2 | M | 4130 | 52.0 | 79.4 | 13.2 | 7.4 | 0 | 31 | 191 |
| 9 | ND 11055 | 6 | M | 4240 | 51.5 | 85.6 | 10.8 | 3.6 | 0 | 35 | 185 |
| 10 | ND 13299 | 2 | M | 3590 | 55.0 | 96.2 | 2.1 | 1.7 | 0 | 30 | 188 |
| 11 | WA 7758-89 | 2 | M | 3290 | 52.5 | 91.1 | 5.8 | 3.1 | 0 | 28 | 194 |
| 12 | SS SDM306B | 6 | F | 4000 | 52.5 | 88.6 | 8.2 | 3.2 | 0 | 26 | 187 |
| 13 | MT 886610 | 2 | M | 3110 | 54.0 | 86.2 | 8.7 | 5.1 | 0 | 28 | 194 |
| 14 | ID 862626 | 2 | M | 3020 | 56.0 | 94.2 | 3.5 | 2.3 | 0 | 20 | 194 |
| 15 | ID 90321 | 2 | M | 3600 | 55.0 | 92.0 | 5.4 | 2.6 | 0 | 22 | 188 |
| 16 | DA 592-47 | 6 | F | 3200 | 52.0 | 93.6 | 4.5 | 1.9 | 0 | 14 | 193 |
| 17 | WA 9339-91 | 6 | M | 3810 | 53.0 | 87.3 | 9.6 | 3.1 | 0 | 26 | 187 |
| 18 | ID 90241 | 2 | M | 3720 | 55.0 | 94.1 | 3.9 | 2.0 | 0 | 24 | 193 |
| 19 | WA 8625-90 | -- | -- | 3360 | 56.0 | 95.1 | 3.0 | 1.9 | 0 | 24 | 192 |
| 20 | WA 9792-90 | -- | M | 5610 | 53.0 | 87.2 | 8.3 | 4.4 | 0 | 28 | 187 |
| 21 | WA 8611-90 | -- | M | 3650 | 52.5 | 92.7 | 4.3 | 3.0 | 0 | 30 | 194 |
| 22 | SK TR128 | -- | -- | 3260 | 53.5 | 85.9 | 10.0 | 4.1 | 0 | 30 | 193 |
| 23 | SK TR133 | -- | -- | 4210 | 54.5 | 94.1 | 3.4 | 2.5 | 0 | 31 | 191 |
| 24 | SK TR139 | -- | -- | 3810 | 54.5 | 93.9 | 3.6 | 2.5 | 0 | 35 | 192 |
| 25 | MT H1851195 | 2 | M | 5060 | 55.0 | 96.4 | 2.5 | 1.2 | 0 | 33 | 189 |
| 26 | PB 1-90-2R-934 | 2 | F | 4050 | 51.0 | 80.5 | 11.9 | 7.5 | 0 | 31 | 192 |
| 27 | PB 1-92-6R-206 | 6 | F | 4550 | 50.5 | 89.7 | 7.3 | 3.0 | 0 | 31 | 190 |
| 28 | BA 2B92-5550 | 2 | M | 3040 | 53.0 | 81.9 | 12.3 | 5.9 | 0 | 30 | 193 |
| 29 | UT 4180 | -- | F | 3420 | 52.5 | 92.2 | 5.6 | 2.1 | 0 | 31 | 187 |
| 30 | UT 4198 | -- | F | 3570 | 53.0 | 93.1 | 4.9 | 2.0 | 0 | 30 | 186 |
| 31 | UT 2468 | -- | F | 3380 | 50.0 | 85.1 | 10.4 | 4.5 | 0 | 20 | 186 |
| 32 | UT 4081 | -- | F | 3440 | 50.5 | 92.5 | 5.3 | 2.2 | 0 | 28 | 186 |
| | Mean | | | 3770 | 53.2 | 89.8 | 6.9 | 3.3 | 0 | 27.8 | 190 |
| | LSD (0.05) | | | NS | | | | | | | 2 |
| | CV (%) | | | 31 | | | | | | | 1 |

1/ F denotes a feed barley variety, while M denotes a malting line.

Table 7. Three-Year Summary of Western Regional Spring Barley Nursery. Grain yield of spring barley lines planted at Klamath Experiment Station, 1994-1996.

| Variety | Row | Use | 1996 Yield | 1995 Yield | 1994 Yield | 2-Year Average Yield | 2-Year Average Rank | 3-Year Average Yield | 3-Year Average Rank |
|---|---|---|---|---|---|---|---|---|---|
| | | | lb/A | lb/A | lb/A | lb/A | | lb/A | |
| BA 2B89-4311 | 2 | M | 3890 | 4740 | 5380 | 4310 | 4 | 4670 | 3 |
| BA 2B91-4947 | 2 | M | 4130 | 4940 | 5660 | 4540 | 2 | 4910 | 1 |
| Klages | 2 | M | 3740 | 4770 | 4980 | 4260 | 6 | 4500 | 6 |
| Morex | 6 | M | 3220 | 4130 | 4640 | 3680 | 14 | 4000 | 10 |
| MT 886610 | 2 | M | 3110 | 4410 | 5300 | 3760 | 13 | 4280 | 7 |
| MT 890008 | 2 | F | 3870 | 5270 | 5000 | 4570 | 1 | 4710 | 2 |
| ND 11055 | 6 | M | 4240 | 4780 | 4770 | 4510 | 3 | 4590 | 4 |
| ND 13299 | 2 | M | 3590 | 3720 | 5350 | 3650 | 15 | 4220 | 9 |
| Steptoe | 6 | F | 3740 | 4590 | 4420 | 4170 | 8 | 4250 | 8 |
| WA 7758-89 | 2 | M | 3290 | 4630 | 5590 | 3960 | 11 | 4500 | 5 |
| DA 592-47 | 6 | F | 3200 | 4340 | | 3770 | 12 | | |
| Harrington | 2 | M | 3320 | 4630 | | 3980 | 10 | | |
| ID 862626 | 2 | M | 3020 | 4200 | | 3610 | 16 | | |
| ID 90321 | 2 | M | 3600 | 4840 | | 4220 | 7 | | |
| SS SDM306B | 6 | F | 4000 | 4140 | | 4070 | 9 | | |
| WA 9339-91 | 6 | M | 3810 | 4730 | | 4270 | 5 | | |
| BA 2B92-5550 | 2 | M | 3040 | | | | | | |
| ID 90241 | 2 | M | 3720 | | | | | | |
| MT H1851195 | 2 | M | 5060 | | | | | | |
| PB 1-90-2R-934 | 2 | F | 4050 | | | | | | |
| PB 1-92-6R-206 | 6 | F | 4550 | | | | | | |
| SK TR128 | -- | -- | 3260 | | | | | | |
| SK TR133 | -- | -- | 4210 | | | | | | |
| SK TR139 | -- | -- | 3810 | | | | | | |
| Stander | 6 | M | 4890 | | | | | | |
| UT 2468 | -- | F | 3380 | | | | | | |
| UT 4081 | -- | F | 3440 | | | | | | |
| UT 4180 | -- | F | 3420 | | | | | | |
| UT 4198 | -- | F | 3570 | | | | | | |
| WA 8611-90 | -- | M | 3650 | | | | | | |
| WA 8625-90 | -- | -- | 3360 | | | | | | |
| WA 9792-90 | -- | M | 5610 | | | | | | |
| Mean | | | 3770 | 4550 | 5110 | 4080 | | 4460 | |
| LSD (0.05) | | | NS | 641 | 974 | NS | | NS | |
| CV (%) | | | 31 | 10 | 12 | 22 | | 17 | |

1/ F denotes a feed barley variety, while M denotes a malting line.

## Spring Wheat Variety Screening in the Klamath Basin, 1996

R.L. Dovel[1], R.S. Karow[2], and G. Chilcote[1]

### Introduction

Spring wheat is grown on approximately 8,500 acres annually in the Klamath Basin. Soft white (SW) and hard red (HR) selections predominate; however, interest has grown recently in the hard white (HW) class. In 1996, spring wheat variety trials were conducted at the KES and on an irrigated site in the Lower Klamath Lake area in cooperation with Oregon State University and Western Regional plant breeding and evaluation programs. Cold-tolerant, short-season cultivars are needed in the Klamath Basin due to a short growing season with the possibility of frost throughout the growing season. Entries evaluated in these trials included SW, HW, and HR selections.

Historically, there has been little disease or insect pressure on small grains in the Klamath Basin. However, the recent introduction of the Russian wheat aphid has altered this situation. Wheatstem maggot is endemic in the area and generally causes only slight damage at the KES. Under mild winter and warm spring conditions in 1992 and 1993, significant damage to cereal crops was experienced, with up to 50 percent of the tillers affected at KES, and with serious crop losses in several commercial fields in the Lower Klamath Lake area.

### Procedures

All small grain variety trials at the KES were on land planted in potatoes the previous year. Soils at the station include Poe, Fordney, and Hosley series, all of which have a fine loamy to sandy texture and are moderately deep and somewhat poorly drained. All plots were sprinkler irrigated.

All trials were arranged in a randomized complete block design with three or four replications. Plots were planted on May 7 at KES and on May 30 at the Lower Klamath Lake site. Seed was planted at a depth of 2 inches. The seeding rate for wheat trials was 100 lb/acre. All plots were fertilized with 20 lb N, 12 lb $P_2O_5$, and 9 lb S/acre at time of seeding. Additional fertilizer was broadcast prior to planting at 80 lb N, 48 lb $P_2O_5$, and 35 lb S/acre. Plots measured 5 x 20 feet, with 10 rows at 6-inch spacing. At KES, Bromoxynil and MCPA were applied at labeled rates to control broadleaf weeds. Weed control at the organic soil site was achieved with a mixture of 2,4-D and Banvel. Plots were harvested in late September at the KES and in late October at the off-station site, using a plot combine with a 5-foot wide header. Grain yield was recorded for all plots. Test weight was measured in only one replication.

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[1]/ Associate Professor and Research Technician, respectively, Klamath Experiment Station, Klamath Falls, OR.

[2]/ Professor, Crop and Soil Science Department, Oregon State University, Corvallis, OR.

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## Results and Discussion

### Western Regional Spring Wheat

Eight of the ten top yielding entries in the trial in 1996 were soft white (SW) lines, and the other two were hard white (HW) lines (Table 1). The three highest yielding entries in the trial were ML 42409, SDM 50030, and SDM 4055, all SW lines. The highest yielding entry, ML 42409, produced yields significantly higher than Penawawa, the most commonly planted SW variety in the region. Penawawa is late maturing in the Klamath Basin where shorter season varieties are desirable. Unfortunately, few entries in the trial headed earlier than Penawawa and none of these were high yielding SW lines.

The fourth and seventh highest yielding entries were hard white lines, OR 895181 and OR 492092. They produced 5,610 and 5,520 lb/acre, respectively, compared to 3,890 produced by Klasic, the most commonly planted HW variety in the region. Over the last three years, Penawawa has produced the highest average yield in the trial, followed closely by OR 895181.

The highest yielding hard red (HR) entry was ID 462. It has been in the trial for three years and is not significantly different in yield than two other HR lines, UT1175 and UT 1146, over that period (Table 2). All three of these lines produced significantly higher yields than McKay, the standard HR variety in the trial, over a three-year period.

The release of the high yielding lines discussed above would benefit grain producers in the Klamath Basin. Release of these promising lines is dependent on their performance in other areas and final approval by state and regional review boards.

### OSU Hard White Spring Wheat

The highest producing entry in the OSU Hard White Spring Wheat Variety Trial in 1996 was ID 377S (Table 3). Over a three-year period, ID 377S has been the highest yielding entry in the trial. It has good milling and baking quality and has been exclusively released by the University of Idaho. Most of the entries produced significantly higher yields than Klasic, the current industry standard. However, all of these entries have a later heading date than Klasic, which may be a disadvantage in the Klamath Basin (Table 3). OR 4870279 produced yields superior to Klasic in this trial over a three-year period and much higher yields in the Western Regional trial. This HW line has good baking quality and may be released if yields in other areas of the Pacific Northwest justify it.

### OSU Hard Red Spring Wheat

Standard HR spring wheat varieties in the Klamath Basin are Westbred 906R, Westbred 926, Westbred 936, and Yecora Rojo. Express, a recently released variety, is increasing in acreage. There was no significant difference in yield among Express and the Westbred lines, but all except Westbred 926 produced significantly higher yields than Yecora Rojo (Table 4).

The experimental line, 4910028, was the highest yielding entry in the trial in 1996 (Table 4). It produced yields significantly higher than the commercially available varieties discussed above. Eight lines not significantly different than 4910028 were 4940107, 4900041, 4870410, 948055, 4920002, 4920330, 4920331, and ID 167.
OR 4900041 and OR 4920002, which have been in the trial four years, are the two highest producing entries over that period. Both of these experimental entries produced significantly more grain than commercially available varieties in the trial. Another entry that should be noted is OR 4910028. All three of these experimental lines have produced high test weights and are of comparable height to Westbred 906R. The heading date of OR 4910028 is the same as Yecora Rojo (Table 4). Grain baking quality is an important consideration in the selection of HR wheat

varieties. Further evaluation of baking quality of top yielding entries will be needed prior to release of these lines.

### OSU Soft White Spring Wheat

Centennial was the second highest yielding entry in 1996 and has produced higher yields than Penawawa for the last four years (Table 5). Centennial is a recent release from the University of Idaho. It was planted in joint trials at KES and the Intermountain Research and Extension Center from 1989 to 1991. Yields of this line were comparable or superior to all released SW varieties at both locations. Centennial is also an earlier maturing variety. It reached 50 percent heading earlier than all other entries except one over a three-year period. Soft white wheat varieties mature slowly in the cool, fall conditions common in the Klamath Basin. The development of an earlier maturing, high yielding SW variety should help producers who choose to grow this commodity in the basin.

### Statewide Spring Wheat Trials

Statewide spring wheat variety trials were established at two locations in Klamath County in 1996. The 23-entry trial was located at the KES on mineral soil, and at an organic soil site on the Lower Klamath Lake. The organic soil site was irrigated by overhead sprinkler irrigation. In general, the yield potential of the two sites is similar, as is reflected in the three-year trial means at each site. Although the two sites have similar yields, the relative performance of varieties at the two sites is quite different.

Irrigated Mineral Soil Site

Pomerelle, formerly ID 448, was the highest yielding entry in the trial in 1996. ID 448 was the second highest producing entry in the trial in 1995 (Table 6). This newly released SW variety has produced grain of comparable test weight and lower protein than Penewawa and Centennial. It is a late maturing variety, which may limit its potential in the short season environment of the Klamath Basin. Six of the eight entries not significantly different that Pomerelle were SW varieties. The other two were a triticale, RSI 310, and a HW line, ID 377S.

RSI 310, a triticale, was the second highest producing entry in the trial in 1996. It was also the second highest producing entry at the organic soil site.

The hard white line, ID 377S, was the seventh highest yielding entry in the trial in 1996 and has been one of the highest yielding entries in a number of trials over a four-year period. It has good milling and baking quality and is being exclusively released by the University of Idaho.

Irrigated Organic Soil Site

Grain yields at this site in 1996 were about 70 percent of the long-term average for this and similar sites in the Klamath Basin. Yield reduction may be attributed to late planting, frost damage, and low level infestation of common root rot. The two highest yielding entries in the trial were triticales. The top yielding line, TriCal 2700-RSI, produced significantly more grain than any wheat entry in the trial (Table 7).

The highest producing wheat entry in the trial was Klasic, a hard white variety. It yielded more than ID 377S and Seri 82, two HW lines that usually produce higher yields than Klasic (Table 7). This switch in ranking may be due to early frost. The earlier maturing Klasic may have avoided yield losses that the later, but usually higher yielding, lines experienced due to frost.

Centennial, which has generally been a top yielding SW variety, produced lower than expected yields. Penawawa and Alpowa produced significantly higher yields than Centennial at this site.

The earliest maturing HR variety, Yecora Rojo, was the highest producing HR entry in this trial. Frost avoidance may account for the change in expected ranking.

Table 1. 1996 Western Regional Spring Wheat Nursery. Grain yield, test weight, lodging, plant height, and date of 50% heading in Julian days (number of days after January 1) of spring wheat lines planted in the 1996 Western Regional Spring Barley Nursery. Plots were established on May 7 at Klamath Experiment Station, Klamath Falls, OR.

| Entry | Variety | Type | Yield | Test wt | Lodge | Height | 50% Heading |
|---|---|---|---|---|---|---|---|
| | | | lb/A | lb/bu | % | inches | Julian |
| 1 | McKay (ID 167) | HR | 3860 | 59.5 | 0 | 31 | 194 |
| 2 | Federation | SW | 4500 | 57.0 | 0 | 45 | 197 |
| 3 | Penawawa | SW | 5560 | 62.0 | 0 | 31 | 193 |
| 4 | Klasic | HW | 3890 | 60.5 | 0 | 24 | 187 |
| 5 | Serra | HR | 3950 | 59.0 | 0 | 31 | 191 |
| 6 | Alpowa | SW | 5320 | 64.0 | 0 | 33 | 194 |
| 7 | Wawawai | SW | 4650 | 61.5 | 10 | 33 | 191 |
| 8 | ID 462 | HR | 5300 | 63.0 | 0 | 31 | 190 |
| 9 | OR 488372 | HW | 4990 | 62.0 | 0 | 31 | 195 |
| 10 | OR 895181 | HW | 5610 | 61.0 | 0 | 31 | 192 |
| 11 | UT 2464 | HR | 4110 | 60.0 | 0 | 31 | 197 |
| 12 | UT 1146 | HR | 4700 | 61.0 | 0 | 31 | 194 |
| 13 | UT 1175 | HR | 5160 | 61.0 | 0 | 33 | 193 |
| 14 | CA 896 | HW | 5210 | 63.0 | 0 | 30 | 193 |
| 15 | ID 469 | SW | 4720 | 61.0 | 0 | 28 | 190 |
| 16 | ID 474 | SW | 4970 | 63.0 | 0 | 31 | 193 |
| 17 | ID 476 | HR | 4440 | 60.5 | 0 | 28 | 191 |
| 18 | ID 488 | SW | 5480 | 63.0 | 0 | 30 | 190 |
| 19 | ID 492 | HR | 5220 | 63.5 | 0 | 30 | 190 |
| 20 | ID 494 | HW | 4490 | 62.0 | 0 | 28 | 189 |
| 21 | ML 316402 | HW | 4490 | 61.0 | 0 | 30 | 191 |
| 22 | SDM 50014 | HR | 4740 | 62.5 | 0 | 30 | 193 |
| 23 | FMBR 9154 | HR | 4620 | 60.0 | 0 | 28 | 188 |
| 24 | FMBR 5783 | HR | 4030 | 59.0 | 0 | 24 | 193 |
| 25 | OR 493032 | HR | 3980 | 64.0 | 0 | 28 | 194 |
| 26 | OR 487401 | HR | 4900 | 64.0 | 0 | 31 | 195 |
| 27 | CA 985 | HR | 4730 | 63.0 | 0 | 28 | 188 |
| 28 | CA 1041 | HR | 3910 | 58.0 | 0 | 22 | 193 |
| 29 | CA 1036 | HR | 4200 | 62.5 | 0 | 22 | 192 |
| 30 | CA 1037 | HR | 3790 | 60.5 | 0 | 20 | 190 |

Table 1 (continued). 1996 Western Regional Spring Wheat Nursery

| Entry | Variety | Type | Yield | Test wt | Lodge | Height | 50% Heading |
|---|---|---|---|---|---|---|---|
| | | | lb/A | lb/bu | % | inches | Julian |
| 31 | CA 1032 | HR | 3240 | 60.5 | 0 | 20 | 196 |
| 32 | SDM 50005 | HR | 4740 | 63.0 | 0 | 31 | 195 |
| 33 | SDM 4055 | SW | 5880 | 63.0 | 0 | 30 | 192 |
| 34 | SDM 50030 | SW | 6090 | 62.0 | 0 | 31 | 192 |
| 35 | ML 42409 | SW | 6490 | 62.5 | 0 | 31 | 194 |
| 36 | ID 489 | HR | 4670 | 62.0 | 0 | 30 | 191 |
| 37 | ID 493 | HW | 4350 | 62.5 | 0 | 30 | 190 |
| 38 | ID 495 | SW | 5390 | 62.0 | 0 | 30 | 190 |
| 39 | ID 496 | SW | 5540 | 63.0 | 0 | 30 | 190 |
| 40 | OR 492092 | HW | 5520 | 62.0 | 0 | 30 | 196 |
| 41 | OR 390362 | HR | 5090 | 60.0 | 0 | 28 | 192 |
| 42 | UT 3007 | HR | 4180 | 62.5 | 40 | 37 | 191 |
| 43 | UT 2938 | HR | 4270 | 61.5 | 30 | 37 | 190 |
| 44 | UT 3006 | HR | 3870 | 62.5 | 75 | 35 | 187 |
| 45 | WA 7798 | HR | 4410 | 61.0 | 0 | 28 | 193 |
| 46 | WA 7802 | HR | 5250 | 62.5 | 0 | 31 | 191 |
| 47 | WA 7806 | SW | 5260 | 63.0 | 0 | 30 | 191 |
| | Mean | | 4760 | 61.6 | 3 | 30 | 192 |
| | LSD (0.05) | | 740 | | | | 2.7 |
| | CV (%) | | 9.7 | | | | 0.9 |

Table 2. Three-Year Summary of Western Regional Spring Wheat Nursery. Grain yield of spring wheat lines planted at Klamath Experiment Station, 1994-1996.

