# 1986 COLUMBIA BASIN AGRICULTURAL RESEARCH

Special Report 776

Agricultural Experiment Station • Oregon State University

*in cooperation with* Agricultural Research Service • USDA

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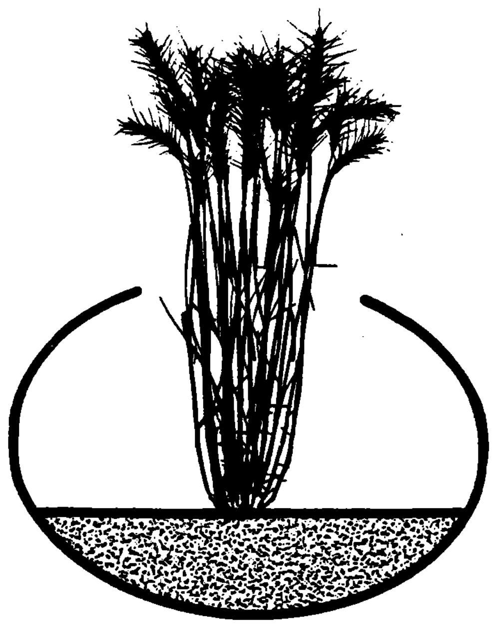
## SPECIAL REPORT 776   JUNE, 1986



### EDITORIAL COMMITTEE

Vance Pumphrey, chairman

Clyde Douglas

Ronald Rickman

Acknowledgment is made to Carol Brehaut, Jennifer Fallgren, and Doris Long, for typing, and to Gordon Fischbacher, for graphic preparation.

# Contents

# Introduction

The past year presented many exciting changes and new challenges to both the Columbia Basin Agricultural Research Center (CBARC-OSU) and the Columbia Plateau Conservation Research Center (USDA-Agricultural Research Service). We were honored by a promotion and several special recognitions. There were changes in personnel, a reorganization of CBARC, establishment of a grower-liaison committee, and erosion of operational funds. At the same time, the level of commitment by our scientists and staff continued to grow.

## Promotions and Awards

We are especially pleased that Don Rydrych was promoted to the rank of Professor of Crop Science and that Gloria Eidam, Clerical Specialist, was presented the College of Agricultural Sciences' Classified Employee Award for her exemplary service. We are also very pleased that Betty Klepper brought prestige and honor to the Center, by being named a Fellow in both the American Society of Agronomy and the Soil Science Society of America. This award recognizes leadership and outstanding professional contributions in research, teaching, and/or extension. The American Sod Producer's Association presented their Honorary Membership Award to Richard Smiley, for his contributions to the turfgrass industry; only three other scientists have received this award during its 17-year history. Paul Rasmussen was selected to serve on the Advisory Board of the Northwest Plant Food Association. Joe Pikul has spent the year at Corvallis on a Training and Development Program, taking coursework in soil science and mathematical studies so that he will be able to develop new concepts and models of heat and water movement in soils, especially surface soils.

## Staff Changes

Steve Lund retired as Superintendent of CBARC, and was replaced by Dr. Richard Smiley. Steve and his family have begun an active retirement in Pendleton. Dick Smiley, a Professor of Plant Pathology, came to the Center after 12 years of research and extension work in plant pathology at Cornell University, in New York state. Dr. Don Wysocki also joined the Center in 1985, as an Assistant Professor of Soil Science with an appointment in the Extension Service. He and his family spent the last 8 years at Iowa State University. Erling Jacobsen joined the staff as an Experimental Biology Aide at the Sherman Station in Moro and Theresa Miglioretto is serving as Research Assistant to Don Wysocki. At the end of September, after 40 years of service, Marion Hibbard retired from her position as Administrative Technician for ARS. She was replaced by David Steele who transferred to Pendleton from Corvallis. Sharron Wart joined us as Administrative Clerk. Our field research capability was enhanced by the addition of Susan Colwell, a Weed Scientist working on the IPM project and Roger Goller, Biological Technician, who works in the area of soil fertility. Our shop and field equipment crew was reorganized with a new position for an Agricultural Research Technician to provide field servicing and operation of specialized equipment. This new position was filled by Larry Baarstad. Because of Gramm-Rudmann budget reductions, a position for an Agricultural Engineer to fabricate and assist in the design of specialized research equipment has been left vacant.

## Reorganization of CBARC

The organization of the CBARC was adjusted by separating out the Hermiston Agricultural Research and Extension Center as an individual Station to serve irrigated agriculture in eastern Oregon. The Center now consists of the Pendleton and Sherman (at Moro) Stations, with a staff of 13 to serve the research needs of dryland crops in northcentral and northeastern Oregon. The two Stations are administered from Pendleton, and are operated locally by skilled research assistants serving as farm managers. Scott Case manages the Sherman Station and Karl Rhinhart manages the Pendleton Station. Scientists serving Oregon State University from the Center now include a plant breeder (Chuck Rohde), an agronomist (Vance Pumphrey), a weed scientist (Don Rydrych), a plant pathologist (Dick Smiley), and an extension soil scientist (Don Wysocki).

## Liaison Committee

The Pendleton Research Center Liaison Committee was formed to facilitate communication and direction to and from growers in each county of the region. The nine members of the committee, with rotating terms of service, are appointed by joint approval of the Director of the Oregon Agricultural Experiment Station and the Director of the Northwestern Area, U.S.D.A.-Agricultural Research Service. Larry Coppock is the current chairman of this committee. The Moro Station Advisory Committee continues to serve the liaison needs of the Sherman Station, under the chairmanship of Paul Alley.

## New Projects

New major projects were initiated. One project, being done by Clyde Douglas, seeks to develop a systematic way to divide the Pacific Northwest into agronomic zones or areas with similar management options and to use computer technology in delineating the boundaries of the zones for mapping. A second major new project is being done in collaboration with Drs. Jim Cook and Lloyd Elliott (ARS, Pullman) and seeks to define the causes of poor wheat growth with high levels of surface residues, especially as occur in chaff rows. Small projects have also been initiated in crop modelling by Ron Rickman in collaboration with ARS at Fort Collins, Colorado, and at Mississippi State, Mississippi. The Integrated Pest Management (IPM) project on peas, initiated last year, is being continued as planned. A third new project addresses the occurrences, biology and control of principal diseases of cereals in eastern Oregon. Dick Smiley will emphasize diseases caused by soilborne pathogens and Dr. Chris Mundt (OSU-Corvallis) will focus upon foliar diseases. The project will also be supported by a third pathologist, Dr. Fred Crowe (OSU-Redmond).