| Variety | Type | 1996 Yield | 1995 Yield | 1994 Yield | 2-Year Average | | 3-Year Average | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Yield | Rank | Yield | Rank |
| | | lb/A | lb/A | lb/A | lb/A | | lb/A | |
| Alpowa | SW | 5320 | 4590 | 7020 | 4950 | 2 | 5640 | 3 |
| Federation | SW | 4500 | 3630 | 4940 | 4060 | 20 | 4350 | 12 |
| ID 462 | HR | 5300 | 4240 | 6360 | 4770 | 6 | 5300 | 6 |
| Klasic | HW | 3890 | 2770 | 6270 | 3330 | 26 | 4310 | 13 |
| McKay (ID 167) | HR | 3860 | 4060 | 6230 | 3960 | 23 | 4720 | 10 |
| OR 488372 | HW | 4990 | 3490 | 6320 | 4240 | 15 | 4930 | 8 |
| OR 895181 | HW | 5610 | 3800 | 7670 | 4700 | 8 | 5690 | 2 |
| Penawawa | SW | 5560 | 4110 | 7750 | 4840 | 4 | 5810 | 1 |
| Serra | HR | 3950 | 3430 | 6500 | 3690 | 25 | 4630 | 11 |
| UT 1146 | HR | 4700 | 4300 | 6980 | 4500 | 10 | 5330 | 5 |
| UT 1175 | HR | 5160 | 4510 | 6660 | 4830 | 5 | 5440 | 4 |
| UT 2464 | HR | 4110 | 4140 | 6240 | 4130 | 18 | 4830 | 9 |
| Wawawai | SW | 4650 | 3850 | 6310 | 4250 | 14 | 4940 | 7 |
| CA 896 | HW | 5210 | 3410 | | 4310 | 13 | | |
| FMBR 5783 | HR | 4030 | 3970 | | 4000 | 22 | | |
| FMBR 9154 | HR | 4620 | 3840 | | 4230 | 16 | | |
| ID 469 | SW | 4720 | 4290 | | 4500 | 9 | | |
| ID 474 | SW | 4970 | 4910 | | 4940 | 3 | | |
| ID 476 | HR | 4440 | 3590 | | 4010 | 21 | | |
| ID 488 | SW | 5480 | 5100 | | 5290 | 1 | | |
| ID 492 | HR | 5220 | 4280 | | 4750 | 7 | | |
| ID 494 | HW | 4490 | 3900 | | 4190 | 17 | | |
| ML 316402 | HW | 4490 | 4360 | | 4430 | 12 | | |
| OR 487401 | HR | 4900 | 4050 | | 4470 | 11 | | |
| OR 493032 | HR | 3980 | 4250 | | 4110 | 19 | | |
| SDM 50014 | HR | 4740 | 3180 | | 3960 | 24 | | |
| ID 495 | SW | 5390 | | | | | | |
| ID 496 | SW | 5540 | | | | | | |
| ML 42409 | SW | 6490 | | | | | | |
| OR 492092 | HW | 5520 | | | | | | |
| SDM 4055 | SW | 5880 | | | | | | |
| SDM 50030 | SW | 6090 | | | | | | |
| Mean | | 4760 | 4000 | 6560 | 4360 | | 5070 | |
| LSD (0.05) | | 740 | 600 | 660 | 370 | | 310 | |
| CV (%) | | 10 | 10 | 7 | 8 | | 8 | |

Table 3. 1996 OSU Hard White Spring Wheat Trial. Grain yield, test weight, lodging, plant height, and date of 50% heading in Julian days (number of days after January 1) of spring wheat lines planted in the 1996 OSU Hard White Spring Wheat Nursery. Plots were established on May 7 at Klamath Experiment Station, Klamath Falls, OR.

| Entry | Variety | Type | Yield | Test wt | Lodge | Height | 50% Heading |
|---|---|---|---|---|---|---|---|
| | | | lb/A | lb/bu | % | inches | Julian |
| 1 | Klasic | HW | 4500 | 62.5 | 0 | 22 | 185 |
| 2 | 4870279 | HW | 5620 | 63.0 | 0 | 28 | 194 |
| 3 | 4870453 | HW | 6280 | 62.0 | 0 | 30 | 197 |
| 4 | 4870255 | HW | 5500 | 63.5 | 0 | 30 | 188 |
| 5 | 4880372 | HW | 5160 | 63.0 | 0 | 31 | 197 |
| 6 | 4895181 | HW | 6390 | 61.0 | 0 | 31 | 195 |
| 7 | ID 377S (4910006) | HW | 6600 | 64.0 | 0 | 30 | 191 |
| 8 | 4920090 | HW | 5770 | 62.0 | 0 | 28 | 194 |
| 9 | 4920092 | HW | 5740 | 62.0 | 0 | 30 | 192 |
| 10 | 9437524 | HW | 5150 | 62.0 | 0 | 26 | 192 |
| 11 | 9437525 | HW | 5360 | 62.5 | 0 | 28 | 191 |
| 12 | 9437534 | HW | 6080 | 62.0 | 0 | 35 | 193 |
| 13 | 4920276 | HW | 5130 | 63.0 | 0 | 30 | 194 |
| 14 | 4920283 | HW | 5100 | 64.0 | 0 | 28 | 193 |
| 15 | 4920292 | HW | 5740 | 62.0 | 0 | 28 | 191 |
| 16 | 4920311 | HW | 6450 | 64.5 | 0 | 31 | 193 |
| 17 | 938964 | HW | 4890 | 61.5 | 0 | 22 | 187 |
| 18 | 938965 | HW | 5110 | 63.0 | 0 | 24 | 186 |
| 19 | 938966 | HW | 4650 | 62.5 | 0 | 24 | 186 |
| 20 | 9437516 | HW | 5610 | 61.5 | 0 | 31 | 196 |
| 21 | 4920302 | HW | 5890 | 61.0 | 0 | 33 | 193 |
| 22 | 4920306 | HW | 5520 | 64.0 | 0 | 33 | 196 |
| 23 | 4920307 | HW | 5740 | 62.5 | 0 | 28 | 196 |
| 24 | 4930230 | HW | 5420 | 62.5 | 0 | 33 | 196 |
| 25 | 4940109 | HW | 5710 | 62.0 | 0 | 28 | 194 |
| 26 | 948034 | HW | 4820 | 62.5 | 0 | 30 | 193 |
| 27 | 948041 | HW | 5680 | 64.0 | 0 | 33 | 195 |
| 28 | 948054 | HW | 5880 | 62.0 | 0 | 30 | 193 |
| 29 | 4940114 | HW | 5340 | 61.5 | 0 | 24 | 189 |
| 30 | 938963 | HW | 4600 | 62.5 | 0 | 22 | 187 |
| | Mean | | 5510 | 62.5 | 0 | 29 | 192 |
| | LSD (0.05) | | 600 | | | | 2 |
| | CV (%) | | 8 | | | | 1 |

Table 4. 1996 OSU Hard Red Spring Wheat Trial. Grain yield, test weight, lodging, plant height, and date of 50% heading in Julian days (number of days after January 1) of spring wheat lines planted in the 1996 OSU Hard Red Spring Wheat Nursery. Plots were established on May 7 at Klamath Experiment Station, Klamath Falls, OR.

| Entry | Variety | Type | Yield | Test wt | Lodge | Height | 50% Heading |
|---|---|---|---|---|---|---|---|
| | | | lb/A | lb/bu | % | inches | Julian |
| 1 | ID 167 (4870148) | HR | 5740 | 62.0 | 0 | 31 | 192 |
| 2 | WB 906R (4870544) | HR | 5620 | 62.0 | 0 | 31 | 188 |
| 3 | Yecora Rj (4870581) | HR | 4830 | 62.0 | 0 | 22 | 187 |
| 4 | WA 7075 (4870535) | HR | 5640 | 61.0 | 0 | 31 | 192 |
| 5 | Klasic (4890001) | HW | 4750 | 62.0 | 0 | 26 | 185 |
| 6 | 4880189 | HR | 4740 | 62.0 | 0 | 30 | 191 |
| 7 | 4870410 | HR | 5930 | 61.5 | 0 | 31 | 193 |
| 8 | 4895019 | HR | 5430 | 62.5 | 0 | 33 | 187 |
| 9 | 4930032 | HR | 4700 | 63.5 | 0 | 30 | 194 |
| 10 | 4920002 | HR | 5900 | 63.0 | 0 | 31 | 194 |
| 11 | 4910028 | HR | 6230 | 61.5 | 0 | 31 | 187 |
| 12 | 4900041 | HR | 5940 | 64.0 | 0 | 30 | 196 |
| 13 | Express (4930001) | HR | 5610 | 62.5 | 0 | 26 | 194 |
| 14 | WPB 926 (4930002) | HR | 5210 | 62.0 | 0 | 30 | 188 |
| 15 | WPB 936 (4930003) | HR | 5660 | 62.5 | 0 | 28 | 190 |
| 16 | 4930034 | HR | 4610 | 59.5 | 0 | 22 | 190 |
| 17 | 4895011 | HR | 5110 | 62.0 | 0 | 28 | 191 |
| 18 | 3900362 | HR | 5340 | 62.0 | 0 | 28 | 191 |
| 19 | 4920023 | HR | 4380 | 62.5 | 0 | 28 | 192 |
| 20 | 4920028 | HR | 5570 | 63.0 | 0 | 31 | 192 |
| 21 | 4920328 | HR | 4900 | 62.5 | 0 | 31 | 194 |
| 22 | 4920330 | HR | 5820 | 62.5 | 0 | 30 | 192 |
| 23 | 4920331 | HR | 5750 | 63.5 | 0 | 28 | 190 |
| 24 | 4940103 | HR | 5250 | 63.0 | 0 | 28 | 191 |
| 25 | 948055 | HR | 5910 | 63.5 | 0 | 30 | 196 |
| 26 | 948059 | HR | 5210 | 64.0 | 0 | 28 | 192 |
| 27 | 4940104 | HR | 5410 | 63.0 | 0 | 28 | 192 |
| 28 | 4940107 | HR | 6150 | 63.0 | 0 | 30 | 192 |
| 29 | 4940108 | HR | 5190 | 62.5 | 0 | 31 | 189 |
| | Mean | | 5370 | 62.4 | 0 | 29 | 191 |
| | LSD (0.05) | | 570 | | | | 2 |
| | CV (%) | | 7 | | | | 1 |

Table 5. 1996 OSU Soft White Spring Wheat Trial. Grain yield, test weight, lodging, plant height, and date of 50% heading in Julian days (number of days after January 1) of spring wheat lines planted in the 1996 OSU Soft White Spring Wheat Nursery. Plots were established on May 7 at Klamath Experiment Station, Klamath Falls, OR.

| Entry | Variety | Type | Yield | Test wt | Lodge | Height | 50% Heading |
|---|---|---|---|---|---|---|---|
| | | | lb/A | lb/bu | % | inches | Julian |
| 1 | Dirkwin (4870118) | SW | 5760 | 59.5 | 0 | 31 | 194 |
| 2 | Centennial (4930004) | SW | 6170 | 63.0 | 0 | 31 | 190 |
| 3 | Penawawa (4870532) | SW | 5280 | 60.0 | 0 | 35 | 196 |
| 4 | Alpowa (4900021) | SW | 6040 | 63.5 | 0 | 31 | 198 |
| 5 | 4850001 | SW | 6270 | 64.0 | 0 | 31 | 192 |
| 6 | 4880013 | HW | 6110 | 63.0 | 0 | 33 | 198 |
| 7 | 4930006 | CL | 5080 | 61.0 | 0 | 30 | 191 |
| 8 | 4900154 | HW | 5630 | 61.5 | 0 | 33 | 199 |
| 9 | 4900085 | -- | 5130 | 63.5 | 0 | 31 | 189 |
| 10 | 4895224 | -- | 4760 | 61.0 | 0 | 30 | 195 |
| 11 | 948037 | SW | 5230 | 62.0 | 0 | 28 | 191 |
| 12 | 4940137 | -- | 4820 | 62.5 | 0 | 31 | 193 |
| 13 | 942838 | -- | 5990 | 63.0 | 0 | 33 | 195 |
| 14 | 942845 | -- | 4880 | 62.5 | 0 | 33 | 194 |
| 15 | 942885 | -- | 5140 | 62.5 | 0 | 33 | 193 |
| 16 | 942889 | -- | 5360 | 63.0 | 0 | 33 | 192 |
| 17 | 942950 | -- | 4650 | 62.0 | 0 | 30 | 196 |
| 18 | 4940142 | -- | 4720 | 62.0 | 0 | 30 | 197 |
| 19 | 4940143 | -- | 5090 | 62.0 | 0 | 31 | 197 |
| 20 | 942956 | -- | 5010 | 62.5 | 0 | 31 | 197 |
| 21 | 3940214 | -- | 4340 | 54.5 | 0 | 33 | 201 |
| | Mean | | 5310 | 61.8 | 0 | 32 | 195 |
| | LSD (0.05) | | 650 | | | | 2 |
| | CV (%) | | 9 | | | | 1 |

Table 6. 1996 Oregon Statewide Spring Wheat Trial. Grain yield and test weight of spring wheat lines planted in the 1996 Oregon Statewide Spring Wheat Trial. Plots were established on May 7 at Klamath Experiment Station, Klamath Falls, OR.

| Entry | Variety | Type | Yield | Test wt | Protein | 50% Heading |
|---|---|---|---|---|---|---|
| | | | lb/A | lb/bu | % | julian |
| 1 | Alpowa | SW | 5860 | 63.4 | 12.3 | 194 |
| 2 | Alpowa + Gaucho | SW | 6090 | 63.2 | 12.4 | 195 |
| 3 | Centennial | SW | 5520 | 61.9 | 11.7 | 191 |
| 4 | Dirkwin | SW | 4570 | 58.4 | 11.8 | 197 |
| 5 | ID 377S | HW | 6080 | 62.9 | 12.7 | 192 |
| 6 | ID 488 | SW | 5970 | 62.7 | 11.0 | 191 |
| 7 | ID 462 | HR | 5300 | 62.3 | 12.9 | 190 |
| 8 | Klasic | HW | 4240 | 61.4 | 13.2 | 186 |
| 9 | OR 4895181 | HW | 5300 | 60.5 | 12.6 | 194 |
| 10 | Penawawa | SW | 6040 | 61.9 | 12.1 | 193 |
| 11 | Pomerelle (ID 448) | SW | 6680 | 62.3 | 11.0 | 195 |
| 12 | RSI 310 | Trit | 6430 | 57.7 | 10.5 | 192 |
| 13 | SDM 405S | SW | 6110 | 62.2 | 11.2 | 194 |
| 14 | Sunstar Promise | SW | 6210 | 62.2 | 10.8 | 193 |
| 15 | Seri 82 | HW | 5530 | 62.3 | 11.3 | 196 |
| 16 | GMV 101 | HR | 4840 | 59.0 | 13.4 | 195 |
| 17 | TriCal 2700 | Trit | 4630 | 53.0 | 10.7 | 194 |
| 18 | Wawawai | SW | 4910 | 61.8 | 12.1 | 191 |
| 19 | Whitebird (ID 392) | SW | 6160 | 63.0 | 11.6 | 196 |
| 20 | UT 1117 | HR | 4940 | 61.6 | 12.7 | 197 |
| 21 | WPB 926R | HR | 4350 | 61.1 | 13.5 | 191 |
| 22 | WPB 936R | HR | 5480 | 60.9 | 13.9 | 189 |
| 23 | Yecora Rojo | HR | 4080 | 61.1 | 13.6 | 189 |
| | Mean | | 5450 | 61.2 | 12.1 | 193 |
| | LSD (0.05) | | 800 | 0.8 | 0.5 | 2.3 |
| | CV (%) | | 9 | 0 | 2 | 1 |

Table 7. 1996 Oregon Statewide Spring Wheat Trial. Grain yield and test weight of spring wheat lines planted in the 1996 Oregon Statewide Spring Wheat Trial. Plots were established on May 30 on Lower lake irrigated organic soil, Klamath County, OR.

| Entry | Variety | Type | Yield | Test wt |
|---|---|---|---|---|
| | | | lb/A | lb/bu |
| 1 | Alpowa | SW | 3860 | 51.0 |
| 2 | Alpowa + Gaucho | SW | 3690 | 49.5 |
| 3 | Centennial | SW | 2500 | 50.5 |
| 4 | Dirkwin | SW | 3120 | 44.0 |
| 5 | ID 377S | HW | 3580 | 48.0 |
| 6 | ID 488 | SW | 3880 | 48.0 |
| 7 | ID 462 | HR | 2980 | 50.5 |
| 8 | Klasic | HW | 4020 | 57.0 |
| 9 | OR 4895181 | HW | 3480 | 40.0 |
| 10 | Penawawa | SW | 3870 | 49.0 |
| 11 | Pomerelle (ID 448) | SW | 2890 | 45.0 |
| 12 | RSI 310 | Trit | 4520 | 44.5 |
| 13 | SDM 405S | SW | 3580 | 53.0 |
| 14 | Sunstar Promise | SW | 3540 | 53.5 |
| 15 | Seri 82 | HW | 3730 | 45.5 |
| 16 | GMV 101 | HR | 1880 | 37.5 |
| 17 | TriCal 2700 | Trit | 4950 | 46.5 |
| 18 | Wawawai | SW | 2910 | 46.5 |
| 19 | Whitebird (ID 392) | SW | 2800 | 47.0 |
| 20 | UT 1117 | HR | 2910 | 48.5 |
| 21 | WPB 926R | HR | 2940 | 47.5 |
| 22 | WPB 936R | HR | 3620 | 50.0 |
| 23 | Yecora Rojo | HR | 3730 | 51.5 |
| | Mean | | 4740 | 48.0 |
| | LSD (0.05) | | 650 | |
| | CV (%) | | 11 | |

# Barley Stripe Rust Control in the Klamath Basin

Randy Dovel[1], Steve Orloff[2], Greg Chilcote[1], Don Kirby[2]

## Introduction

Barley stripe rust (BSR) is a newly introduced barley pest in the Klamath Basin. BSR was introduced from Europe into South America in 1975. By 1990, the disease was established in central Mexico, and in 1991 incidence of the disease was reported in Texas. BSR spread to Colorado in 1992, and Arizona and Idaho in 1993. Several barley plants with symptoms typical of the disease were found in the Lower Lake leases in 1994, but laboratory confirmation of the presence of the disease was not possible. Economically significant occurrences of the disease were seen in the Klamath Basin for the first time in 1995.

The impact of BSR on barley yield can be devastating, with up to 85 percent yield reduction reported from Bolivia and Mexico. In general, yield reduction in the United States has been less than in Latin America. However, the cool moist spring conditions of the Pacific Northwest could provide an ideal environment for BSR and appropriate disease control precautions should be taken.

Few winter varieties and no commercially available spring barley varieties are resistant to this pathogen. Breeding programs at OSU, UC Davis, WSU, and USDA research centers in Idaho are all working to develop resistant spring and winter varieties. However, seed of BSR resistant varieties will not be available in significant quantities for several years. Until resistant varieties are available, producers must rely on chemical control of the disease.

Chemical fungicides may be applied either as a seed treatment or as a post-emergence foliar spray. Baytan is a fungicidal seed treatment that is effective in controlling early season infestation by BSR. Baytan has provided protection against BSR infestation for 5 to 9 weeks after emergence. In areas where early infestation occurs, Baytan has been effective in reducing BSR infestation and increasing yields. Baytan has been included in several trials in the Klamath Basin to test its effectiveness against other pathogens for the last four years. In the absence of BSR, yields using Baytan have not been different from standard seed treatments.

Tilt is currently the only fungicide registered for foliar application to control BSR on barley in Oregon. Tilt cannot be applied after flag leaf emergence. Folicur is a systemic fungicide that should soon be registered in Oregon for BSR control in barley. A section 18 emergency exemption was available in Oregon for Folicur in 1996. Folicur may be applied as late as 50 percent head emergence. Alto is another new fungicide that should be available for BSR control in the near future.

Baytan has the same chemistry as Folicur. The use of both a fungicide seed treatment and a foliar spray may have interactive effects. The relative effectiveness of Baytan seed treatment and foliar fungicides in various combinations was examined in three locations in the Klamath Basin in 1996.

[1] Associate Professor, and Research Technician, respectively, Klamath Experiment Station, Klamath Falls, OR.

[2] Farm Advisor, Siskiyou Co. and Acting Superintendent/Research Associate, Intermountain Research and Extension Center, respectively, University of California, Tulelake, CA.

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## Procedures

The effectiveness of three foliar fungicides, either with or without Baytan seed treatment, was evaluated at a mineral soil site (KES), an organic soil site on Lower Klamath Lake, Klamath Co., Oregon (LKL), and an irrigated organic soil site in Siskiyou Co., California (IREC). Colter spring barley was treated with either a standard seed treatment (Vitavax RTU) or with Baytan, then with Tilt, Folicur, or Alto. Two rates of Tilt, Folicur, and Alto were included at all sites, and a third rate of Alto at the Oregon sites. An experimental BSR resistant selection from Idaho (78Ab10274), was included in the Oregon trials to evaluate its resistance to BSR under Oregon conditions. Table 1 details treatment combinations included in the trials. Foliar fungicides were applied to plots at approximately 50 percent head emergence. Applications were made on July 3 and 12 at KES and LKL, respectively. BSR infestation at the time of fungicide application was less than 5 percent.