## Visitors

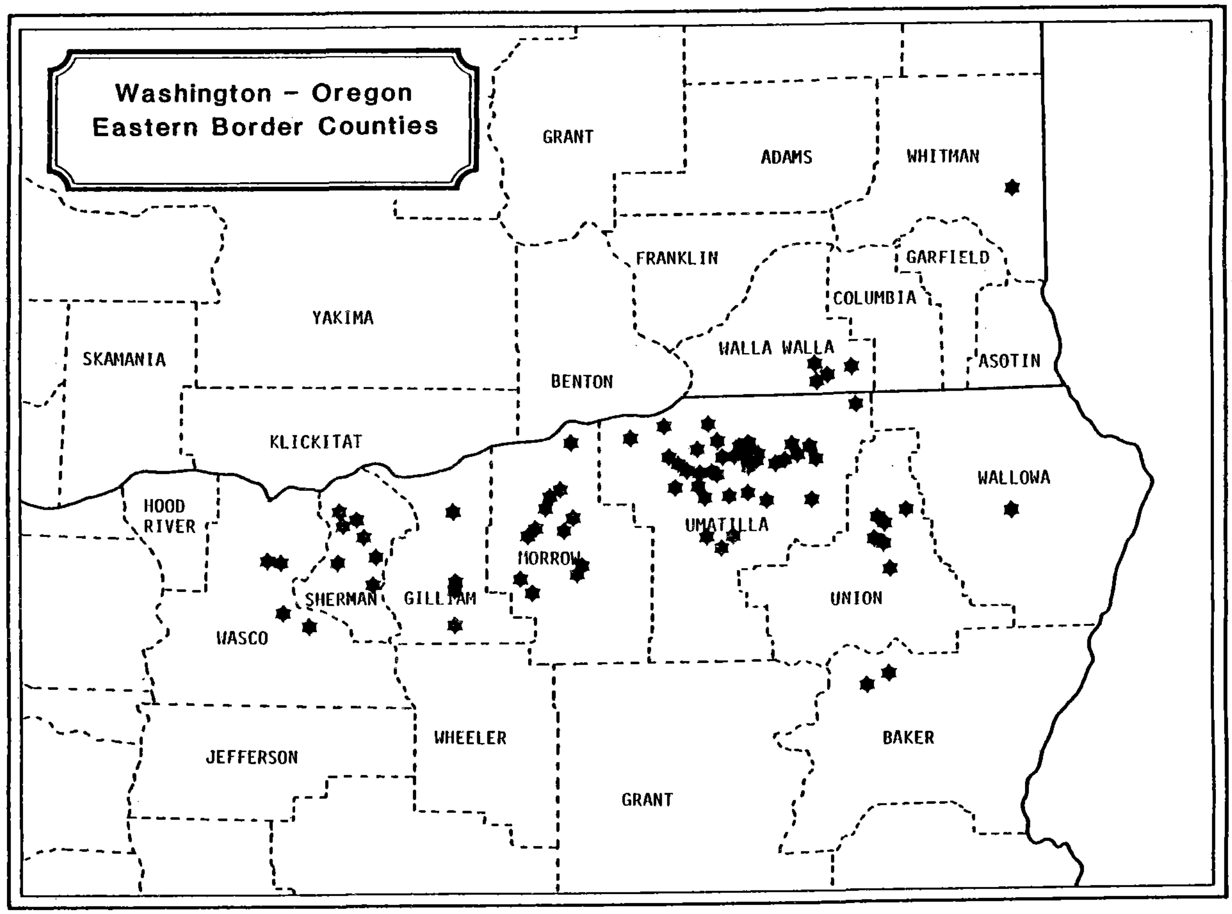
We had a number of distinguished visitors, including legislative aides for several northwest Senators and a Chinese trade delegation interested in wheat quality and milling. Foreign visitors included M. A. Choudhary (New Zealand), R. S. Rekhi (India), Mario Carvalho (Portugal), and Francois Chahaneau (France) and three Australians (June McMahon, Barbara Graham, and Adele Millerd).

Expressions of Appreciation

The staff wishes to express their appreciation to individuals, associations, and corporations who have given special assistance for the operation of experimental plot area on or associated with the Center during 1985. The Oregon Wheat Commission continues to provide the critical support upon which many of the Center's projects are founded. Thanks are also given to those who donated herbicides (Monsanto Agricultural Products Co., Rhone-Poulenc, Inc., and Imperial Chemical Industries-Americas through Wilbur Ellis), loaned a tractor for spring tillage (Frank Tubbs), and provided financial assistance for labor and supplies (Floyd Bolton), and constructed a combine sieve (John Rea). We also acknowledge those who donated labor, supplies, equipment, or funding for the Pendleton Field Day (Umatilla County Ag Lender's Assoc., Pendleton Grain Growers, Century Chemical Corp., Frank Tubbs, and Larry Coppock) and the Moro Field Day (Monsanto Agr. Products Co., Condon Grain Growers, Midco Grain Growers, Sherman Cooperative Grain Growers, PureGro, Sherman Farm Chemicals, Grass Valley Rebekah Lodge, and Sherman County Schools). Additionally, we are very thankful for the ever-present assistance from the Extension Service personnel in all counties of the region, and especially from Umatilla, Union, Sherman, Morrow, Gilliam, Wallowa, and Wasco counties. We also wish to thank the many farmers who have allowed us to work on their property and who have often gone the extra mile by performing field operations, loaning equipment, donating chemicals, and adjusting their practices to accommodate our plots. The locations of these outlying sites are shown on the map that follows.

We truly appreciate the support and encouragement of growers, organizations, and businesses with a mission common to ours; to serve in the best manner possible the crop production needs of the region. We welcome your suggestions as to how we may continue to improve our attempts to reach this goal.

| | |
|---|---|
| Richard W. Smiley<br>Superintendent<br>CBARC | Betty Klepper<br>Research Leader<br>USDA-ARS |




# Off-Station Research Plot Locations

**WALLOWA, OREGON**
Jim Dawson

**BAKER, OREGON**
Jim Blatchford
Daryl Leggett

**UNION, OREGON**
John Cuthbert
East Oreg Exp Stn
Dale Eisiminger
Kent Hug
Shaw-DeLint-Rudd
Gil Witherspoon

**UMATILLA, OREGON**
Glen Broigotti
Dutch Clark
Larry Coppock
Pat Davis
Scott Duff
Bill Etter
Dean Friedly
Mark Hales
Doug Harper
Herm. Agr Res Ctr
Harold Kirk
Sheldon Kirk
Dave Lindberg
John Martin
Bob Newtson

**UMATILLA, OREGON**
Bob Newtson
Larry Newtson
Harold Peters
Arnold Peterson
Clinton Reeder
Leon Reese
Sherman Reese
Larry Rew
Quintin Rugg
Cal Spratling
Mack Temple
Glen Thorne
Mike Thorne
Stan Timmerman
Frank Tubbs
Dwight Wolfe

**MORROW, OREGON**
Eric Anderson
Frank Anderson
East Oregon Farms
Tom Martin
Tad Miller
Chuck Nelson
Don Peterson
Kenneth Peck
Ken Smouse
Jim Swanson
Keith Rea

**GILLIAM, OREGON**
Frank Dyer
Bill Jaeger
Bob Maley
Louis Rucker

**SHERMAN, OREGON**
Steve Burnet
Larry Kaseberg
Terry Kaseberg
Leroy Martin
Dave Pinkerton
Sherman Exp Stn
Bill Todd

**WASCO, OREGON**
Van Harth
Leland Mayhew
James Johnson
Ted Von Borstel

**WHITMAN, WASHINGTON**
Steven Mader

**WALLA WALLA, WASHINGTON**
James Ferrel
Tom Martin
Donald Meiners

# Publications - 1985

The following list consists of publications by personnel of the USDA-ARS, Columbia Plateau Conservation Research Center and Oregon State University Columbia Basin Agricultural Research Center in 1985.


Allmaras, R. R., P. W. Unger, and D. E. Wilkins. 1985. Conservation tillage systems and soil productivity. Chapter 21, pp. 351-411. In (R. F. Follett and B. A. Stewart, eds.) Soil Erosion and Crop Productivity. American Society of Agronomy, Madison, WI.

Allmaras, R. R., C. L. Douglas, Jr., P. E. Rasmussen, and L. L. Baarstad. 1985. Distribution of small grain residue produced by combines. Agronomy Journal 77:730-734.

Baker, D. N., F. D. Whisler, W. J. Parton, B. L. Klepper, C. V. Cole, W. O. Willis, D. E. Smika, A. L. Black, and A. Bauer. 1985. The development of WINTER WHEAT: A physical physiological process model. pp. 176-187. In (W. O. Willis, ed.) ARS Wheat Yield Project. U.S. Department of Agriculture, Agricultural Research Service ARS-38, 217 pp.