Plots measured 15 x 40 feet with a row spacing of 6 inches. BSR infestation was recorded for all plots at KES and IREC. The trial at the KES was on land planted in potatoes the previous year. Soils at the station include Poe, Fordney, and Hosley series, all of which have a fine-loamy to sandy texture, and are moderately deep and somewhat poorly drained. The LKL site was on very deep, poorly drained, lake bottom soils with high organic matter content. These fields are continuously cropped in spring cereals. All sites were sprinkler irrigated.

All trials were arranged in a randomized complete block design with four replications. The trials at KES and LKL were planted on May 5 and 10, respectively. Seed was planted one inch deep at a seeding rate of 100 lb/acre. All plots received 50 lb N, 30 lb $P_2O_5$, and 22 lb S/acre by broadcast application prior to planting, and 30 lb N, 18 lb $P_2O_5$, and 13 lb S/acre banded at planting.

At KES, bromoxynil and MCPA were applied at labeled rates to control broadleaf weeds. Weed control at organic soil sites was achieved with a mixture of 2,4-D and Banvel. Plots were harvested in late September using a plot combine with a 5-foot wide header. Grain yield was recorded for all plots. Test weight, percent plumps, and percent thins were measured in all replications.

## Results

Foliar fungicide application significantly reduced BSR infestation at KES and IREC (Tables 2, 3, and 5). Both locations had similar trends and a two-site average will be used to discuss BSR infestation below. In plots not treated with a foliar fungicide, BSR infestation of Baytan treated plots was significantly lower than Vitavax treated plots in Colter at KES (Table 3), but not at IREC (Table 1). There was no significant difference in BSR infestation between the two seed treatments when foliar fungicides were applied. Both Folicur and Alto applications reduced BSR infestation levels compared to Tilt. The high rate of Tilt resulted in less BSR infestation than the low rate at both locations. In contrast, the higher rates of Folicur did not reduce levels of infestation at either site. There was no difference in BSR infestation at KES due to different rates of Alto application. It appears that an application of 10 gm ai/acre of Alto in combination with Baytan seed treatment will adequately control BSR in the Klamath Basin (Table 3).

The experimental selection, 78Ab10274, did not have any rust pustules while untreated Colter had 56 percent infestation at KES (Table 4). The resistant line displayed poor agronomic characteristics similar to its parent, Klages. It yielded only 3,880 lb/acre, compared to 5,870 for untreated Colter. The development of higher yielding resistant lines is clearly needed. However, it is clear that good sources of resistance such as 78Ab10274 are available.

Grain yield did not correlate well with BSR control in all locations. Grain yield and BSR infestation were highly correlated at IREC (Table 2). Plots receiving no foliar fungicide produced 6,570 lb/acre compared to average yields of 7,900, 8,060, and 8,110 for Tilt, Folicur, and Alto treated plots, respectively. Yield differences between foliar fungicide treatments were not significant. In general, there was no difference in grain yield due to seed treatment.

In contrast, there was no difference in yield due to either seed treatment or foliar fungicide application at KES. At LKL, only two treatment combinations produced significantly higher yields than the untreated plots, the four and eight ounce rates of Folicur in combination with Vitavax seed treatment (Table 4).

Lodging reduction due to foliar fungicide application was noted at LKL prior to harvest. Reduction in lodging included in Table 4 represents lodging compared to adjacent untreated plots.

Grain quality was positively affected by foliar fungicide application at all sites. Test weight increased from an average of 48.2 lb/bu without foliar fungicide to 49.4, when averaged across all foliar fungicide treatments (Table 5). Plumps increased from 73 percent to over 82 percent due to fungicide application (Table 5).

Application of foliar fungicide was economically beneficial at only one site, IREC. An increase in average yield of 1,500 lb/acre due to foliar fungicide application would result in an additional $75/acre in net sales with a grain price of $100/ton. Fungicide and appplication costs vary, but should not exceed $35/acre.

Table 1. 1996 Foliar Fungicide Trial Treatments. Seed and foliar fungicide treatments and varieties were not identical at all locations in 1996. Additional entries were included at Klamath Experiment Station (KES) and the Lower Klamath Lake location (LKL) and are detailed below.

| | Treatment | | Location | | |
|---|---|---|---|---|---|
| Variety | Seed | Foliar | KES | LKL | IREC |
| Colter | Vitavax | None | X | X | X |
| Colter | Baytan/Captan | None | X | X | X |
| Colter | Vitavax | Tilt 4 oz | X | X | X |
| Colter | Baytan/Captan | Tilt 4 oz | X | X | X |
| Colter | Vitavax | Tilt 8 oz | X | X | X |
| Colter | Vitavax | Folicur 4 oz | X | X | X |
| Colter | Baytan/Captan | Folicur 4 oz | X | X | X |
| Colter | Vitavax | Folicur 8 oz | X | X | X |
| Colter | Baytan/Captan | Alto 10 gm | X | X | |
| Colter | Vitavax | Alto 20 gm | X | X | X |
| Colter | Baytan/Captan | Alto 20 gm | X | X | X |
| Colter | Vitavax | Alto 40 gm | X | X | |
| 78Ab10274 | Vitavax | None | X | X | |
| 78Ab10274 | Vitavax | Tilt 4 oz | X | X | |

Table 2. Foliar Trial at IREC. Seed treatment and foliar fungicide effects on barley stripe rust infestation (BSR), grain yield, test weight, and thins of Colter spring barley planted at the Intermountain Research and Experiment Center (IREC), Tulelake, CA in 1996.

| Entry | Treatment: Seed | Treatment: Foliar | BSR | Yield | Test wt | Thins 6/64 | Thins 5.5/64 |
|---|---|---|---|---|---|---|---|
| | | | % | lb/A | lb/bu | --------%-------- | |
| 1 | Vitavax | None | 44 | 6650 | 44.0 | 54.9 | 34.4 |
| 2 | Baytan/Captan | None | 40 | 6490 | 45.0 | 60.1 | 28.5 |
| 3 | Vitavax | Tilt 4 oz | 16 | 8190 | 46.0 | 74.3 | 19.2 |
| 4 | Baytan/Captan | Tilt 4 oz | 8 | 7610 | 47.0 | 73.1 | 19.5 |
| 5 | Vitavax | Tilt 8 oz | 4 | 7890 | 48.0 | 80.4 | 14.4 |
| 6 | Vitavax | Folicur 4 oz | 1 | 8090 | 47.0 | 83.1 | 12.0 |
| 7 | Baytan/Captan | Folicur 4 oz | 2 | 8020 | 47.0 | 81.2 | 14.0 |
| 8 | Vitavax | Folicur 8 oz | 0 | 8010 | 47.0 | 85.7 | 10.6 |
| 9 | Vitavax | Alto 20 gm | 0 | 8170 | 48.0 | 80.1 | 15.4 |
| 10 | Baytan/Captan | Alto 20 gm | 0 | 8040 | 45.0 | 75.0 | 17.0 |
| | Mean | | 12 | 7720 | 46.0 | 74.8 | 18.5 |
| | LSD (0.05) | | 10 | 330 | 2.0 | 6.6 | 4.4 |
| | CV (%) | | 60 | 3 | 2 | 6 | 17 |

Table 3. Foliar Trial at KES. Seed treatment and foliar fungicide effects on barley stripe rust infestation (BSR), grain yield, test weight, and thins of Colter and 78Ab10274 spring barley planted at the Klamath Experiment Station (KES), Klamath Falls, OR in 1996.

| Variety | Treatment | | BSR | Yield | Test | Thins | | |
|---|---|---|---|---|---|---|---|---|
| | Seed | Foliar | | | wt | 6/64 | 5.5/64 | Pan |
| | | | % | lb/A | lb/bu | --------%-------- | | |
| Colter | Vitavax | None | 56 | 5870 | 52.3 | 81.7 | 11.5 | 6.7 |
| Colter | Baytan/Captan | None | 39 | 6010 | 52.0 | 85.4 | 9.8 | 4.8 |
| Colter | Vitavax | Tilt 4 oz | 28 | 5810 | 52.3 | 88.8 | 7.6 | 3.6 |
| Colter | Baytan/Captan | Tilt 4 oz | 24 | 6690 | 52.9 | 88.2 | 7.9 | 3.9 |
| Colter | Vitavax | Tilt 8 oz | 18 | 5990 | 52.3 | 88.3 | 8.1 | 3.6 |
| Colter | Vitavax | Folicur 4 oz | 14 | 6130 | 52.6 | 89.9 | 6.9 | 3.2 |
| Colter | Baytan/Captan | Folicur 4 oz | 8 | 5650 | 52.5 | 89.8 | 6.9 | 3.3 |
| Colter | Vitavax | Folicur 8 oz | 4 | 6120 | 52.3 | 89.4 | 7.2 | 3.4 |
| Colter | Baytan/Captan | Alto 10 gm | 9 | 6690 | 52.1 | 86.6 | 8.9 | 4.4 |
| Colter | Vitavax | Alto 20 gm | 4 | 5720 | 53.1 | 90.5 | 6.8 | 2.7 |
| Colter | Baytan/Captan | Alto 20 gm | 4 | 6570 | 52.6 | 89.0 | 7.4 | 3.6 |
| Colter | Vitavax | Alto 40 gm | 3 | 6570 | 52.9 | 88.5 | 8.0 | 3.5 |
| 78Ab10274 | Vitavax | None | 0 | 3880 | 53.5 | 88.3 | 7.0 | 4.7 |
| 78Ab10274 | Vitavax | Tilt 4 oz | 0 | 3580 | 52.1 | 84.8 | 9.0 | 6.1 |
| Mean | | | 15 | 5810 | 52.5 | 87.8 | 8.1 | 4.1 |
| LSD (0.05) | | | 10 | 1600 | 0.9 | 4.3 | 2.5 | 1.9 |
| CV (%) | | | 45 | 12 | 1 | 3 | 22 | 32 |

Table 4. Foliar Trial on Lower Lake Organic Soil. Seed treatment and foliar fungicide effects on grain yield, test weight, lodging and reduction of lodging compared to adjacent untreated plots of Colter and 78Ab10274 spring barley planted on Lower Klamath Lake (LKL) organic soil in Klamath County, OR in 1996.

| Entry | Variety | Treatment | | Yield | Test wt | Lodge | Lodge reduction |
|---|---|---|---|---|---|---|---|
| | | Seed | Foliar | | | | |
| | | | | lb/A | lb/bu | % | % |
| 1 | Colter | Vitavax | None | 4810 | 47.6 | 63 | 0 |
| 2 | Colter | Baytan/Captan | None | 4860 | 48.0 | 40 | 0 |
| 3 | Colter | Vitavax | Tilt 4 oz | 4980 | 48.5 | 48 | 15 |
| 4 | Colter | Baytan/Captan | Tilt 4 oz | 5000 | 48.6 | 43 | 13 |
| 5 | Colter | Vitavax | Tilt 8 oz | 5090 | 49.5 | 38 | 3 |
| 6 | Colter | Vitavax | Folicur 4 oz | 5220 | 49.1 | 28 | 9 |
| 7 | Colter | Baytan/Captan | Folicur 4 oz | 4630 | 48.9 | 48 | 33 |
| 8 | Colter | Vitavax | Folicur 8 oz | 5590 | 49.0 | 30 | 33 |
| 9 | Colter | Baytan/Captan | Alto 10 gm | 4920 | 49.1 | 34 | 9 |
| 10 | Colter | Vitavax | Alto 20 gm | 4340 | 48.8 | 49 | 4 |
| 11 | Colter | Baytan/Captan | Alto 20 gm | 4960 | 46.8 | 48 | 8 |
| 12 | Colter | Vitavax | Alto 40 gm | 4810 | 49.1 | 40 | 13 |
| 13 | 78Ab10274 | Vitavax | None | 3200 | 48.5 | 53 | 0 |
| 14 | 78Ab10274 | Vitavax | Tilt 4 oz | 3330 | 48.6 | 40 | 0 |
| | Mean | | | 4700 | 48.6 | 43 | 10 |
| | LSD (0.05) | | | 390 | 1.4 | NS | 17 |
| | CV (%) | | | 6 | 2 | 48 | 124 |

Table 5. Three-Location Summary of Spring Barley Foliar Fungicide Trial. Seed treatment and foliar fungicide effects on barley stripe rust infestation (BSR), grain yield, test weight, and thins of Colter spring barley planted at three locations in Klamath Co., Oregon and Siskiyou Co., California, 1996.

| Entry | Treatment | | BSR[1] | Yield | Test wt | Thins | |
|---|---|---|---|---|---|---|---|
| | Seed | Foliar | | | | 6/64 | 5.5/64 |
| | | | % | lb/A | lb/bu | ---------%--------- | |
| 1 | Vitavax | None | 50 | 5780 | 48.1 | 71.8 | 19.9 |
| 2 | Baytan/Captan | None | 40 | 5790 | 48.2 | 74.1 | 17.8 |
| 3 | Vitavax | Tilt 4 oz | 22 | 6370 | 49.1 | 80.6 | 13.6 |
| 4 | Baytan/Captan | Tilt 4 oz | 16 | 6430 | 49.3 | 79.5 | 14.1 |
| 5 | Vitavax | Tilt 8 oz | 11 | 6320 | 49.8 | 82.7 | 12.0 |
| 6 | Vitavax | Folicur 4 oz | 8 | 6480 | 49.6 | 84.8 | 10.4 |
| 7 | Baytan/Captan | Folicur 4 oz | 5 | 6100 | 49.5 | 83.5 | 11.4 |
| 8 | Vitavax | Folicur 8 oz | 2 | 6570 | 49.6 | 85.5 | 10.0 |
| 9 | Vitavax | Alto 20 gm | 2 | 6080 | 49.8 | 82.2 | 12.5 |
| 10 | Baytan/Captan | Alto 20 gm | 2 | 6530 | 48.2 | 80.5 | 12.9 |
| | Mean | | 16 | 6240 | 49.1 | 80.5 | 13.5 |
| | P - Value | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | LSD (0.05) | | 9.8 | 500 | 1.4 | 9.9 | 5.3 |
| | Trt * Location Interaction | | 0.32 | 0.01 | 0.04 | 0.00 | 0.00 |

[1]/ Average of two sites, Klamath Experiment Station and Intermountain Research and Exension Center.

# Barley Seed Treatment in the Klamath Basin

R.L. Dovel[1], Steve Orloff[2], Don Kirby[2], George Stallings[3], and G. Chilcote[1]

## Introduction

Seed treatment is an environmentally safe method of protecting small grains from seed and soil borne pathogens. The use of seed treatments for control of a number of smut species is universally accepted in the industry. New products are being developed for controlling other pathogens as well. Field scale trials were established at three sites in the Klamath Basin in 1996 to examine several new products for effectiveness against local diseases and pests.

Baytan is a fungicidal seed treatment, which may be effective in controlling early season infestation by barley stripe rust (BSR). BSR has been introduced into the United States from Europe and was found in neighboring states in 1993. Several barley plants with symptoms typical of the disease were found in the Lower Lake leases in 1994, but confirmation of the presence of the disease in the laboratory was not possible. Economically significant occurrences of the disease were seen in the Klamath Basin for the first time in 1995. Baytan was included in the trials to test its effectiveness against this new fungal organism in the Klamath Basin.

Raxil is a systemic fungicidal seed treatment that uses the same chemistry as the foliar fungicide, Folicur. Raxil is currently labeled for use in barley, and provides about three weeks of BSR control after emergence. It is a less expensive treatment than Baytan, and may be an economically advantageous alternative to currently used seed treatments that provide no stripe rust control.

Gaucho, a systemic insecticide, will soon be labeled for use as a seed treatment on small grains. It has proven very effective in control of Russian wheat aphid and other pests. There is also some indication that it may be effective in controlling Hessian fly, which is similar to the wheat stem maggot (WSM), a significant pest of grain in Klamath County. The use of the chemical as labeled has little effect on the environment because seed treatment delivers a very small amount of material in a way that is relatively unavailable to non-target species, and Gaucho has a relatively low acute toxicity (very high $LD_{50}$) in non-target species. It is not known if Gaucho seed treatment on small grains is effective in controlling WSM.

Detection of treatment effects in seed treatment studies can be difficult due to soil variability and the ephemeral nature of many of the pathogens that they control. The use of field scale experimental designs can reduce experimental error due to field variability and allow for detection of subtle differences that may not be verifiable in smaller scale plot studies. A small number of selected treatments were included in a field scale trial that was conducted at three locations in the Klamath Basin.

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[1]/ Associate Professor, and Research Technician, respectively, Klamath Experiment Station, Klamath Falls, OR.

[2]/ Farm Advisor, Siskiyou Co. and Acting Superintendent/Research Associate, Intermountain Research and Extension Center, respectively, University of California, Tulelake, CA.

[3]/ Technical Sales Representative, Gustafson Incorporated, Plano, TX.

**Acknowledgments:** Gustafson provided material and partial funding for these trials. Henzel Farms provided the Klamath Co. organic soil site and crop care. The Experiment Station greatly appreciates their support and participation.

## Procedures

Three field scale seed treatment trials were established in the Klamath Basin in 1996 to examine the effectiveness of various seed treatments in protecting barley from BSR and WSM. The trials were located at Klamath Experiment Station (KES) on irrigated mineral soil, Intermountain Research and Extension Center (IREC) on irrigated organic soil, and at Lower Klamath Lake (LKL) on unirrigated organic soil.

The trial at KES was established on land planted to potatoes the previous year. Soils at the station include Poe, Fordney, and Hosley series, all of which have a fine-loamy to sandy texture, and are moderately deep and somewhat poorly drained. The LKL trial was on very deep, poorly drained, lake bottom soils with high organic matter content. These fields are cropped in spring cereals continuously. All plots at KES and IREC were irrigated by a solid set sprinkler irrigation system.

Colter barley seed received eight seed treatments prior to planting. Treatments included: Vitavax (RTU VT) at 6 oz/cwt; two rates of Baytan (1.25 and 1.5 oz/cwt); two rates of Gaucho (1.3 and 2.0 oz/cwt) in combination with a 6 oz rate of RTU VT; two rates of Gaucho (1.3 and 2.0 oz/cwt) in combination with a 1.5 oz rate of Baytan; and Raxil at 0.6 oz/cwt.

All trials were arranged in a randomized complete block design with three replications. The trial at KES was planted on May 14 and the LKL site on May 1. Seed was planted one inch deep at a seeding rate of 100 lb/acre using a 12-foot wide John Deere grain drill. Plots were 24 feet wide. Plot length varied from site to site. All plots received 50 lb N, 30 lb $P_2O_5$, and 22 lb S/acre by broadcast application prior to planting, and 30 lb N, 18 lb $P_2O_5$, and 13 lb S/acre banded at planting. At KES, bromoxynil and MCPA were applied at labeled rates to control broadleaf weeds. Weed control at organic soil sites was achieved with a mixture of 2,4-D and Banvel. Plots were harvested using a conventional combine with an 18-foot header at KES and a 24-foot header at LKL. Grain yield was recorded for all plots. Test weight, percent plumps, and percent thins were measured in all replications.

BSR infestation was determined when plants were in the soft dough stage. Thirty individual flag leaves were collected from each plot and transported to the laboratory where estimates of BSR infestation were made for each leaf. The average infestation for each plot was then determined for use in statistical analyses.

## Results

Seed treatment did not have a dramatic effect on BSR infestation. There was no significant effect at IREC and results were not definitive at KES (Tables 1 and 3). BSR was first confirmed in the Klamath Basin late in the season in 1996. This was well after the expected window of protection provided by Baytan and Raxil seed treatments.

Grain yields of Gaucho treated plots were significantly higher than those of plots not receiving Gaucho at both KES and LKL. Seed treatment did not significantly affect grain yield at IREC. Grain yields at the high rate of Baytan and the Raxil treatments were greater than RTU VT at LKL. Grain quality (test weight and thins) was not significantly affected by seed treatment at any location.

Conclusions as to the effectiveness of Baytan and Raxil in the control of BSR are difficult using only one year of data. If infestations of BSR continue to occur late in the season, benefit from these seed treatments in controlling BSR would be expected to be low. However, early season infestation is possible in the Klamath Basin and continued monitoring is necessary.

Table 1. Field Scale Seed Treatment at KES. Effect of seed treatment on barley stripe rust (BSR) infestation, grain yield, test weight, and thins of spring planted Colter barley at Klamath Experiment Station, Klamath Falls, OR, 1996.

| Entry | Variety | BSR | Yield | Test wt | Thins 6/64 | Thins 5.5/64 |
|---|---|---|---|---|---|---|
| | | % | lb/A | lb/bu | % | % |
| 1 | RTU VT @ 6.0 | 25 | 3820 | 51.0 | 85.7 | 9.5 |
| 2 | Baytan @ 1.25 | 30 | 3840 | 50.8 | 85.6 | 9.9 |
| 3 | Baytan @ 1.50 | 29 | 3590 | 51.2 | 86.6 | 9.1 |
| 4 | Gaucho @ 1.5 + RTU VT @ 6.0 | 26 | 4350 | 50.5 | 84.9 | 10.2 |
| 5 | Gaucho @ 1.3 + RTU VT @ 6.0 | 49 | 4410 | 51.2 | 83.8 | 11.1 |
| 6 | Baytan @ 1.5 + Gaucho @ 1.3 | 46 | 4250 | 50.8 | 88.4 | 7.9 |
| 7 | Baytan @ 1.5 + Gaucho @ 2.0 | 30 | 4450 | 51.5 | 85.1 | 10.0 |
| 8 | RXT @ 6.0 | 18 | 3610 | 50.7 | 85.7 | 9.6 |
| | Mean | 32 | 4040 | 51.0 | 85.7 | 9.7 |
| | LSD (0.05) | 14 | 720 | 1 | 4 | 2 |
| | CV (%) | 25 | 10 | 1 | 3 | 14 |

Table 2. Field Scale Seed Treatment on Lower Lake Organic Soil. Effect of seed treatment on grain yield, test weight, and thins of Colter barley spring planted on Lower Lake organic soil in Klamath County, 1996.

| Entry | Variety | Yield | Test wt | Thins 6/64 | Thins 5.5/64 | Thins Pan |
|---|---|---|---|---|---|---|
| | | lb/A | lb/bu | % | % | % |
| 1 | RTU VT @ 6.0 | 3040 | 46.3 | 69.6 | 14.8 | 15.6 |
| 2 | Baytan @ 1.25 | 3160 | 47.0 | 73.1 | 13.6 | 13.3 |
| 3 | Baytan @ 1.50 | 3390 | 45.7 | 69.4 | 14.4 | 16.2 |
| 4 | Gaucho @ 1.5 + RTU VT @ 6.0 | 3660 | 48.0 | 68.5 | 16.5 | 15.0 |
| 5 | Gaucho @ 1.3 + RTU VT @ 6.0 | 3740 | 48.0 | 69.9 | 15.8 | 14.3 |
| 6 | Baytan @ 1.5 + Gaucho @ 1.3 | 3530 | 46.3 | 66.3 | 16.0 | 17.7 |
| 7 | Baytan @ 1.5 + Gaucho @ 2.0 | 3150 | 47.7 | 71.4 | 14.1 | 14.5 |
| 8 | RXT @ 6.0 | 3480 | 46.7 | 65.0 | 17.5 | 17.6 |
| | Mean | 3380 | 47.0 | 69.2 | 15.3 | 15.5 |
| | LSD (0.05) | 240 | 2.0 | 6 | 3 | 2 |
| | CV (%) | 4 | 2 | 5 | 9 | 30 |

Table 3. Field Scale Seed Treatment at IREC. Effect of seed treatment on grain yield, test weight, and thins of spring planted Colter barley at Intermountain Research and Extension Center, Tulelake, CA,1996.

| Entry | Variety | Yield | wt | Thins 6/64 | Thins 5.5/64 |
|---|---|---|---|---|---|
| | | lb/A | lb/bu | -----------%----------- | |
| 1 | RTU VT @ 6.0 | 5980 | 48 | 75.5 | 16.4 |
| 2 | Baytan @ 1.25 | 6220 | 48 | 75.3 | 16.6 |
| 3 | Baytan @ 1.50 | 6080 | 48 | 74.2 | 18.7 |
| 4 | Gaucho @ 1.5 + RTU VT @ 6.0 | 5910 | 48 | 73.9 | 18.3 |
| 5 | Gaucho @ 1.3 + RTU VT @ 6.0 | 6110 | 48 | 77.2 | 16.1 |
| 6 | Baytan @ 1.5 + Gaucho @ 1.3 | 6150 | 48 | 76.7 | 16.6 |
| 7 | Baytan @ 1.5 + Gaucho @ 2.0 | 6290 | 48 | 75.7 | 16.5 |
| 8 | RXT @ 6.0 | 6010 | 48 | 74.9 | 16.1 |
| | Mean | 6090 | 48 | 75.4 | 16.9 |
| | LSD (0.05) | NS | NS | NS | NS |
| | CV (%) | 6 | 1 | 3 | 12 |

Table 4. Three-location Summary Field Scale Seed Treatment Trial. Effect of seed treatment on grain yield, test weight, and thins of spring planted Colter barley at three locations in Klamath County, Oregon and Siskiyou, County, California, 1996.

| Entry | Variety | Yield | Test wt | Thins 6 /64 | Thins 5.5/64 |
|---|---|---|---|---|---|
| | | lb/A | lb/bu | -----------%----------- | |
| 1 | RTU VT @ 6.0 | 4250 | 48.7 | 78.0 | 12.8 |
| 2 | Baytan @ 1.25 | 4430 | 48.6 | 78.5 | 13.3 |
| 3 | Baytan @ 1.50 | 4350 | 48.4 | 77.0 | 13.9 |
| 4 | Gaucho @ 1.5 + RTU VT @ 6.0 | 4610 | 48.9 | 76.4 | 14.4 |
| 5 | Gaucho @ 1.3 + RTU VT @ 6.0 | 4750 | 49.2 | 77.3 | 14.2 |
| 6 | Baytan @ 1.5 + Gaucho @ 1.3 | 4650 | 48.4 | 77.1 | 13.5 |
| 7 | Baytan @ 1.5 + Gaucho @ 2.0 | 4610 | 49.2 | 77.6 | 13.4 |
| 8 | RXT @ 6.0 | 4420 | 48.6 | 75.7 | 14.3 |
| | Mean | 4510 | 48.8 | 77.2 | 13.7 |
| | LSD (0.05) | 630 | NS | NS | NS |
| | Trt * Location Interaction | 0.06 | 0.1 | 0.06 | 0.02 |

# Small Scale Seed Treatment Trials in the Klamath Basin

R.L. Dovel[1], George Stallings[2], and G. Chilcote[1]

## Introduction

Seed treatment is an environmentally safe method of protecting small grains from seed and soil borne pathogens. The use of seed treatments for control of a number of smut species is universally accepted in the industry. New products are being developed for controlling other pathogens as well.

Imazalyl has been an effective control against common root rot in other areas, but has not been tested in the Klamath Basin. Common root rot is a continuing problem in the Klamath Basin and is especially damaging in continuously cropped small grains. This pathogen is favored by wet, cold springs and improper irrigation management.

System3 is a dry seed treatment designed to be added to seed in the seed box in addition to standard smut and seed borne disease treatments.

Baytan, Raxil, and Gaucho are discussed in the previous section of this report. All products were compared to an untreated control in small scale experiments at the KES, and irrigated and unirrigated Lower Klamath Lake sites previously described.

## Procedures

Two small scale seed treatment trials were established in the Klamath Basin in 1996. Trial 1 examined the effectiveness of various seed treatments in protecting spring seeded barley from a variety of fungal pathogens using traditional small plot techniques. Trial 2 examined the effectiveness of various rates of Gaucho seed treatment in controlling damage by the wheat stem maggot and other insects using small plots.

### Trial 1. Fungicide Seed Treatments

Seed of Gus barley was treated with eight seed treatments prior to planting. Treatments included: one rate of Baytan and Captan; one rate of Baytan and RTU Vitavax; one rate of Imazalyl and RTU Vitavax; two Raxil formulations; one rate of System3; and one RTU Vitavax treatment, which is the industry standard. An untreated control was also included in the trial. Treatment rates are shown in ounce product/cwt of seed in Table 1.

All trials were arranged in a randomized complete block design with four replications. The trial at KES was planted on May 10. Irrigated and unirrigated organic soil sites were planted on May 30 and May 2, respectively. Seed was planted one inch deep at a seeding rate of 100 lb/acre. All plots were fertilized with 100 lb N, 60 lb $P_2O_5$, and 44 lb S/acre at time of seeding. Plots measured 5 x 20 feet with a row spacing of 6 inches (10 rows).

At KES, bromoxynil and MCPA were applied at labeled rates to control broadleaf weeds. Weed control at organic soil sites was achieved with a mixture of 2,4-D and Banvel. Plots were harvested using a plot combine

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[1] Associate Professor, and Research Technician, respectively, Klamath Experiment Station, Klamath Falls, OR.

[2] Technical Sales Representative, Gustafson Incorporated, Plano, TX.

**Acknowledgments:** Gustafson provided material and partial funding for these trials. Henzel Farms provided the Klamath Co. organic soil site and crop care. The Experiment Station greatly appreciates their support and participation.

with a 5-foot wide header. Grain yield was recorded for all plots. Test weight, percent plumps, and percent thins were measured in only one replication.

### Trial 2. Gaucho Seed Treatment

Seed was treated with four rates of Gaucho in addition to the standard rate of RTU Vitavax. Rates of Gaucho application were 0.75, 1.0, 1.5, and 2.0 oz of material per 100 lb seed. An untreated control was also included in the trial. The trial was arranged in a randomized complete block design with four replications. Cultural practices were identical to those described for Trial 1.

## Results

### Trial 1. Fungicidal Seed Treatments

There was no significant difference in grain yield due to fungicidal seed treatment at any site (Tables 1-3). A light infestation of barley stripe rust occurred at all three sites in August 1996. The infestation was not severe enough to cause dramatic yield losses. The occurrence of the disease was so late in the season that the early season protection provided by Baytan was no longer effective. A severe mid-August frost at the unirrigated organic soil site severely damaged heads in the mid-stage of grain fill, resulting in substantial yield loss.

Barley stripe rust was also present in 1995, but seed treatment trials in that year did not show any seed treatment efficacy against barley stripe rust. As in 1996, the infestation occurred late in the season after the expected window of protection from Baytan was passed. Data from the Baytan/Captan plots was lost at the irrigated organic soil site; however, the Baytan/RTU VT treatment was not different than the RTU VT treatment in either yield or quality (Table 2). When averaged across three sites, four entries (3 through 6) had higher test weights than the RTU VT treatment (Table 4). Only the Baytan/RTU VT treatment had a higher test weight than the untreated control.

### Trial 2. Gaucho Seed Treatments

Gaucho seed treatment did not affect barley grain yield at KES or the irrigated organic soil site in 1996 (Tables 5 and 6). The unirrigated organic soil site showed mixed results, and due to high variability caused by frost, no conclusion can be drawn (Table 7).

In 1994, yields of Gaucho treated plots were significantly higher than the control at both irrigated sites, but not at the unirrigated site. Although infestation of wheat stem maggot was very light in 1994, there was a low level of Russian wheat aphid at the experiment station and a high level of infestation of corn leaf aphids at the irrigated organic soil site. It appears that the Gaucho seed treatment suppressed the populations of these insects, resulting in higher yields. Grain quality parameters such as test weight and percent plumps (percent above 6/64 screen) were also higher for the Gaucho treatment than the control at the two organic soil sites.

## Conclusions

Further testing is needed to determine the effectiveness of these seed treatments against the various pest species in the Klamath Basin. Differences in yield and grain quality due to seed treatments is often small and hard to detect in small scale plots. Results from field scale trials using similar treatments produced positive results, low coefficients of variation, and improved precision in evaluating the efficacy of treatments. The increased labor and time needed to conduct field-scale trials requires that a limited number of entries be used. The continued use of small scale testing to identify treatments for inclusion in field-scale trials is warranted.

Table 1. Seed Treatment Trial (Irrigated Mineral Soil). Effect of seed treatment on grain yield, test weight, and percent thins of spring-planted Colter barley. Plots were established on May 8, 1996 at Klamath Experiment Station, Klamath Falls, OR.

| Entry | Treatment | Yield | Test wt | Thins 6/64 | Thins 5.5/64 | Thins Pan |
|---|---|---|---|---|---|---|
| | | lb/A | lb/bu | % | % | % |
| 1 | Baytan @1.25 + Captan @2.0 | 3560 | 51.8 | 81.8 | 11.5 | 6.7 |
| 2 | Baytan @1.50 + Captan @2.0 | 3180 | 51.8 | 80.2 | 13.3 | 6.5 |
| 3 | Baytan @ 1.50 + RTU VT @ 6.0 | 3560 | 51.5 | 81.8 | 12.0 | 6.2 |
| 4 | Imazalyl @0.25 + RTU VT @6.0 | 3480 | 51.8 | 79.1 | 13.7 | 7.2 |
| 5 | RXT @0.60 | 3750 | 51.8 | 79.3 | 13.9 | 6.8 |
| 6 | Raxil / Thiram @ 3.5 | 4040 | 52.9 | 81.7 | 12.3 | 6.0 |
| 7 | System3 @4.0 | 3600 | 51.8 | 76.7 | 15.3 | 8.0 |
| 8 | RTU VT @6.0 | 3480 | 51.6 | 78.0 | 14.8 | 7.2 |
| 9 | Untreated Control | 3610 | 51.4 | 78.2 | 13.9 | 7.9 |
| | Mean | 3580 | 51.8 | 79.6 | 13.4 | 6.9 |
| | LSD (0.05) | NS | NS | NS | NS | NS |
| | CV (%) | 20 | 1 | 6 | 26 | 22 |

Table 2. Seed Treatment Trial (Irrigated Organic Soil). Effect of seed treatment on grain yield, test weight, and percent thins of spring-planted Colter barley. Plots were established on May 30, 1996 on irrigated organic soil, in Klamath County, OR.

| Entry | Treatment | Yield | Test wt | Thins 6/64 | Thins 5.5/64 | Thins Pan |
|---|---|---|---|---|---|---|
| | | lb/A | lb/bu | % | % | % |
| 1 | Baytan @1.25 + Captan @2.0 | -- | -- | -- | -- | -- |
| 2 | Baytan @1.50 + Captan @2.0 | -- | -- | -- | -- | -- |
| 3 | Baytan @ 1.50 + RTU VT @ 6.0 | 4780 | 47.6 | 77.7 | 15.2 | 7.2 |
| 4 | Imazalyl @0.25 + RTU VT @6.0 | 4940 | 47.6 | 76.8 | 15.4 | 7.8 |
| 5 | RXT @0.60 | 5330 | 48.0 | 79.9 | 13.5 | 6.6 |
| 6 | Raxil / Thiram @ 3.5 | 4570 | 48.6 | 76.9 | 14.8 | 8.3 |
| 7 | System3 @4.0 | 4700 | 48.1 | 77.9 | 14.5 | 7.6 |
| 8 | RTU VT @6.0 | 4530 | 47.8 | 74.0 | 17.7 | 8.3 |
| 9 | Untreated Control | 4930 | 47.8 | 80.5 | 13.0 | 6.5 |
| | Mean | 4830 | 47.9 | 77.7 | 14.9 | 7.5 |
| | LSD (0.05) | NS | NS | NS | 2.7 | NS |
| | CV (%) | 11 | 2 | 4 | 12 | 15 |

Table 3. Seed Treatment Trial (Unirrigated Organic Soil). Effect of seed treatment on grain yield, test weight, and percent thins of spring-planted Colter barley. Plots were established on May 2, 1996 on unirrigated organic soil, in Klamath County, OR.

| Entry | Treatment | Yield | Test wt | Thins 6/64 | Thins 5.5/64 | Thins Pan |
|---|---|---|---|---|---|---|
| | | lb/A | lb/bu | % | | |
| 1 | Baytan @1.25 + Captan @2.0 | 1590 | 44.5 | 58.1 | 22.6 | 19.3 |
| 2 | Baytan @1.50 + Captan @2.0 | 1140 | 43.9 | 59.8 | 21.7 | 18.5 |
| 3 | Baytan @ 1.50 + RTU VT @ 6.0 | 1110 | 44.3 | 62.0 | 20.4 | 17.6 |
| 4 | Imazalyl @0.25 + RTU VT @6.0 | 1350 | 44.8 | 57.0 | 23.8 | 19.2 |
| 5 | RXT @0.60 | 1910 | 45.8 | 55.8 | 24.3 | 19.8 |
| 6 | Raxil / Thiram @ 3.5 | 1440 | 44.5 | 52.6 | 25.4 | 21.9 |
| 7 | System3 @4.0 | 1560 | 43.8 | 51.2 | 26.2 | 22.6 |
| 8 | RTU VT @6.0 | 1520 | 44.8 | 51.8 | 25.0 | 23.2 |
| 9 | Untreated Control | 1310 | 43.3 | 55.3 | 23.2 | 21.5 |
| | Mean | 1440 | 44.4 | 56.0 | 23.6 | 20.4 |
| | LSD (0.05) | NS | NS | NS | 2.7 | NS |
| | CV (%) | 11 | 2 | 4 | 12 | 15 |

Table 4. Three-location summary of Seed Treatment Trial. Effect of seed treatment on grain yield, test weight, and percent thins of spring-planted Colter barley. Plots were established at three sites in Klamath County, OR in 1996.

| Entry | Treatment | Yield | Test wt | Thins 6/64 | Thins 5.5/64 | Thins Pan |
|---|---|---|---|---|---|---|
| | | lb/A | lb/bu | % | | |
| 1 | Baytan @1.25 + Captan @2.0 | -- | -- | -- | -- | -- |
| 2 | Baytan @1.50 + Captan @2.0 | -- | -- | -- | -- | -- |
| 3 | Baytan @ 1.50 + RTU VT @ 6.0 | 3150 | 73.8 | 15.9 | 10.3 | 17.6 |
| 4 | Imazalyl @0.25 + RTU VT @6.0 | 3260 | 71.0 | 17.6 | 11.4 | 19.2 |
| 5 | RXT @0.60 | 3660 | 71.6 | 17.3 | 11.1 | 19.8 |
| 6 | Raxil / Thiram @ 3.5 | 3350 | 70.4 | 17.5 | 12.1 | 21.9 |
| 7 | System3 @4.0 | 3290 | 68.6 | 18.7 | 12.8 | 22.6 |
| 8 | RTU VT @6.0 | 3180 | 67.9 | 19.2 | 12.9 | 23.2 |
| 9 | Untreated Control | 3280 | 71.3 | 16.7 | 12.0 | 21.5 |
| | Mean | 3310 | 70.7 | 17.6 | 11.8 | 20.8 |
| | LSD (0.05) | NS | 0.8 | NS | NS | 1.7 |
| | CV (%) | 17 | 2 | 7 | 16 | 17 |

Table 5. 1996 Gaucho Seed Treatment (Irrigated Mineral Soil). Effect of Gaucho seed treatment on grain yield, test weight, and percent thins of Colter barley planted on May 8, 1996 on irrigated mineral soil at Klamath Experiment Station, OR.

| | | | Test | Thins | | |
|---|---|---|---|---|---|---|
| Entry | Treatment | Yield | wt | 6/64 | 5.5/64 | Pan |
| | | lb/A | lb/bu | % | | |
| 1 | Control | 5120 | 52.4 | 85.3 | 9.1 | 5.7 |
| 2 | Gaucho @ 0.75 | 4790 | 53.0 | 90.0 | 6.5 | 3.5 |
| 3 | Gaucho @ 1.00 | 4640 | 52.9 | 89.4 | 6.9 | 3.6 |
| 4 | Gaucho @ 1.50 | 4810 | 52.8 | 87.3 | 7.8 | 4.9 |
| 5 | Gaucho @ 2.00 | 4700 | 52.4 | 87.5 | 8.0 | 4.5 |
| | Mean | 4810 | 52.7 | 87.9 | 7.7 | 4.4 |
| | LSD (0.05) | NS | NS | 2.6 | 1.4 | 1.3 |
| | CV (%) | 9 | 1 | 2 | 12 | 19 |

Table 6. 1996 Gaucho Seed Treatment (Irrigated Organic Soil). Effect of Gaucho seed treatment on grain yield, test weight, and percent thins of Colter barley. Plots were established on May 30, 1996 on irrigated organic soil, in Klamath County, OR.

| | | | Test | Thins | | |
|---|---|---|---|---|---|---|
| Entry | Treatment | Yield | wt | 6/64 | 5.5/64 | Pan |
| | | lb/A | lb/bu | % | | |
| 1 | Control | 4410 | 47.9 | 74.8 | 16.6 | 8.7 |
| 2 | Gaucho @ 0.75 | 4840 | 47.8 | 74.9 | 16.4 | 8.6 |
| 3 | Gaucho @ 1.00 | 4390 | 47.1 | 73.4 | 17.9 | 8.7 |
| 4 | Gaucho @ 1.50 | 4070 | 47.8 | 71.5 | 18.6 | 9.9 |
| 5 | Gaucho @ 2.00 | 4080 | 46.4 | 69.5 | 19.9 | 10.6 |
| | Mean | 4360 | 47.4 | 72.8 | 17.9 | 9.3 |
| | LSD (0.05) | NS | 0.9 | NS | NS | NS |
| | CV (%) | 11 | 1 | 6 | 14 | 20 |

Table 7. 1996 Gaucho Seed Treatment (Unirrigated Organic Soil). Effect of Gaucho seed treatment on grain yield, test weight, and percent thins of Colter barley. Plots were established on May 2, 1996, on unirrigated organic soil, in Klamath County, OR.

| Entry | Treatment | Yield | Test wt | Thins 6/64 | Thins 5.5/64 | Thins Pan |
|---|---|---|---|---|---|---|
| | | lb/A | lb/bu | -----------%----------- | | |
| 1 | Control | 2060 | 46.4 | 62.6 | 20.4 | 17.0 |
| 2 | Gaucho @ 0.75 | 1710 | 44.4 | 59.9 | 22.2 | 17.9 |
| 3 | Gaucho @ 1.00 | 1670 | 46.0 | 61.3 | 21.6 | 17.1 |
| 4 | Gaucho @ 1.50 | 2020 | 46.9 | 63.6 | 19.9 | 16.5 |
| 5 | Gaucho @ 2.00 | 2140 | 45.1 | 61.6 | 21.2 | 17.2 |
| | Mean | 1920 | 45.8 | 61.8 | 21.1 | 17.1 |
| | LSD (0.05) | 530 | 2.4 | 8.0 | 3.2 | 5.0 |
| | CV (%) | 18 | 3 | 8 | 10 | 19 |

Table 8. Three-location Summary of Gaucho Trial. Effect of seed treatment on grain yield, test weight, and percent thins of spring-planted Colter barley. Plots were established at three sites in Klamath County, OR.

| Entry | Treatment | Yield | Test wt | Thins 6/64 | Thins 5.5/64 | Thins Pan |
|---|---|---|---|---|---|---|
| | | lb/A | lb/bu | -----------%----------- | | |
| 1 | Control | 3860 | 48.9 | 74.2 | 15.4 | 10.5 |
| 2 | Gaucho @ 0.75 | 3780 | 48.4 | 74.9 | 15.0 | 10.0 |
| 3 | Gaucho @ 1.00 | 3570 | 48.7 | 74.7 | 15.5 | 9.8 |
| 4 | Gaucho @ 1.50 | 3630 | 49.2 | 74.1 | 15.4 | 10.4 |
| 5 | Gaucho @ 2.00 | 3640 | 48.0 | 72.9 | 16.4 | 10.8 |
| | Mean | 3700 | 48.6 | 74.2 | 15.5 | 10.3 |
| | LSD (0.05) | NS | NS | NS | NS | NS |
| | CV (%) | 11 | 2 | 5 | 13 | 21 |

## Intercropping Annual Forage Species With Spring Planted Barley

R.L. Dovel, G. Chilcote, and J. Rainey[1]

### Introduction

The Klamath Basin has a short growing season with frequent frosts throughout the summer, which limits cropping options in the area to small grains, alfalfa, potatoes, sugar beets, and pasture. Much of the acreage planted to small grains is on soils that are not suitable for potatoes or alfalfa and are maintained in a continuous small grain rotation. Due to greater susceptibility of spring wheat to frost damage, and lower oat yields and price, barley is planted on over 80 percent of the acreage devoted to small grains.

Under continuous cropping, diseases and pests such as wheat stem maggot, common root rot, and barley root knot nematode have become serious problems in some areas. Wind erosion is also a problem on some soils. Much of the cropland in the lower Klamath Basin is reclaimed lake bottom. Some of these soils have very poor structure and poor aggregate strength. The inclusion of legumes and forage grasses in a rotation has been shown to improve soil structure, soil aggregate strength, and other measures of soil health.

The production of other commodities such as canola, dry peas, and lentils in the Klamath Basin is being investigated. However, local commercial production of these commodities does not appear to be economically viable at this time. It may be possible to intercrop forage legumes and grasses with spring planted barley and derive some of the benefits of a legume or forage rotation as well as provide late season grazing and ground cover to prevent fall and early spring erosion.

Interseeding of legumes into small grains has increased grain yield in some locations. Increased yield has been attributed to nitrogen transfer from the legume, weed suppression, and improved soil conditions. The effects of legume interseeding on the subsequent year's crop is attributable to residual nitrogen transfer from decaying plant material and improved soil conditions. It seems that indeterminant legumes with lower seed yield potentials are more beneficial to associated cereals in terms of nitrogen transfer in the current season and as residual nitrogen for subsequent crops. The production of a second grain crop by interseeding is impossible in the Klamath Basin due to an extremely short growing season. However, it is possible to prolong the growing season past grain harvest date by interseeding a forage species for either hay or pasture. Interseeding a forage legume would enhance nitrogen transfer to the associated cereal and maximize residual nitrogen for the following crop.

Annual forage legume variety trials have been conducted at KES over the past four years. In 1992 and 1993, legumes were planted in monoculture and total biomass production and forage quality were monitored. Several annual medic, rose clover, and sub clover species showed promise for interseeding in barley for grain. In an annual legume trial in central Oregon, good fall regrowth was seen in plots interseeded with annual medic species; however, regrowth of berseem clover entries was roughly twice that of annual medic entries. Further testing of annual forage legumes is needed to determine which is appropriate

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1/ Associate Professor, Research Technician, and Biological Sciences Research Technician III, respectively, Klamath Experiment Station, Klamath Falls, OR.

for inclusion in a small grain-forage intercropping system in the Klamath Basin. A trial to evaluate legumes for interseeding in spring-planted barley was established at the Klamath Experiment Station in 1994 and 1995. George black medic, Multicut berseem clover, and Parrabinga barrel medic were selected from this trial for further study.

The success of intercropping systems has also differed with grain variety. Several barley varieties need to be examined to evaluate their production potential in an intercropping system with the most promising forage varieties. Three legume varieties mentioned above and an annual ryegrass variety were included in a study initiated at Klamath Experiment Station in 1995 and continued in 1996. The trial was conducted to examine the interaction of barley variety and forage species in an intercropping system.

## Procedures

Three barley varieties were interseeded at planting with four different forage species to evaluate the compatibility of different barley varieties and forage species in an interseeded grain production system. The barley varieties included represent different height groups ranging from Gustoe, (a very short semi-dwarf variety), to Colter, ( a very tall variety), and Columbia, (an intermediate variety). The barley varieties were interseeded at planting with one of the following treatments: no forage species (control); George black medic; Parrabinga barrel medic; Multicut berseem clover; or Magnum annual ryegrass.

Barley seed was sown one inch deep with a modified Kincaid planter. Plots were established on May 23, 1995 and May 10, 1996. Plots were fertilized with 50 lb N, 62 lb $P_2O_5$, and 37 lb S/acre in a band application at planting. Seed of the forage species was broadcast using the same drill and incorporated by light raking. Plots measured 5 x 20 feet with a barley row spacing of six inches. The study was sprinkler irrigated by a solid-set irrigation system.

Data collected included plant height, percent lodging, date of 50 percent heading, grain yield, bushel weight, percent thins, test weight, grain protein content, fall herbage, and plant height of the forage component. Grain contamination by the forage component was also measured. No chemical weed control was applied and weed population density was monitored.

## Results and Discussion

### Grain Yield and Quality

Barley yields were almost twice as high in 1995 as in 1996 due to infestation of 1996 plots with common root rot and barley stripe rust. Establishment of the interseeded forage species was also better in 1995 than in 1996. Trends in barley variety and interseeded species effects on grain yield, quality, and contamination of grain by interseeded species differed slightly between the two years. Data from the two years were analyzed separately due to these differences between years.

#### 1995

Interseeding barley with forage legumes tended to reduce grain yields slightly, but the difference was not statistically significant (Table 1). Interseeding with annual ryegrass significantly reduced grain yield when compared to the control and the black medic treatment. There was no difference in yield among the three barley varieties in 1995.

Interseeding did not reduce grain quality as measured by test weight and percent plumps in 1995, nor was there a difference in grain quality due to barley variety. Lodging and barley plant height were not affected by interseeding treatments. However, plant height differed significantly between barley varieties.

Forage maturity is a measure of the maturity of the interseeded species at the time of grain harvest. A rating of 1 indicates that the plant was green and actively growing. A rating of 0 indicates that the plant was dead and senesced. Green growing plants could interfere with grain harvest, while dry material would readily pass through a combine. Parrabinga barrel medic is a determinant short season species. It had set seed and was very dry by grain harvest. In contrast, the other three forage species were green and growing at grain harvest. There was some desiccation of berseem clover and annual medic due to moisture stress, but much of the material still had a high moisture content.

Forage height is the height of interseeded species relative to the cutting height required to harvest the grain. Combine cutting height of tall varieties, such as Colter, is much higher than for short varieties, such as Gustoe. This affects whether an interseeded grass or legume will be cut along with the barley at grain harvest. It is important that an interseeded species not interfere with grain harvest and is desirable that a large amount of residual material remain for ground cover, green manure, or forage. Because barley plant height affected the height of the interseeded species relative to combine cutting height, there was an interaction of barley variety and interseeded species on relative forage height. In the short variety, Gustoe, all interseeded species were above combine cutting height. In Colter, the tallest variety, none of the forage species were growing above estimated combine cutting height (Table 2). Columbia, the intermediate variety had two species, black medic and berseem clover, growing above estimated combine cutting height.

Grain contamination by the interseeded legume is affected by the relative forage height discussed above, the amount of material produced (usually seeds), and the ease of removal of the material. Actual combine cutting height was lower than estimated and contamination was seen in Colter, which had relative forage height values of 0.0 with all interseeded species. Contamination from the interseeded species followed similar trends as relative forage height. Gustoe had more contamination than Columbia and Colter had significantly less contamination than the two shorter varieties.

Berseem clover and annual ryegrass were not contaminants in any variety despite being cut with the grain at harvest. This is due to late maturity in berseem clover. Seed had not yet been formed at harvest time. Annual ryegrass seed and stems were removed by the combine and failed to contaminate the grain. In contrast, barrel medic had lower relative forage height values than any other entry, yet had the highest contamination level. Objectionable levels of barrel medic contamination were present in all barley varieties. Barrel medic had produced mature seed by grain harvest. The seed is in a dense spiny pod that is about the size of a pea. It is not easily removed by the combine and would be a marketing problem in the quantities found in this trial. Black medic contamination was less severe than barrel medic. However, objectionable levels of black medic seed were in the two shorter varieties in the trial. Slight amounts were observed in Colter. The seed are in small pods that are smooth and can be removed by a number of seed cleaning processes.

**1996**

Interseeding with forage species did not affect grain yield in 1996. There were significant differences in yield between barley varieties (Table 1). As in 1995, interseeding treatments did not affect grain quality, lodging or plant height. Forage maturity trends were the same as seen in 1995. Barrel medic had set seed and died by grain harvest, but the other three forage species were green and growing. Due to shorter barley plants, relative forage height and resultant grain contamination were higher in 1996 than in 1995.

As in 1995, there was an interaction of barley variety and interseeded species in their effect on relative forage height and grain contamination. The two shorter varieties had more contamination than Colter. Both berseem clover and annual medic were not contaminants in any barley variety. Objectionable levels of barrel medic contamination were present in all barley varieties. The levels of black medic contamination found in the two shortest barley varieties would have caused the grain to be penalized for excess dockage.

### Forage production and ground cover

Data on regrowth following grain harvest, spring ground cover, and forage production the following year are still being gathered and analyzed. However, general observations of these parameters can be made. There was little fall growth from any of the legumes. In an annual legume trial in central Oregon, good fall regrowth occurred in plots interseeded with annual medic species and berseem clover. The shorter growing season in the Klamath Basin may account for that difference. Also berseem clover failed to establish robust stands in the two years of this trial. Annual ryegrass produced the highest amount of forage in the fall following grain harvest.

The only two entries to survive the winter were George black medic and Max annual ryegrass. Both provided excellent ground cover the following spring. If allowed to grow to the middle of June they produced an excellent forage crop. Annual ryegrass would provide season long forage production and could persist for several years depending on variety. Black medic failed to regrow following the first cutting.

## Conclusions

The potential benefits of interseeding spring barley with annual forage legumes and grasses include improved soil tilth, enhanced ground cover, forage production for both fall and spring grazing, and improved nutrient cycling. The costs for these benefits are interseeded species seed cost, more expensive or more complicated weed control, and possible yield reduction and grain contamination. The results of this trial indicate that yield reduction and grain contamination may be minimal, depending on the species selected.

The two most promising species for interseeding in spring barley in the Klamath Basin are black medic and annual ryegrass. Both provide good ground cover and forage production. Annual ryegrass does not complicate broadleaf weed control and will prevent N leaching following grain harvest. However, it suppressed grain yield more than any other species in the trial. Black medic fixes N and tends to suppress weeds, while not adversely affecting grain yield.

The tallest barley variety was the most successful variety in this intercropping system. Grain yields of all varieties were similarly affected, but grain contamination in the taller varieties was much less than in Gustoe, the shortest variety.

Further economic analysis is needed to determine the relative profitability of these practices.

Table 1. Barley Interseeding Trial Main Effects. Barley variety and interseeded forage species effects on grain yield, test weight, plumps, lodging, plant height, forage maturity, relative forage height, and grain contamination of spring barley planted at Klamath Experiment Station, Klamath Falls, OR.

| Treatments | Grain Yield | Test Wt | Plumps | Lodge | Height | Forage Maturity[1] |
|---|---|---|---|---|---|---|
| | lb/A | lb/bu | --------%------- | | inches | |
| | | | **1995** | | | |
| Forage Species | | | | | | |
| Control | 7040 | 51.5 | 95 | 0 | 73 | 0.0 |
| George Black Medic | 6830 | 51.1 | 95 | 0 | 74 | 1.0 |
| Parrabinga Barrel Medic | 6706 | 50.7 | 94 | 0 | 75 | 0.3 |
| Multicut Berseem Clover | 6740 | 51.0 | 94 | 0 | 74 | 0.8 |
| Max Annual Ryegrass | 6280 | 51.8 | 94 | 0 | 73 | 0.9 |
| Mean | 6720 | 51.2 | 94 | 0 | 74 | 0.6 |
| LSD (0.05) | 460 | 0.6 | NS | -- | NS | 0.2 |
| Barley Varieties | | | | | | |
| Gustoe | 6540 | 51.3 | 96 | 0 | 61 | 0.7 |
| Columbia | 6830 | 50.3 | 96 | 0 | 72 | 0.6 |
| Colter | 6790 | 52.0 | 91 | 0 | 88 | 0.6 |
| Mean | 6720 | 51.2 | 94 | 0 | 74 | 0.6 |
| LSD (0.05) | NS | 0.5 | 2 | -- | 2 | NS |
| Var*Forage Interaction | NS | NS | NS | -- | NS | NS |
| | | | **1996** | | | |
| Forage Species | | | | | | |
| Control | 2900 | 48.1 | 82 | 0 | 58 | 0.0 |
| George Black Medic | 2880 | 48.3 | 83 | 0 | 60 | 1.0 |
| Parrabinga Barrel Medic | 2900 | 47.5 | 81 | 0 | 60 | 0.4 |
| Multicut Berseem Clover | 3249 | 48.2 | 82 | 0 | 59 | 0.6 |
| Max Annual Ryegrass | 2710 | 48.9 | 84 | 0 | 58 | 1.0 |
| Mean | 2930 | 48.2 | 82 | 0 | 59 | 0.6 |
| LSD (0.05) | NS | NS | NS | -- | NS | 0.2 |
| Barley Varieties | | | | | | |
| Gustoe | 2600 | 47.1 | 80 | 0 | 46 | 0.6 |
| Columbia | 2460 | 47.0 | 87 | 0 | 56 | 0.7 |
| Colter | 3730 | 50.6 | 80 | 0 | 75 | 0.6 |
| Mean | 2930 | 48.2 | 82 | 0 | 59 | 0.6 |
| LSD (0.05) | 550 | 0.8 | 5 | -- | 2 | NS |
| Var*Forage Interaction | NS | NS | NS | -- | NS | NS |

[1]/ Forage Maturity: 1 = green and growing, 0 = dead and senescing

Table 2. Barley Interseeding Trial Barley Variety by Forage Species Interaction. Interactive effect of barley variety and interseeded forage species, relative forage height, and grain contamination of spring barley planted at Klamath Experiment Station, Klamath Falls, OR.

| | 1995 | | 1996 | |
|---|---|---|---|---|
| Forage Species | Forage Height[1] | Contamination Rating[2] | Forage Height[1] | Contamination Rating[2] |
| Gustoe | | | | |
| Control | 0.0 | 0.0 | 0.0 | 0.0 |
| George Black Medic | 1.0 | 1.5 | 1.0 | 1.8 |
| Parrabinga Barrel Medic | 0.5 | 2.0 | 0.7 | 3.0 |
| Multicut Berseem Clover | 0.5 | 0.0 | 0.6 | 0.0 |
| Max Annual Ryegrass | 0.8 | 0.0 | 1.0 | 0.0 |
| Mean | 0.6 | 0.7 | 0.7 | 1.0 |
| Columbia | | | | |
| Control | 0.0 | 0.0 | 0.0 | 0.0 |
| George Black Medic | 0.8 | 1.5 | 0.9 | 2.3 |
| Parrabinga Barrel Medic | 0.0 | 1.5 | 0.4 | 2.8 |
| Multicut Berseem Clover | 0.5 | 0.0 | 0.5 | 0.0 |
| Max Annual Ryegrass | 0.0 | 0.0 | 0.6 | 0.0 |
| Mean | 0.3 | 0.6 | 0.5 | 1.0 |
| Colter | | | | |
| Control | 0.0 | 0.0 | 0.0 | 0.0 |
| George Black Medic | 0.0 | 0.3 | 0.1 | 1.0 |
| Parrabinga Barrel Medic | 0.0 | 0.5 | 0.1 | 2.5 |
| Multicut Berseem Clover | 0.0 | 0.0 | 0.2 | 0.0 |
| Max Annual Ryegrass | 0.0 | 0.0 | 0.0 | 0.0 |
| Mean | 0.0 | 0.2 | 0.1 | 0.7 |
| Mean | 0.3 | 0.5 | 0.4 | 0.8 |
| LSD (0.05) | 0.2 | 0.3 | 0.2 | 0.2 |
| Var*Forage Interaction | 0.03 | 0.00 | 0.03 | 0.00 |
| CV (%) | 19 | 17 | 28 | 46 |

[1]/ Forage Height: 1 = tall enough to be cut by combine, 0 = below combine cutting height
[2]/ Contamination Rating: 0 = no forage seed contamination, 1 = slight contamination, 2 = objectional amounts of forage seed present, 3 = grain unmarketable due to contamination.

# Pasture and Hay Grass Variety Trial

R.L. Dovel and J. Rainey[1]

## Introduction

Several grass hay variety trials were established at Klamath Experiment Station in 1988. Since that time, new varieties have been developed and should be tested in this area. In addition, there is a need to test pasture grasses under a management system that more accurately reflects controlled grazing rather than a three cutting hay schedule. A trial was established to test forage production and stand persistence of pasture grasses in the Klamath Basin under both haying and simulated grazing management. Entries included released and soon to be released varieties of tall fescue, orchardgrass, perennial ryegrass, and *Bromus* species.

## Procedures

The trial was planted on August 21, 1995 at KES. Plots were arranged in a randomized split plot design with three replications. Clipping management was the main plot and variety was the split plot. Seed was sown in 6-inch rows using a cone seeder. Seeding rate was as recommended for each species. Planting depth was 0.25 inches. Plots were 5 x 20 feet with 3-foot wide alleyways.

Prior to seeding, fertilizer was applied and incorporated as indicated by soil tests. At planting, 75 lb N/acre was applied. Following establishment, 50 lb N/acre was applied in mid-March, mid-June, and mid-July. Plots were irrigated by solid-set sprinkler irrigation. Evapotranspiration was estimated from the KES weather station data and weekly applications were made accordingly.

All plots were allowed to grow unclipped in the establishment year. Plots managed as a hay trial were cut when 50 percent of the entries were heading. Cutting height in these plots was 2 inches. Plots being managed to simulate grazing were cut when 50 percent of the entries reached 10 inches or more in height. Simulated grazing plots were cut to a 4-inch cutting height. The trial was harvested using a Carter flail plot harvester. Measurements will be taken for three full production years. Winter survival will be determined for three winter periods.

All yields are reported on a dry weight basis. Subsamples were collected and analyzed for forage quality measured as, acid detergent fiber (ADF), neutral detergent fiber (NDF), crude protein (CP) and relative feed value (RFV), using a near-infrared reflectance spectrophotometer.

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[1]/ Associate Professor, and Biological Sciences Research Technician III, respectively, Klamath Experiment Station, Klamath Falls, OR.

**Acknowledgments:** Partial support for this trial has been provided by a number of seed companies, whose varieties are represented here. The Experiment Station greatly appreciates their support and participation.

## Results

### Forage Yield

Clipping management was the most significant factor affecting forage yield. Simulated grazing produced only 53 percent as much dry matter as hay management (Table 1). Frequent clipping reduces photosynthetic surface area and thus reduces growth. The longer interval of the hay clipping treatment allowed a much larger photosynthetic area to produce growth.

Matua was the highest yielding entry under both hay and simulated grazing management. The next three highest yielding entries under hay management were tall fescue entries, ISI-9077, ISI-8872, and AU Triumph. Kemal, a Festulolium, was not significantly lower yielding than the three highest yielding tall fescues. Average tall fescue yield under hay management was significantly higher than either orchardgrass or perennial ryegrass.

Forage yield of some entries was less affected by clipping management. Under simulated grazing, two entries, AU Triumph and Latar, produced 60 percent as much dry matter as under hay clipping management. In contrast, BG3 and Cambria produced 43 percent as much dry matter under simulated grazing as under hay clipping management. In general, orchardgrass was less affected by clipping management than tall fescue and perennial ryegrass, 55 percent compared to 50 percent. However, variability within species was very high.

### Forage Quality

As was seen in forage yield, clipping management was the most significant factor affecting forage quality, measured as protein content and Total Digestible Nutrients (TDN). Average protein and TDN were 16.8 and 59.0 percent under clipping management compared to 22.2 and 64.2 under simulated grazing. All entries had high forage quality, with minimum values of 14.1 percent protein and 53.6 percent TDN, under hay management. Matua produced the lowest protein concentration and Gala the lowest TDN value under grazing. The low protein value of Matua is due to high biomass production. Nitrogen uptake and assimilation did not keep pace with the rate of forage production. Gala TDN values are probably low due to low genetic potential. It was not selected for high forage quality and has been criticized by other researchers for low digestibility.

Average forage TDN values for tall fescue were higher than for perennial ryegrass and similar to orchardgrass under both hay and simulated grazing management. This was not expected. Perennial ryegrass is reputed to have higher forage quality than other cool-season pasture grasses and tall fescue is thought to have lower forage quality than either orchardgrass or perennial ryegrass. Under hay management, lower perennial ryegrass TDN values may be explained by different maturity levels of the species involved. Perennial ryegrass tends to be earlier maturing than the orchardgrass and tall fescue varieties included in this trial. However, clipping frequency under simulated grazing management was approximately two weeks and differences in maturity would be negligible.

Average forage protein concentration of orchardgrass and tall fescue was similar and significantly better than perennial ryegrass, under hay management. It may be that fertilization and irrigation management moved N below the effective rooting depth of perennial ryegrass but was still accessible to the deeper rooted species. Under grazing management, orchardgrass had slightly higher protein levels than perennial ryegrass and tall fescue, which were not different from each other.

There was also considerable variability in forage quality within species. The most notable example of this is Barcel tall fescue, which has been selected for high quality. It had an average TDN of 60.1 and 66.7 percent under hay and simulated grazing clipping management, respectively.

### Nutritional Yield

Nutritional yield is the product of forage yield and nutrient concentration. It is useful in determining expected animal production and performance. Protein and TDN yield were less affected by clipping management than forage yield. Although frequent clipping reduced forage yield by 46 percent, it only reduced protein and TDN yield by 30 and 42 percent, respectively, because of higher forage quality in frequently clipped plots. Rankings of total nutrient production closely resemble those of forage production because the relative differences in forage quality between entries were less than relative differences in forage yield.

**Seasonal Trends**

Because the clipping frequency of the simulated grazing treatment was approximately every two weeks, seasonal trends in forage growth and quality can be examined. Growth rate is calculated by dividing the dry matter produced by the number of days in the growth period. Growth rate was initially slow in the spring due to cool temperatures (Figure 1). It rose to maximum levels by late June and remained high through mid-July, before dropping to half the maximum level during late July and early August. This was due to temperatures exceeding optimal levels for cool-season grass growth in late summer. As temperatures cooled in late August, growth rates recovered to former levels. Growth rates declined in late September as temperatures cooled.

Cool-season grass growth responses to temperature may be examined by comparing growth rates during a growth period to the average temperature during that period. The relationship of growth rate and temperature can be determined using regression analysis. This relationship is depicted in Figure 2. Growth rate approached zero as temperatures dropped below 52 °F and rose until reaching an optimal temperature of about 63 °F. As average temperatures rose above 63 °F, growth rates declined. Using this correlation it is easy to understand the phenomena known as the summer slump, when cool-season grass growth declines even when moisture is not limiting.

Forage quality also varied across the season. Protein concentration of simulated grazed plots varied widely from cutting to cutting. Initially there appeared to be no pattern (Figure 3); however, N fertilization dates must also be considered. Plots were fertilized immediately after each hay cutting, which are depicted in Figure 3 as light squares. Immediately after fertilization, forage protein concentration rose, and then declined steadily until fertilizer was applied again. Multiple N applications will result in more uniform protein levels throughout the season than a single large application in the spring.

Seasonal trends were also seen in TDN levels, and were largely correlated with temperature and not N fertilization (Figure 4). TDN levels declined as temperatures increased in the spring until reaching a low in early August. They returned to the high spring levels as temperatures cooled in the fall.

TDN was highly correlated with temperature. A simple linear relationship adequately described the effect of temperature on TDN. Regression equations were developed for most of the entries in the trial and are depicted in Figure 5. There is little difference in the slope of the lines, which indicates that the entries respond similarly to temperature. There is a large group of entries in the middle with little difference between them and two clearly distinct entries. The entry with high TDN is Barcel and the low TDN entry is Matua. This is similar to the tabular data using season-long averages in Table 2.

Table 1. Total Forage Yield. Effect of clipping management on forage yield of cool-season grasses in 1996. Values represent totals from three and eight harvests for hay and simulated grazing, respectively. Plots were established at Klamath Experiment Station on August 21, 1995.

| Variety | Species[1] | HAY Yield | | | GRAZING Yield | | | Percent of Hay Yield |
|---|---|---|---|---|---|---|---|---|
| | | lb/A | ton/A | rank | lb/A | ton/A | rank | %[2] |
| Gala | BS | 13,930 | 7.0 | 7 | 8,280 | 4.1 | 3 | 59 |
| Matua | BW | 19,450 | 9.7 | 1 | 11,480 | 5.7 | 1 | 59 |
| Kemal | FES | 14,880 | 7.4 | 5 | 6,570 | 3.3 | 8 | 44 |
| BAR 051 | OG | 10,720 | 5.4 | 21 | 6,470 | 3.2 | 13 | 60 |
| BAR 5USF | OG | 10,990 | 5.5 | 16 | 5,370 | 2.7 | 21 | 49 |
| Bronc | OG | 10,950 | 5.5 | 18 | 6,440 | 3.2 | 12 | 59 |
| Cambria | OG | 10,470 | 5.2 | 23 | 4,490 | 2.2 | 23 | 43 |
| Comet | OG | 11,240 | 5.6 | 15 | 6,040 | 3.0 | 18 | 54 |
| Latar | OG | 10,570 | 5.3 | 22 | 6,310 | 3.2 | 11 | 60 |
| Lupre | OG | 11,640 | 5.8 | 13 | 6,580 | 3.3 | 9 | 57 |
| Pizza | OG | 10,880 | 5.4 | 19 | 6,080 | 3.0 | 16 | 56 |
| Potomac | OG | 10,790 | 5.4 | 20 | 6,190 | 3.1 | 14 | 57 |
| Tekapo | OG | 11,290 | 5.6 | 14 | 5,920 | 3.0 | 19 | 52 |
| Mean OG | | 10,954 | 5.5 | | 5,989 | 3.0 | | 55 |
| BG3 | PRG | 11,630 | 5.8 | 12 | 5,040 | 2.5 | 22 | 43 |
| Moy | PRG | 10,960 | 5.5 | 17 | 6,010 | 3.0 | 17 | 55 |
| Zero-nui | PRG | 11,660 | 5.8 | 11 | 6,060 | 3.0 | 15 | 52 |
| Mean PRG | | 11,417 | 5.7 | | 5,703 | 2.8 | | 50 |
| AU Triumph | TF | 15,110 | 7.6 | 4 | 9,080 | 4.5 | 2 | 60 |
| Barcel | TF | 12,370 | 6.2 | 10 | 5,400 | 2.7 | 20 | 44 |
| Desperado | TF | 13,820 | 6.9 | 9 | 6,630 | 3.3 | 10 | 48 |
| Dovey | TF | 13,820 | 6.9 | 8 | 7,620 | 3.8 | 5 | 55 |
| Fawn | TF | 14,190 | 7.1 | 6 | 6,670 | 3.3 | 7 | 47 |
| ISI-8872 | TF | 15,230 | 7.6 | 3 | 8,060 | 4.0 | 4 | 53 |
| ISI-9077 | TF | 15,320 | 7.7 | 2 | 6,880 | 3.4 | 6 | 45 |
| Mean TF | | 14,266 | 7.1 | | 7,191 | 3.6 | | 50 |
| Mean | | 12,520 | 6.3 | | 6,681 | 3 | | 53 |
| LSD (0.05) | | 570 | .3 | | 180 | .1 | | |
| CV (%) | | 14 | 14 | | 38 | 38.0 | | |

[1]BS=*Bromus stamineus*, BW=*Bromus willdenowii*, FES=Festulolium(a meadow fescue x ryegrass hybrid), OG=orchardgrass, PRG=perennial ryegrass, and TF=tall fescue.

[2]Values represent the change in yield due to clipping management. Values represent Hay Yield / Grazed Yield * 100.

Table 2. Average Forage Quality. Effect of clipping management on forage quality of cool-season grasses in 1996. Values represent averages of three and eight harvests for hay and simulated grazing, respectively. Plots were established at Klamath Experiment Station on August 21, 1995.

| | Species[1] | Hay (Protein) | Grazed (Protein) | Hay (TDN) | Grazed (TDN) |
|---|---|---|---|---|---|
| | | % | % | % | % |
| Gala | BS | 16.0 | 22.7 | 53.6 | 60.6 |
| Matua | BW | 14.1 | 21.7 | 54.1 | 61.3 |
| Kemal | FES | 16.1 | 21.6 | 56.6 | 63.5 |
| BAR 051 | OG | 16.2 | 22.2 | 56.7 | 63.2 |
| BAR 5USF | OG | 16.1 | 22.7 | 57.8 | 65.0 |
| Bronc | OG | 16.5 | 22.7 | 58.3 | 64.6 |
| Cambria | OG | 17.4 | 23.0 | 58.5 | 65.5 |
| Comet | OG | 17.2 | 22.8 | 59.2 | 64.9 |
| Latar | OG | 16.5 | 23.0 | 58.2 | 64.3 |
| Lupre | OG | 16.2 | 23.1 | 56.8 | 64.8 |
| Pizza | OG | 16.5 | 23.5 | 58.3 | 64.9 |
| Potomac | OG | 16.5 | 23.0 | 57.2 | 65.2 |
| Tekapo | OG | 16.8 | 22.4 | 56.9 | 63.7 |
| Mean OG | | 16.6 | 22.8 | 57.8 | 64.6 |
| BG3 | PRG | 16.1 | 22.4 | 58.9 | 65.0 |
| Moy | PRG | 15.7 | 20.9 | 56.4 | 62.9 |
| Zero-nui | PRG | 14.9 | 21.4 | 55.5 | 62.7 |
| Mean PRG | | 15.6 | 21.6 | 56.9 | 63.5 |
| AU Triumph | TF | 17.4 | 22.1 | 60.3 | 64.4 |
| Barcel | TF | 17.7 | 22.7 | 60.1 | 66.7 |
| Desperado | TF | 16.3 | 21.8 | 58.1 | 65.1 |
| Dovey | TF | 15.9 | 20.8 | 57.7 | 62.6 |
| Fawn | TF | 16.3 | 21.9 | 58.7 | 64.7 |
| ISI-8872 | TF | 15.9 | 21.4 | 57.4 | 64.7 |
| ISI-9077 | TF | 16.8 | 20.8 | 58.5 | 63.8 |
| Mean TF | | 16.8 | 21.8 | 59.0 | 64.9 |
| Mean | | 16.4 | 22.2 | 57.7 | 64.2 |
| LSD (0.05) | | 0.9 | 0.7 | 1.3 | 0.8 |
| CV (%) | | 6.2 | 5.3 | 2.5 | 2.2 |

[1]BS=*Bromus stamineus*, BW=B. *willdenowii*, FES=Festulium (meadow fescue x annual ryegrass), OG=orchardgrass, PRG=perennial ryegrass, and TF=tall fescue.

Table 3. Nutritional Yield. Effect of clipping management on production of nutrients, protein and TDN, of cool-season grasses in 1996. Values represent production of three and eight harvests for hay and simulated grazing, respectively. Plots were established at Klamath Experiment Station on August 21, 1995.

| Variety | Species | Hay | Grazed | Hay | Grazed |
|---|---|---|---|---|---|
| | | ---------Protein--------- | | -----------TDN----------- | |
| | | lb/A | | | |
| Gala | BS | 2109 | 1735 | 7413 | 5001 |
| Matua | BS | 2631 | 2242 | 10479 | 7163 |
| Kemal | FES | 2282 | 1321 | 8310 | 4223 |
| BAR 051 | OG | 1701 | 1367 | 6051 | 4110 |
| BAR 5USF | OG | 1754 | 1194 | 6354 | 3487 |
| Bronc | OG | 1791 | 1415 | 6378 | 4165 |
| Cambria | OG | 1817 | 1023 | 6132 | 2924 |
| Comet | OG | 1930 | 1325 | 6663 | 3915 |
| Latar | OG | 1731 | 1390 | 6147 | 4082 |
| Lupre | OG | 1868 | 1492 | 6585 | 4256 |
| Pizza | OG | 1785 | 1355 | 6351 | 3944 |
| Potomac | OG | 1763 | 1371 | 6174 | 4033 |
| Tekapo | OG | 1884 | 1298 | 6417 | 3789 |
| Mean OG | | 1802 | 1323 | 6325 | 3871 |
| BG3 | PRG | 1838 | 1094 | 6810 | 3278 |
| Moy | PRG | 1687 | 1203 | 6213 | 3804 |
| Zero-nui | PRG | 1708 | 1243 | 6468 | 3822 |
| Mean PRG | | 1744 | 1180 | 6497 | 3634 |
| AU Triumph | TF | 2640 | 1956 | 9081 | 5867 |
| Barcel | TF | 2179 | 1202 | 7431 | 3587 |
| Desperado | TF | 2232 | 1431 | 8010 | 4322 |
| Dovey | TF | 2198 | 1554 | 7986 | 4797 |
| Fawn | TF | 2277 | 1388 | 8298 | 4326 |
| ISI-8872 | TF | 2395 | 1706 | 8748 | 5170 |
| ISI-9077 | TF | 2512 | 1373 | 8946 | 4386 |
| Mean TF | | 2348 | 1516 | 8357 | 4636 |
| Mean | | 2031 | 1421 | 7280 | 4280 |
| LSD (0.05) | | 329 | 315 | 1026 | 912 |
| CV (%) | | 17.6 | 39.7 | 15.3 | 38.2 |

[1]BS=*Bromus stamineus*, BW=*Bromus willdenowii*, FES=Festulolium (a meadow fescue x annual ryegrass hybrid), OG=orchardgrass, PRG=perennial ryegrass, and TF=tall fescue.

**Figure 1.** Growth Rate of Cool-season Grasses Under a Simulated Grazing Management System. Grown at Klamath Experiment Station, 1996.

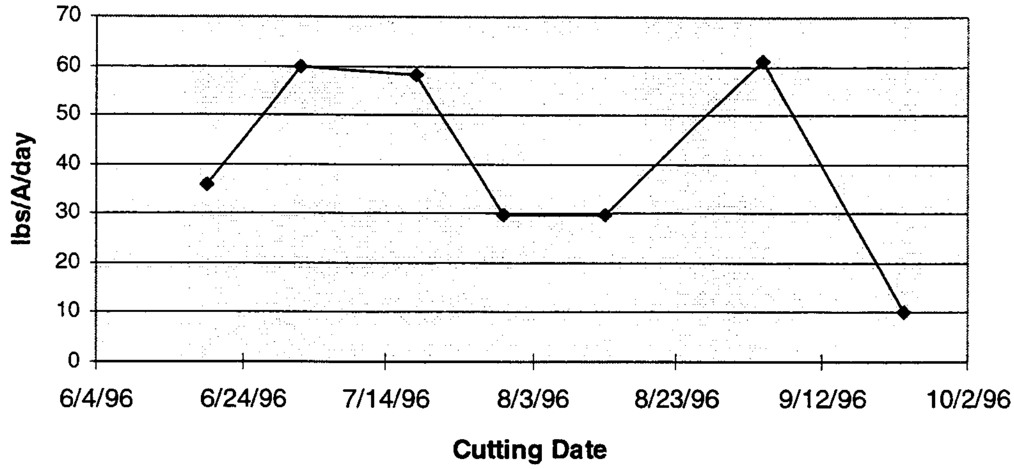



**Figure 2.** Effect of Mean Temperature on Growth Rate of Cool-Season Grasses Under Simulated Grazing. Grown at Klamath Experiment Station, 1996.

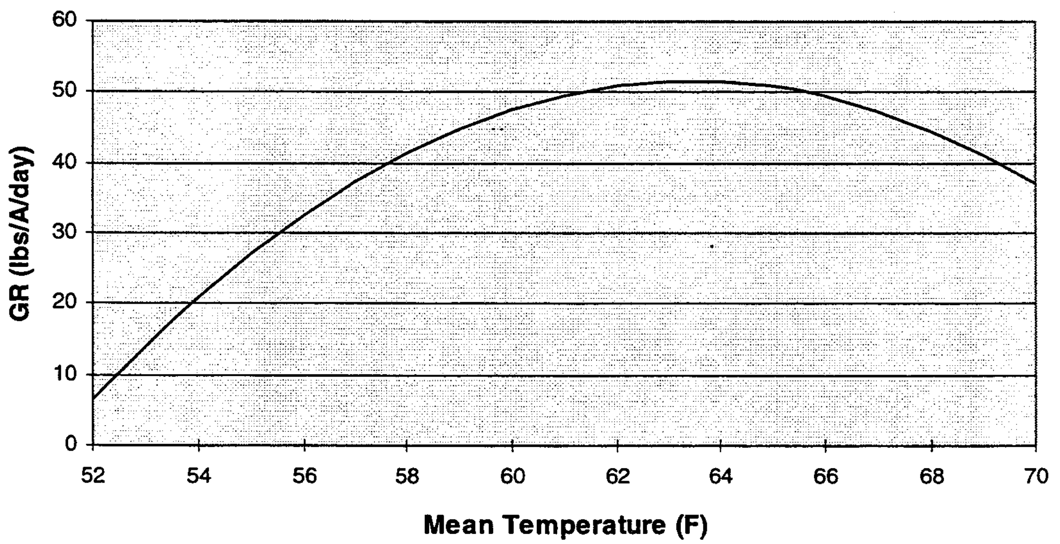


**Figure 3.** Protein of Forage Clipped Under Hay or Simulated Grazing Management Systems. Grown at Klamath Experiment Station.

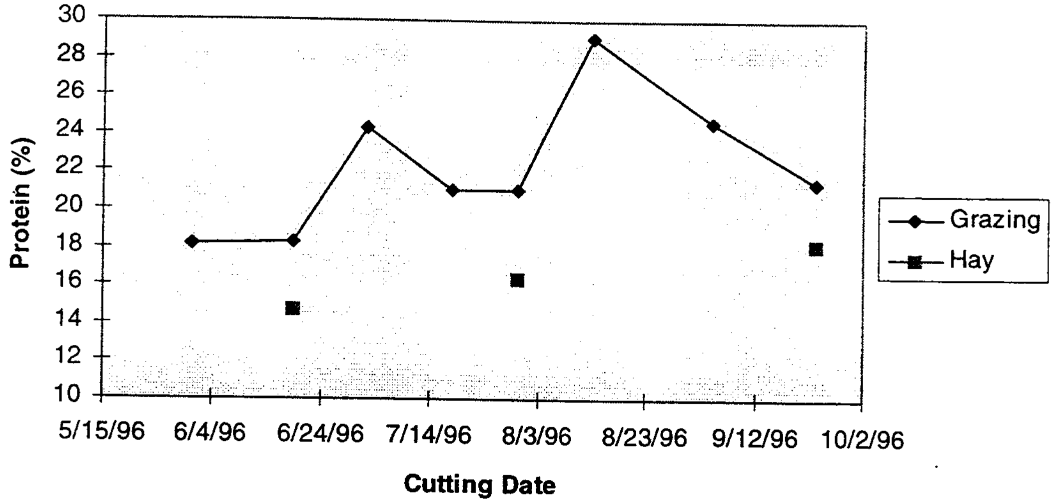



**Figure 4.** TDN of Forage Clipped Under Hay or Simulated Grazing Management Systems. Grown at Klamath Experiment Station.

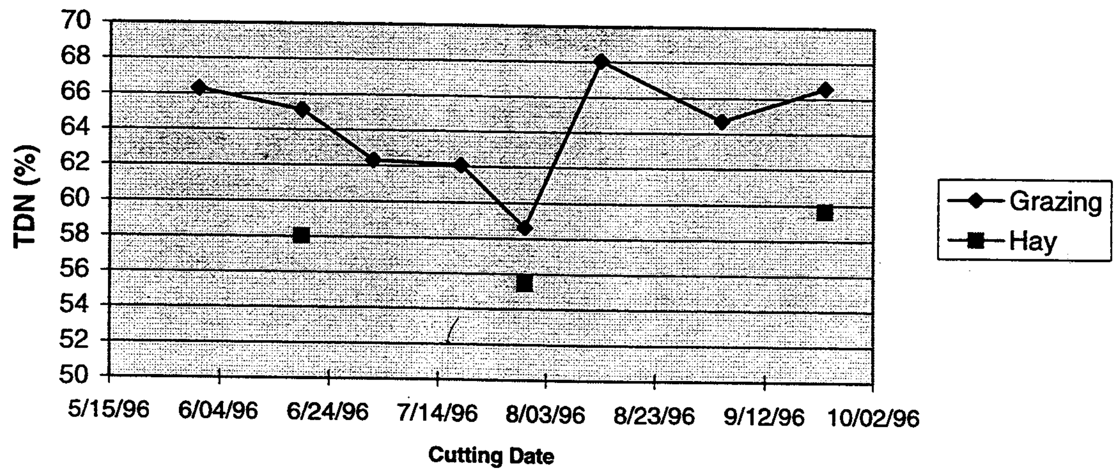
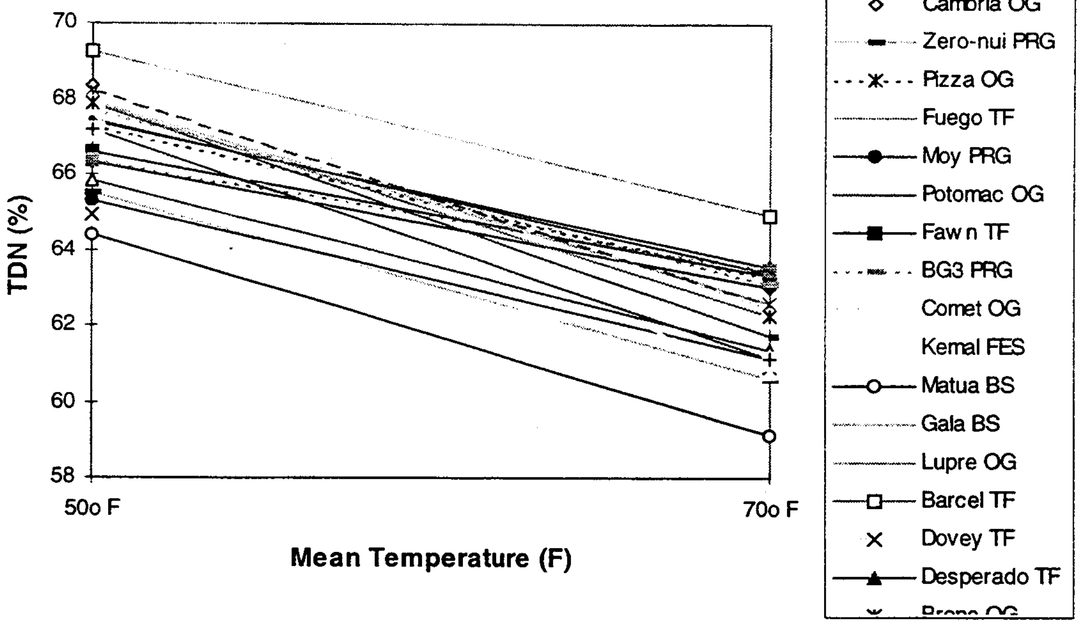


**Figure 5.** Effect of Mean Temperature on TDN of Cool-Season Grasses Under Simulated Management. Grown at Klamath Experiment Station, 1996.



# Cool-Season Grass Agroecozone Trial

R.L. Dovel and J. Rainey[1]

## Introduction

Irrigated pastures occupy over 100,000 acres in Klamath County and provide summer grazing for approximately 100,000 cattle. The currently recommended grass variety for irrigated pastures is Fawn tall fescue, a variety released in 1964. Quackgrass is also an important hay and pasture species in the area. Recently developed cultivars need to be evaluated for adaptation to the Klamath Basin. The acquisition of new germplasm from international forage breeding programs adds further impetus to the development of a forage variety screening program in the Klamath Basin.

Results from a single trial location would be applicable only to that location. By establishing identical trials in different locations and documenting environmental conditions in each location, extrapolation of the data to other areas may be possible. Environmental conditions that should be monitored include soil type and pH, maximum and minimum daily temperature, precipitation, slope and aspect, and irrigation. Such a trial, called an agroecozone trial, was established on sandy loam soil at the KES in August 1994 with a complement of perennial forage grasses representing a range of forage species. A similar trial was established at Powell Butte at the Central Oregon Agricultural Research Center. Only KES data will be presented in this report.

## Procedures

The trial was arranged in a randomized complete block design with four replications. Soil samples were analyzed, and appropriate fertilizer was applied prior to planting. Seed was drilled 1/4-inch deep using a modified Kincaid plot drill. Seeding rates used in the trial are shown inTable 1. Plots were 5 x 20 feet with 3-foot wide alleyways. Plots were irrigated with solid-set sprinklers.

Forages were planted in August 1994 and allowed to grow uncut through the first growing season. Three harvests per year were taken when plants began to flower in 1995 and 1996. Crops were harvested with a flail harvester. All yields are reported on a dry weight basis. Forage quality, as determined by crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients (TDN), and relative feed value (RFV), was evaluated from samples obtained at all harvests using a near-infrared spectrophotometer.

## Results

### 1995

Matua, an introduced *Bromus* species, produced the highest total season forage yield; almost 7.5 tons of dry matter /acre, which was significantly higher than all other entries (Table 2). The second highest yielding entry was Black Mountain. This perennial cereal rye, which produced forage mostly in the first cutting, had forage quality similar to hay produced by other cereal rye varieties. Other more typical grasses that produced high total forage yields include Bromar mountain brome, Fawn and Festorina tall fescue, and Potomac orchardgrass.

Bromar mountain brome is a short lived perennial. It is sod forming and is used extensively in reclamation work.

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[1]/ Associate Professor and Biological Sciences Research Technician III, respectively, Klamath Experiment Station, Klamath Falls, OR.

It would make a significant contribution to forage yields for short term pastures, but would eventually be replaced by stronger perennial grasses.

Festorina is actually a *Festulolium* or tall fescue-perennial ryegrass cross. It is a forage-type variety that has smoother, finer leaves than traditional tall fescues. It is said to have higher forage quality than traditional tall fescues like Fawn. There was no difference in forage yield between Fawn and Festorina in 1995. Although there were no large differences in forage quality between these two varieties, there was a trend for Festorina to have higher forage quality than Fawn. Leaves of Festorina are not as rough as leaves of Fawn and it is reported to be more palatable than Fawn. More study is required to determine if tall fescue-perennial ryegrass crosses are as persistent in the Klamath Basin as tall fescue.

The greatest early season growth was produced by Black Mountain, a perennial cereal rye. This entry produced over 5 tons of dry matter/acre by June 22 (Table 2). The second highest early season yielding entry in the trial was Matua prairie grass. It produced significantly higher levels of forage than all other entries except the two tall fescue entries.

Other entries with over 2 tons of dry matter/acre by June 22, included Fawn tall fescue, Festorina tall fescue, Potomac orchardgrass, Gala grazing brome, Bromar mountain brome, and Linn perennial ryegrass. Wana, a grazing tolerant orchardgrass, did not produce much early spring growth and only yielded 1,180 lb dry matter/acre by June 22. Palaton reed canarygrass also produced low levels of forage in the first cutting compared to its forage production in the second cutting.

Black Mountain had the lowest forage quality, based on all quality parameters measured, of any entry at the first cutting (Table 3). Gala grazing brome also had lower quality than most entries at the first cutting. This variety has been noted to have lower forage quality than Matua and other Brome varieties. Forage quality of Linn perennial ryegrass was also depressed in the first cutting due to advanced maturity.

Although Black Mountain produced more dry matter than any other entry at the first cutting, regrowth following cutting was poor. Black Mountain only produced 970 and 730 lb dry matter/acre in the second and third cuttings, respectively (Table 2). Matua prairie grass produced almost 3 tons of dry matter/acre in the second cutting, significantly higher than all other entries in the trial (Table 2).

Other high yielding varieties in the second cutting included Bromar mountain brome, Potomac and Wana orchardgrass, Palaton reed canarygrass, Festorina and Fawn tall fescue, and Gala grazing brome. Second cutting yields of both Wana orchardgrass and Palaton reed canarygrass were significantly higher than their first cutting yields.

Matua prairie grass produced significantly higher third cutting forage yields than all other entries. Other entries producing above average third cutting forage yields included Fawn and Festorina tall fescue, Wana and Potomac orchardgrass, Bromar mountain brome, and Gala grazing brome.

**<u>1996</u>**

Yield trends were not the same in 1996 as 1995. Palaton, which was ranked in the lower third of the trial in 1995, was the highest yielding entry in 1996 (Table 4). Yields of Matua, which were significantly higher than any other entry in 1995, were not significantly different than yields of Palaton, Potomac, Bromar, Festorina, or Fawn.

Black Mountain did not perenniate well and forage production dropped to half that of 1995. Stand thinning was also observed in Matua and Gala, and may account for the yield declines seen in these two varieties. In contrast, yields of a number of entries increased significantly over 1995 yields (Figure 1). Regar meadow brome, Oahe intermediate wheatgrass, Carlton smooth brome, and Clair Timothy are all species that tend to establish and reach full production potential rather slowly. The increase in forage yield in the second harvest year is due to plants maturing and increasing individual plant size. Palaton reed canary grass is a rhizomatous species that is known for low seedling vigor; however, it can be very aggressive once established. Garrison creeping foxtail is also rhizomatous and has low seedling vigor. It showed increased production in the second harvest year as well.

Yields of Park Kentucky bluegrass were depressed by severe rust infestation in 1995. Rust infestation of bluegrass was light in 1996 and yields of Park more than tripled. Wana orchardgrass failed to survive the winter and much of the yield seen in 1996 is from invading Kentucky bluegrass, which is a common invasive species in irrigated pastures in the Klamath Basin.

Time of production may also be an important consideration in addition to total production. Oahe produced the highest yield at the first cutting but very low yields in the second cutting. Forage yield at the third cutting recovered to levels near those of the first. Other entries with relatively high first cutting, low second cutting, and high third cutting yields include Regar, Carlton, and Bromar. In contrast, Palaton tends to produce similar yields at all three cuttings, as does Matua, the tall fescues, and to a lesser degree, the orchardgrasses.

Protein concentration was generally higher in 1996 than in 1995. Some entries had larger increases in protein than others, but protein concentration exceeded 11 percent for all varieties except Black Mountain, which was 9.7 percent at the first cutting (Table 5). TDN was relatively unchanged from one year to the next. TDN levels of Clair increased slightly form 1995 to 1996 and were significantly higher than other entries in the trial. TDN levels of all entries except Black Mountain exceeded 50 percent. Forage quality of Festorina was always slightly higher than Fawn, but differences were never statically significant.

## Discussion and Conclusions

The species currently recommended for seeding long-term irrigated pastures in the Klamath Basin is tall fescue. Data from this trial tends to support that recommendation. The tall fescue entries were in the highest yielding group in 1996 and were only exceeded by Matua in 1995. They produced high forage yields throughout the growing season and did not exhibit severe heat induced yield depression. Tall fescue is a long-lived species that resists a number of environmental stresses common to the Klamath Basin. The forage quality of the tall fescue varieties in this trial was not significantly different from other species reported to be of higher forage quality, including orchardgrass and several brome species. Orchardgrass appears to be another good choice for a long-term pasture, if appropriate grazing management is practiced.

Matua and Bromar appear to have great potential for shorter rotation hay fields and pastures. Despite the excellent hay yields and quality of Matua, it is not recommended for long-term pastures due to stand thinning. This variety has experienced severe stand losses in the winter, probably due to fungal attack. It also will not withstand continuous grazing or prolonged flooding. Due to high production and high protein content, nitrogen fertilization requirements are higher for Matua than other grass species. Planting this variety for hay production on well drained soil should result in a highly productive stand that will last for three to five years. Commercial stands of Matua have persisted in the Klamath Basin with moderate levels of N fertilization for four to five years. Bromar is a short-lived species that is more winter hardy than Matua. Long-term data on this species in the Klamath Basin is not available.

Several drought tolerant species included in this trial yielded well. Regar meadow brome, Oahe intermediate wheatgrass and Carlton smooth brome produced about 75 percent as much dry matter as Fawn and had better forage quality. The largest yield was in the first cutting. In pastures and hay meadows that have a seasonal or unreliable irrigation supply, the use of these varieties could provide an acceptable forage yield and survive drought stress in years when they were not irrigated. Fall regrowth of both Oahe and Regar stockpiles well and can be a valuable source of fall grazing following a spring cutting of hay.

Frequently inundated or wet sites may need species that are more tolerant to flooding than tall fescue. Appropriate species for such environments include reed canarygrass and meadow foxtail. Palaton and Garrison are examples of each of these species. The impressive yields produced by Palaton in the second year of the trial on well drained soil indicate that planting of this species need not be restricted to very wet sites. However, high seed costs and low seedling vigor will probably restrict the use of this species to areas where flooding tolerance is needed. Palaton has been selected for low alkaloid content to improve palatability and animal performance. Only low alkaloid varieties of reed canarygrass should be planted for hay or pasture.

These findings are preliminary. The trial will be continued for at least another year and changes in stand survival and production may occur.

Table 1. Seeding rates for species included in the forage agroecozone trial at Klamath Falls, OR., August 1994.

| Species | Common name | Seeding Rate | | |
|---|---|---|---|---|
| | | lb/A | Kg/ha | g/m |
| *Bromus willdenowii* | prairie grass | 35 | 39.2 | 392 |
| *B. inermus* | smooth brome | 25 | 28.0 | 280 |
| *B. stamineus* | grazing brome | 25 | 28.0 | 280 |
| *B. riparius* | meadow brome | 35 | 39.2 | 392 |
| *B. marginatus* | mountain brome | 35 | 39.2 | 392 |
| *Dactylis glomerata* | orchardgrass | 20 | 22.4 | 224 |
| *Festuca arundinacea* | tall fescue | 25 | 28.0 | 280 |
| *Lolium perenne* | perennial ryegrass | 30 | 33.6 | 336 |
| *Poa pratensis* | Kentucky bluegrass | 10 | 11.2 | 112 |
| *Alopecuras arundinacea* | meadow foxtail | 5 | 5.6 | 56 |
| *Thinopyrum intermedium* | intermediate wheatgrass | 10 | 11.2 | 112 |
| *Elymus lanceolatus* | thick spike wheatgrass | 10 | 11.2 | 112 |
| *Secale cereale* | perennial cereal rye | 60 | 67.8 | 678 |
| *Phalaris arundinacea* | reed canarygrass | 15 | 16.8 | 168 |
| *Phleum pratense* | timothy | 10 | 11.2 | 112 |

Table 2. Agroecozone 1995 Yield Summary. 1995 forage, protein, and TDN yield summary of cool-season grasses planted at Klamath Experiment Station in August 1994.

| Variety | Species[1] | Forage Yield Cut 1 | Forage Yield Cut 2 | Forage Yield Cut 3 | Forage Yield Total | Protein yield | TDN yield |
|---|---|---|---|---|---|---|---|
| | | lb/A | | | | | |
| Park | BLG | 740 | 830 | 140 | 1710 | 270 | 1010 |
| Regar | BMD | 3710 | 2440 | 330 | 6490 | 880 | 3670 |
| Bromar | BMT | 4870 | 4840 | 1290 | 10990 | 1330 | 6260 |
| Carlton | BSM | 3330 | 2450 | 210 | 5980 | 830 | 3490 |
| Gala | BST | 4480 | 3550 | 1210 | 9240 | 1170 | 4880 |
| Matua | BW | 6820 | 5940 | 2180 | 14940 | 1590 | 8250 |
| Garrison | CFT | 2050 | 1960 | 230 | 4250 | 660 | 2540 |
| Oahe | IWG | 3270 | 1980 | 840 | 6090 | 840 | 3590 |
| Potomac | OG | 4780 | 4070 | 1200 | 10050 | 1270 | 5830 |
| Wana | OG | 1180 | 3760 | 1350 | 6280 | 880 | 3510 |
| Black Mnt | PCR | 10410 | 970 | 730 | 12110 | 1290 | 6540 |
| Linn | PRG | 4990 | 2260 | 450 | 7700 | 800 | 4330 |
| Madera | PRG | 3920 | 2960 | 350 | 7220 | 870 | 4300 |
| Palaton | RCG | 1730 | 3810 | 410 | 5940 | 880 | 3450 |
| Fawn | TF | 5510 | 3690 | 1480 | 10680 | 1370 | 6210 |
| Festorina | TF | 5390 | 3910 | 1320 | 10630 | 1410 | 6110 |
| Clair | TIM | 3360 | 2960 | 300 | 5760 | 740 | 3810 |
| Critana | TSWG | 1760 | 1870 | 390 | 4030 | 540 | 2260 |
| Mean | | 4020 | 3010 | 800 | 7780 | 430 | 2270 |
| LSD (0.05) | | 1550 | 1150 | 400 | 2060 | 200 | 870 |
| CV (%) | | 27 | 27 | 35 | 19 | 33 | 27 |

[1]BLG Kentucky bluegrass
BMD meadow brome
BMT mountain brome
BSM smooth brome
BST *Bromus stamineus*
BW *Bromus willdenowii*
CFT creeping foxtail
IWG intermediate wheatgrass
OG orchardgrass
PCR perennial cereal rye
PRG perennial ryegrass
RCG reed canarygrass
TF tall fescue
TIM timothy
TSWG thickspike wheatgrass

Table 2. Agroecozone 1995 Yield Summary. 1995 forage, protein, and TDN yield summary of cool-season grasses planted at Klamath Experiment Station in August 1994.

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| | | lb/A | | | | | |
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| Regar | BMD | 3710 | 2440 | 330 | 6490 | 880 | 3670 |
| Bromar | BMT | 4870 | 4840 | 1290 | 10990 | 1330 | 6260 |
| Carlton | BSM | 3330 | 2450 | 210 | 5980 | 830 | 3490 |
| Gala | BST | 4480 | 3550 | 1210 | 9240 | 1170 | 4880 |
| Matua | BW | 6820 | 5940 | 2180 | 14940 | 1590 | 8250 |
| Garrison | CFT | 2050 | 1960 | 230 | 4250 | 660 | 2540 |
| Oahe | IWG | 3270 | 1980 | 840 | 6090 | 840 | 3590 |
| Potomac | OG | 4780 | 4070 | 1200 | 10050 | 1270 | 5830 |
| Wana | OG | 1180 | 3760 | 1350 | 6280 | 880 | 3510 |
| Black Mnt | PCR | 10410 | 970 | 730 | 12110 | 1290 | 6540 |
| Linn | PRG | 4990 | 2260 | 450 | 7700 | 800 | 4330 |
| Madera | PRG | 3920 | 2960 | 350 | 7220 | 870 | 4300 |
| Palaton | RCG | 1730 | 3810 | 410 | 5940 | 880 | 3450 |
| Fawn | TF | 5510 | 3690 | 1480 | 10680 | 1370 | 6210 |
| Festorina | TF | 5390 | 3910 | 1320 | 10630 | 1410 | 6110 |
| Clair | TIM | 3360 | 2960 | 300 | 5760 | 740 | 3810 |
| Critana | TSWG | 1760 | 1870 | 390 | 4030 | 540 | 2260 |
| Mean | | 4020 | 3010 | 800 | 7780 | 430 | 2270 |
| LSD (0.05) | | 1550 | 1150 | 400 | 2060 | 200 | 870 |
| CV (%) | | 27 | 27 | 35 | 19 | 33 | 27 |

[1]BLG Kentucky bluegrass
BMD meadow brome
BMT mountain brome
BSM smooth brome
BST *Bromus stamineus*
BW *Bromus willdenowii*
CFT creeping foxtail
IWG intermediate wheatgrass
OG orchardgrass
PCR perennial cereal rye
PRG perennial ryegrass
RCG reed canarygrass
TF tall fescue
TIM timothy
TSWG thickspike wheatgrass

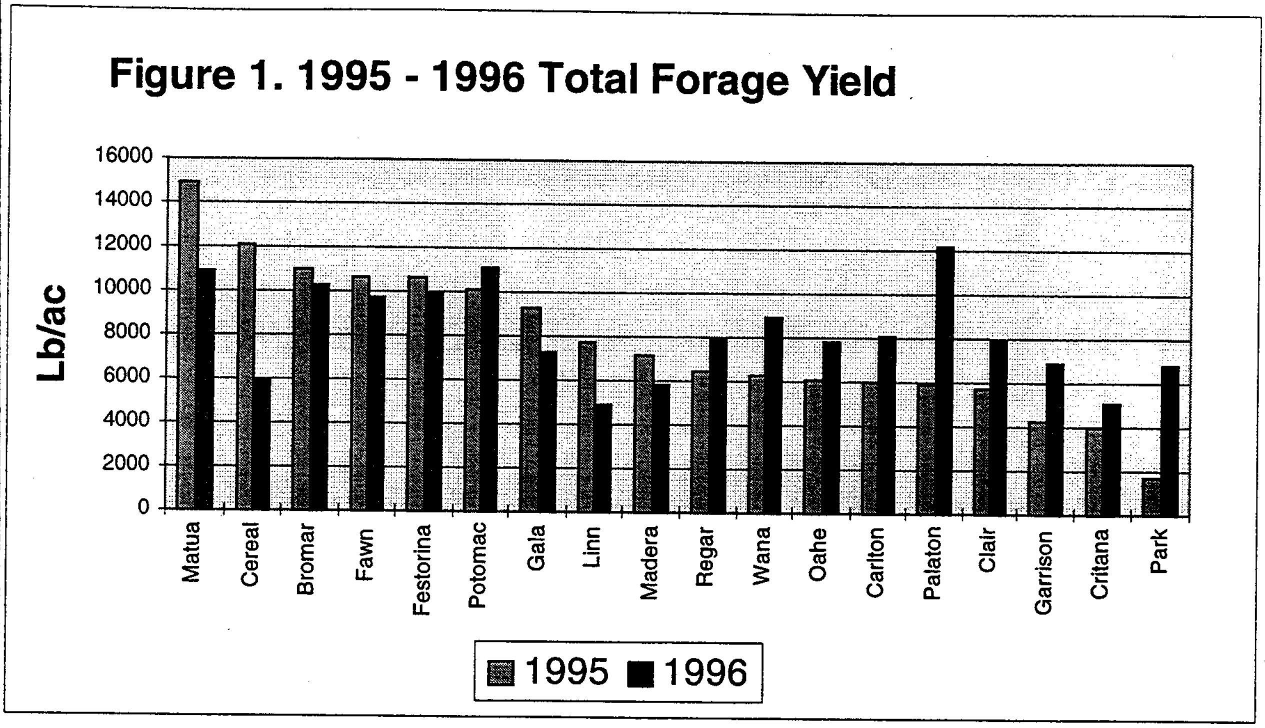
Figure 1. 1995 - 1996 Total Forage Yield
Lb/ac
16000
14000
12000
10000
8000
6000
4000
2000
0
Matua
Cereal
Bromar
Fawn
Festorina
Potomac
Gala
Linn
Madera
Regar
Wana
Oahe
Carlton
Palaton
Clair
Garrison
Critana
Park
1995
1996

Table 4. Agroecozone 1996 Yield Summary. 1996 forage, protein, and TDN yield summary of cool-season grasses planted at Klamath Experiment Station in August 1994.

| Variety | Species[1] | Forage Yield Cut 1 | Forage Yield Cut 2 | Forage Yield Cut 3 | Forage Yield Total | Protein yield | TDN yield |
|---|---|---|---|---|---|---|---|
| | | lb/A | | | | | |
| Park | BLG | 2550 | 1250 | 2990 | 6790 | 1150 | 4480 |
| Regar | BMD | 4230 | 1770 | 1910 | 7910 | 1040 | 4090 |
| Bromar | BMT | 4450 | 2400 | 3450 | 10300 | 1360 | 5400 |
| Carlton | BSM | 4780 | 1460 | 1870 | 8110 | 1170 | 4390 |
| Gala | BST | 2040 | 1520 | 3730 | 7290 | 1220 | 4120 |
| Matua | BSW | 3680 | 3140 | 4090 | 10910 | 1490 | 6260 |
| Garrison | CFT | 2750 | 1640 | 2480 | 6870 | 1170 | 4710 |
| Oahe | IWG | 4980 | 980 | 1860 | 7820 | 920 | 3830 |
| Potomac | OG | 3470 | 2820 | 4790 | 11080 | 1670 | 6270 |
| Wana | OG | 2020 | 2940 | 3920 | 8880 | 1520 | 5450 |
| Black Mnt | PCR | 4580 | 1340 | 0 | 5920 | 500 | 2250 |
| Linn | PRG | 2000 | 970 | 1980 | 4950 | 950 | 3730 |
| Madera | PRG | 1880 | 1150 | 2820 | 5850 | 1130 | 4420 |
| Palaton | RCG | 4530 | 3830 | 3830 | 12190 | 1820 | 6880 |
| Fawn | TF | 3780 | 2630 | 3300 | 9710 | 1280 | 5190 |
| Festorina | TF | 3840 | 2680 | 3380 | 9900 | 1310 | 5190 |
| Clair | TIM | 2820 | 2750 | 2300 | 7870 | 1280 | 5590 |
| Critana | TSWG | 2240 | 1350 | 1520 | 5110 | 890 | 3480 |
| Mean | | 3370 | 2030 | 2790 | 8190 | 1220 | 4760 |
| LSD (0.05) | | 690 | 600 | 1060 | 1420 | 310 | 1170 |
| CV (%) | | 14 | 21 | 27 | 12 | 18 | 17 |

[1]BLG Kentucky bluegrass
BMD meadow brome
BMT mountain brome
BSM smooth brome
BST *Bromus stamineus*
BW *Bromus willdenowii*
CFT creeping foxtail
IWG intermediate wheatgrass
OG orchardgrass
PCR perennial cereal rye
PRG perennial ryegrass
RCG reed canarygrass
TF tall fescue
TIM timothy
TSWG thickspike wheatgrass

Table 5. Agroecozone 1996 Quality Summary. 1996 protein and TDN summary of cool-season grasses planted at Klamath Experiment Station in August 1994.

| Variety | Species[1] | Cut 1 Protein | Cut 1 TDN | Cut 2 Protein | Cut 2 TDN | Cut 3 Protein | Cut 3 TDN |
|---|---|---|---|---|---|---|---|
| | | % | | | | | |
| Park | BLG | 12.3 | 58.0 | 16.8 | 58.8 | 18.5 | 65.4 |
| Regar | BMD | 12.3 | 56.8 | 14.5 | 53.3 | 18.6 | 62.1 |
| Bromar | BMT | 11.7 | 56.6 | 14.2 | 53.9 | 17.1 | 59.8 |
| Carlton | BSM | 13.4 | 58.3 | 16.8 | 56.6 | 20.2 | 65.9 |
| Gala | BST | 14.1 | 54.4 | 15.7 | 52.0 | 17.3 | 54.9 |
| Matua | BW | 11.2 | 55.2 | 12.5 | 51.3 | 16.4 | 61.4 |
| Garrison | CFT | 12.7 | 57.2 | 15.4 | 54.5 | 16.4 | 59.0 |
| Oahe | IWG | 11.4 | 55.6 | 16.8 | 57.4 | 18.2 | 65.3 |
| Potomac | OG | 13.2 | 58.4 | 14.4 | 55.4 | 17.8 | 61.9 |
| Wana | OG | 16.7 | 59.0 | 14.4 | 54.4 | 16.5 | 57.4 |
| Black Mnt | PCR | 9.7 | 49.9 | 16.4 | 59.5 | --- | --- |
| Linn | PRG | 13.8 | 56.5 | 15.7 | 55.9 | 16.4 | 62.1 |
| Madera | PRG | 13.9 | 58.7 | 15.3 | 55.4 | 16.7 | 61.9 |
| Palaton | RCG | 14.4 | 57.5 | 14.2 | 53.7 | 17.7 | 63.5 |
| Fawn | TF | 11.8 | 56.8 | 15.0 | 55.0 | 16.4 | 63.6 |
| Festorina | TF | 13.0 | 58.2 | 15.8 | 56.6 | 16.3 | 63.3 |
| Clair | TIM | 12.7 | 61.9 | 13.9 | 58.0 | 16.7 | 65.7 |
| Critana | TSWG | 13.3 | 57.0 | 14.4 | 54.4 | 18.7 | 63.2 |
| Mean | | 12.9 | 57.0 | 15.1 | 55.3 | 17.4 | 62.1 |
| LSD (0.05) | | 1.1 | 1.7 | 1.1 | 1.8 | 1.0 | 1.8 |
| CV (%) | | 6 | 2 | 5 | 2 | 1 | 2 |

[1]BLG Kentucky bluegrass
BMD meadow brome
BMT mountain brome
BSM smooth brome
BST *Bromus stamineus*
BW *Bromus willdenowii*
CFT creeping foxtail
IWG intermediate wheatgrass
OG orchardgrass
PCR perennial cereal rye
PRG perennial ryegrass
RCG reed canarygrass
TF tall fescue
TIM timothy
TSWG thickspike wheatgrass

# Oat Hay Variety Trial

R.L. Dovel, J. Rainey, and G. Chilcote[1]

## Introduction

Oat hay is an important commodity in the Klamath Basin. An increasing acreage of oat hay is being produced in the basin. Oat hay variety trials were conducted at KES in 1989 and 1990. Since that time, several new oat varieties have been released for grain production and some oat varieties have been released specifically for hay production. Oat hay variety trials were established at KES in 1994, 1995, and 1996 to provide growers with information needed to make variety selection decisions. Both forage yield and quality of commercially available oat varieties were examined.

## Procedure

The trials were established at KES on Fordney fine sandy loam that is moderately deep and somewhat poorly drained. The previous crop was potatoes. The crop was irrigated by a solid-set sprinkler system. The trials were arranged in a randomized complete block design with four replications. Seed was planted April 20, 1994, May 23, 1995, and May 10, 1996. Seed was planted to a depth of 1 inch at a seeding rate of 100 lb/acre. All plots were fertilized with 50 lb N, 62 lb $P_2O_5$, and 37 lb S/acre at time of seeding. Plots measured 5 x 20 feet with a row spacing of 6 inches. Bromoxynil and MCPA were applied at labeled rates to control broadleaf weeds.

Plots were harvested when Magnum oat plants reached the soft dough stage in 1994. In 1995, there were two harvest dates. Plots that were in the soft dough stage were harvested on August 10. All remaining plots were harvested on August 23. Only one harvest was taken in 1996, on August 1. Prior to harvest, plots were trimmed to 17 feet long. The crop was harvested using a flail harvester with a three-foot wide head. All yields were reported on a dry weight basis. Subsamples were collected and analyzed for forage quality measured as acid detergent fiber (ADF), neutral detergent fiber (NDF), crude protein (CP), and relative feed value (RFV), using a near-infrared reflectance spectrophotometer.

## Results

Trial variability was high in 1994, making variety separation difficult. The highest yielding variety, Magnum, was not significantly different from eight other varieties (Table 1). The only two entries with significantly lower yield than Magnum in 1994 were Magnum II and Dusty. These two varieties are early maturing while Magnum is a late maturing variety. Harvesting all entries when Magnum was at soft dough resulted in the early varieties reaching stages too advanced for optimal production. This is reflected in the lower CP and higher fiber content of the earlier maturing varieties.

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1/ Associate Professor, Biological Sciences Research Technician III, and Research Technician, respectively, Klamath Experiment Station, Klamath Falls, OR.

In 1995, Westford hooded barley and Byrd were the two highest yielding entries in the trial (Table 2). They produced significantly higher forage yields than the five lowest yielding entries. The trial was harvested when most varieties were in the soft dough stage in 1995. Dusky, the earliest maturing oat variety in the trial, was harvested on August 10 with the hooded barley entries (Table 2). All other oat varieties were harvested on August 23 when the majority of oat entries were at soft dough. Magnum, a late maturing variety, was not yet at the soft dough stage and yields were suppressed when compared to the previous year. When Dusky was harvested at an appropriate stage in 1995, it yielded much better than in 1994 and also produced better forage quality values. It appears that Dusky would be a good oat variety for short-season oat hay production. The hooded barley entries would also be excellent choices for short-season cereal hay production.

Forage yields were even lower in 1996 than in 1995, due to frost damage and uneven irrigation distribution (Table 3). Ensiler, a newly released forage variety, was the highest producer in 1996. Entries that were not significantly different from Ensiler include Byrd, 83Ab3250, Magnum 2000, and Border. Cayuse was the lowest producing entry in the trial in 1996.

Forage quality was highest in 1995. This is due largely to harvesting at a more appropriate time in 1995, while harvest was delayed past the appropriate time for many varieties in 1994 and 1996. Average crude protein concentration in the 1995 trial was 10.0 percent compared to 7.3 and 8.9 percent in 1994 and 1996, respectively. ADF, which is a predictor of forage digestibility, and thus animal performance, averaged 35.0 in 1995 compared to 41.3 and 38.5 in 1994 and 1995, indicating that feeding oat hay produced in the 1995 trial would result in the best animal performance (lower ADF values indicate higher quality).

Minimum nutritional requirements for a dry pregnant cow in the middle third of pregnancy are 7.0 percent crude protein and 48.6 percent TDN, which corresponds to 55 percent ADF. Oat hay produced in all three years was adequate to meet the energy needs of a dry cow, but hay from 1994 was only marginally adequate in crude protein. Crude protein concentration of some varieties dropped below minimum levels in 1994. The variability in forage quality between varieties and between years illustrates the need for forage testing when purchasing hay, even oat hay to feed dry cows.

Table 1. 1994 Oat Hay Variety Trial. Forage yield, dry matter, and forage quality of oat varieties grown at Klamath Experiment Station, Klamath Falls, OR, 1994.

| Variety or Selection | -----Yield------ | | Dry matter | Protein | ADF | NDF | RFV |
|---|---|---|---|---|---|---|---|
| | ton/A | rank | % | % | % | % | |
| Cayuse | 6.8 | 2 | 31 | 7.3 | 40.2 | 58.3 | 92 |
| Border | 6.3 | 4 | 29 | 8.6 | 38.8 | 55.6 | 99 |
| Ajay | 5.9 | 7 | 29 | 7.5 | 39.0 | 57.9 | 95 |
| Magnum ll | 5.7 | 10 | 33 | 6.9 | 42.3 | 61.4 | 85 |
| 83Ab3250 | 5.8 | 9 | 25 | 7.2 | 41.0 | 59.2 | 90 |
| Rio Grande | 5.8 | 8 | 31 | 6.6 | 42.5 | 61.6 | 84 |
| Monida | 6.1 | 5 | 26 | 7.8 | 41.0 | 59.5 | 91 |
| Magnum | 7.3 | 1 | 29 | 8.8 | 38.5 | 57.0 | 97 |
| Byrd (B-3) | 5.0 | 12 | 27 | 7.2 | 43.7 | 63.9 | 80 |
| Dusky (DU-1) | 5.5 | 11 | 33 | 6.7 | 44.2 | 64.6 | 79 |
| Magnum ll | 6.0 | 6 | 25 | 6.4 | 44.4 | 63.3 | 80 |
| Otana | 6.8 | 3 | 29 | 7.2 | 39.4 | 57.3 | 95 |
| Mean | 6.1 | | 29 | 7.3 | 41.3 | 60.0 | 89 |
| CV (%) | 18.7 | | 16.2 | 19.7 | 8.8 | 7.8 | 13 |
| LSD (0.05) | 1.5 | | 6.8 | 2.1 | 5.2 | 6.6 | 17 |

Table 2. 1995 Oat Hay Variety Trial. Forage yield, dry matter, and forage quality of oat varieties grown at Klamath Experiment Station, Klamath Falls, OR, 1995.

| Variety or Selection | ------Yield------ | | Dry matter | Protein | ADF | NDF | RFV |
|---|---|---|---|---|---|---|---|
| | ton/A | rank | % | % | % | % | |
| Cayuse | 4.5 | 9 | 37 | 9.3 | 35.6 | 52.1 | 109 |
| Border | 3.9 | 15 | 40 | 9.5 | 35.5 | 52.9 | 108 |
| Ajay | 4.4 | 11 | 34 | 10.6 | 34.0 | 50.7 | 115 |
| Magnum 2000 (Magnum II) | 4.0 | 14 | 33 | 9.6 | 37.6 | 55.8 | 100 |
| 83Ab3250 | 4.6 | 5 | 34 | 10.3 | 33.3 | 50.4 | 116 |
| Rio Grande (81Ab5792) | 4.6 | 6 | 33 | 10.1 | 34.8 | 49.8 | 116 |
| Monida | 4.5 | 10 | 34 | 9.8 | 34.5 | 51.9 | 111 |
| Magnum | 4.5 | 7 | 35 | 9.5 | 36.0 | 53.3 | 107 |
| Byrd (B-3) | 5.0 | 1 | 38 | 9.2 | 35.5 | 51.6 | 111 |
| Dusky (DU-1) | 4.7 | 3 | 30 | 10.6 | 34.8 | 52.9 | 109 |
| Otana | 4.5 | 8 | 38 | 9.1 | 36.1 | 53.7 | 106 |
| Park | 4.3 | 13 | 34 | 10.3 | 36.2 | 53.7 | 105 |
| Ogle | 4.3 | 12 | 33 | 9.8 | 37.4 | 53.4 | 104 |
| Westford (Barley) | 5.0 | 2 | 34 | 10.7 | 34.1 | 51.9 | 112 |
| Belford (Barley) | 3.5 | 16 | 36 | 10.0 | 31.2 | 50.0 | 121 |
| WA 7999-88 (Barley) | 4.6 | 4 | 28 | 11.3 | 34.0 | 53.0 | 110 |
| Mean | 4.4 | | 34 | 10.0 | 35.0 | 52.3 | 110 |
| CV (%) | 13.3 | | 9 | 10.2 | 6.2 | 5.2 | 7.6 |
| LSD (0.05) | NS | | 8 | 1.5 | 3.1 | NS | NS |

Table 3. 1996 Oat Hay Variety Trial. Forage yield, dry matter, and forage quality of oat varieties grown at Klamath Experiment Station, Klamath Falls, OR, 1996.

| Variety or Selection | -------Yield------- | | Dry matter | Protein | ADF | NDF | RFV |
|---|---|---|---|---|---|---|---|
| | ton/A | rank | % | % | % | % | |
| Cayuse | 2.5 | 14 | 47 | 7.6 | 41.9 | 62.5 | 84 |
| Border | 3.7 | 5 | 38 | 9.7 | 36.9 | 55.7 | 101 |
| Ajay | 3.0 | 12 | 55 | 8.7 | 39.5 | 59.5 | 91 |
| Magnum 2000 (Magnum II) | 3.9 | 4 | 37 | 9.6 | 37.9 | 58.3 | 95 |
| 83Ab3250 | 4.2 | 3 | 32 | 9.7 | 36.0 | 54.6 | 104 |
| Rio Grande (81Ab5792) | 3.1 | 10 | 36 | 8.4 | 39.1 | 59.1 | 92 |
| Monida | 3.4 | 8 | 32 | 10.1 | 35.8 | 54.8 | 104 |
| Magnum | 3.3 | 9 | 44 | 9.2 | 37.9 | 58.2 | 95 |
| Byrd (B-3) | 4.2 | 2 | 51 | 8.6 | 40.3 | 60.3 | 89 |
| Dusky (DU-1) | 3.5 | 7 | 46 | 8.1 | 41.4 | 63.4 | 84 |
| Stampede | 3.6 | 6 | 43 | 9.8 | 38.4 | 59.0 | 93 |
| Bay | 3.1 | 11 | 43 | 8.0 | 38.8 | 57.9 | 95 |
| Ensiler | 4.8 | 1 | 37 | 8.2 | 38.6 | 57.6 | 95 |
| Westford (Barley) | 2.9 | 13 | 45 | 9.2 | 36.5 | 56.2 | 100 |
| Mean | 3.5 | | 42 | 8.9 | 38.5 | 58.4 | 95 |
| CV (%) | 22.6 | | 22 | 13.9 | 4.7 | 5.1 | 7.2 |
| LSD (0.05) | 1.1 | | 13 | NS | 2.6 | 4.2 | 10 |

# Bluegrass Seed Production in the Klamath Basin

R.L. Dovel and J. Rainey[1]

## Introduction

Over 540 million pounds of grass seed are produced in Oregon each year, with a value in excess of 192 million dollars. Curtailment of field burning has significantly impacted this important industry. Alternative production sites are actively being sought by seed companies for species that are very dependent upon burning for disease prevention, such as bluegrass. Central Oregon is already a significant producer of bluegrass seed. The Klamath Basin is very similar to central Oregon climatically, and could also be a potential production site for bluegrass seed.

There is a historical precedent for the production of bluegrass in the region. Bluegrass seed was first produced in the Klamath Basin in 1926 by Ed Geary. Reports indicate that seed size and plumpness were excellent and seed yields reached as high as 1,000 lb/acre. Seed production at the Geary ranch led to the development of a variety marketed as Geary Kentucky Bluegrass. No recent data has been collected documenting seed production of modern bluegrass varieties in the Klamath Basin.

## Procedures

An eight entry bluegrass variety trial was established on August 16, 1993 at the Klamath Experiment Station (KES). Plots were seeded at an approximate rate of 4.5 lb seed/acre. Plots measured 5x20 feet with a one-foot border. Row spacing was one foot with 5 rows per plot. Seed was planted with a Planet Junior planter at a depth of 1/4 inch or less. Plots were fertilized with a broadcast application at a rate of 150 lb/acre 16-16-16 following planting. Post-emergence broadleaf weed control was accomplished by application of bromoxynil at a rate of 0.38 lb ai/acre. There was inadequate vernalization for good seed production in 1994 due to late planting. Seed production in 1995 was not adequate for harvest due to insufficient N fertilization in the fall of 1994.

In preparing for the 1996 seed production year, 16-16-16 fertilizer was applied at a rate of 312 lb/acre (50 lb N/acre) on September 13, 1995. Additional nitrogen was applied at 75 lb N/acre on March 12, 1996, and 50 lb N/acre on May 17. Bromoxynil was applied at 0.38 lb ai/acre on May 15. Plots were irrigated weekly with solid-set sprinklers until three weeks prior to harvest.

## Results

The highest yielding entry was Abbey. It produced over 1,000 lb/acre, twice that of most other entries in the trial. Ba 76-204 and Nottingham also produced significantly higher yields than other entries in the trial, producing 675 and 580 lb/acre, respectively. The

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1/ Associate Professor and Biological Sciences Research Technician III, respectively, Klamath Experiment Station, Klamath Falls, OR.

average trial yield was 480 lb/acre. This is lower than experienced in central Oregon, where the average expected yield is about 1,000 lb/acre. Yields in the Klamath Basin would be expected to increase as additional expertise is gained and management is refined. Break-even production levels in central Oregon, assuming a $1.00/lb price for seed paid to the farmer, is 570 lb/acre. Costs of production should be similar in central Oregon and Klamath County. It appears that bluegrass seed production is a viable alternative for farmers in the Klamath Basin. Further research is warranted.

Table 1. Summary of Bluegrass Seed Production. Seed yield, seed weight, heading rating, plant height, and panicle weight for 1996, and heading and maturity ratings for 1995 for Bluegrass grown at Klamath Falls, OR.

| | Variety/Selection | 1996 | | | | | 1995 | |
|---|---|---|---|---|---|---|---|---|
| | | Seed yield | Ten head weight | Heading[1] | Plant height | Panicle weight | Heading[1] | Maturity[2] |
| | | lb/A | gm | | cm | gm | | |
| 1 | Abbey | 1019 | 1.3 | 8.3 | 51 | 6.6 | 4.0 | 3.8 |
| 2 | Buckingham | 233 | 1.4 | 4.8 | 44 | 8.0 | 3.5 | 4.5 |
| 3 | Ba 91-025 | 220 | 0.7 | 3.3 | 61 | 7.1 | 4.3 | 8.5 |
| 4 | Nottingham | 580 | 1.0 | 7.8 | 47 | 7.1 | 2.5 | 2.8 |
| 5 | Coventry | 339 | 0.9 | 5.0 | 54 | 6.8 | 4.8 | 7.0 |
| 6 | Ascot | 428 | 0.8 | 4.0 | 43 | 6.4 | 6.3 | 7.5 |
| 7 | Sidekick | 344 | 1.0 | 5.8 | 43 | 7.6 | 5.5 | 4.3 |
| 8 | Ba 76-204 | 675 | 1.1 | 8.3 | 50 | 7.6 | 2.8 | 1.5 |
| | Mean | 480 | 1.0 | 5.9 | 49 | 7.2 | 4.2 | 5.0 |
| | LSD (0.05) | 182 | 0.3 | 2.2 | 12 | 0.9 | 2.0 | 2.0 |
| | CV (%) | 26 | 3 | 25 | 17 | 9 | 32 | 28 |

1/ Visual rating of heading from one to ten with ten being the best and one the worst.
2/ Visual rating of maturity from one to ten with ten being the most mature and one the least mature.