Douglas, C. L. Jr., P. E. Rasmussen, and R. R. Allmaras. 1985. Residue management at harvest. pp. 50-51. In Fourth Annual Inland Empire Conservation Tillage Conference Proceedings. Soil Conservation Society of America, Pullman, WA.

Klepper, Betty. 1985. Origin, branching and distribution of root systems. Abstracts of Invited Papers. Root Development and Function, Effects of the Physical Environment. Society for Experimental Biology Symposium, Bangor, Wales. (Abstract)

Klepper, Betty. 1985. Plant growth, stresses, and production potential of wheat with conservation tillage. p. 4. Proceedings of the Fourth Annual Inland Empire Conservation Tillage Conference. Soil Conservation Society of America, Pullman, WA. (Abstract)

Klepper, Betty, A. B. Frank, A. Bauer, and J. A. Morgan. 1985. Physiological and phenological research in support of wheat yield modeling. pp. 134-150. In (W. O. Willis, ed.) ARS Wheat Yield Project. U.S. Department of Agriculture, Agricultural Research Service ARS-38, 217 pp.

Klepper, Betty, F. Vance Pumphrey, and T. R. Toll. 1985. Phenological timing in four legume species. 1985 Agronomy Abstracts, p. 13.

Pikul, J. L. Jr., and R. R. Allmaras. 1985. Hydraulic potential in unfrozen soil in response to diurnal freezing and thawing of the soil surface. American Society Agriculture Engineering Transactions (28):164-168.

Pikul, J. L. Jr., and R. R. Allmaras. 1985. Late season heat flux and water distribution in a summer-fallowed Haploxeroll. Soil Science Society America Journal 49:1517-1522.

Pumphrey, F. V., D. E. Wilkins, and P. E. Rasmussen. 1985. Fertilizing wheat following alfalfa on irrigated sandy soil. Proceedings Irrigated Agriculture Fertilizer Conference, Pasco, WA, pp. 1-2.

Ramig, R. E., and R. W. Rickman. 1985. Description of data collection sites and methods. D. Pacific Northwest: winter wheat. In (W. O. Willis, ed.) Agricultural Research Service ARS-38, 217 pp.

Rickman, R. W., B. Klepper, and R. K. Belford. 1985. Developmental relationships among roots, leaves, and tillers in winter wheat. pp. 83-98. In (W. Day and R. K. Atkins, eds.) Wheat Growth and Modelling. Plenum Publishing.

Rickman, R. W., E. L. Klepper, J. Pardue, and M. Grube. 1985. Projecting leaf development of a population of winter wheat plants from air temperature after planting. 1985 Agronomy Abstracts, p. 45. (Abstract)

Rickman, R. W., Betty Klepper, and Curt M. Peterson. 1985. Wheat seedling growth and developmental response to incident photosynthetically active radiation. Agronomy Journal 77:283-287. 1985.

Rickman, Ron, Betty Klepper, Sue Waldman, and Jerry Brog. 1985. PLANTEMP a degree days cover, plant development calculator. Oregon State University Series EM8308, Corvallis, OR.

Rickman, R. W., and Paul E. Rasmussen. 1985. Ground cover estimates for seedling cereal crops. Soil Science Society America Journal 49:1251-1255.

Rush, C. M., R. E. Ramig, and J. M. Kraft. 1985. Effects of wheat residue and tillage on Pythium ultimum populations in a dryland pea-wheat rotation. Phytopathology 75:1301. (Abstract)

Rydrych, D. J. 1985. Inactivation of metribuzin in winter wheat by activated carbon. Weed Science 33-229-232.

Rydrych, D. J. and D. C. Maxwell. June 1985. Chemical fallow in Oregon dryland grain. STEEP Report 746, p. 1-4.

Smiley, R. W. and M. C. Fowler. 1985. Arsenate herbicide stress and the incidence of summer patch on Kentucky bluegrass turfs. Plant Disease 69:44-48.

Smiley, R. W. and M. Craven Fowler. 1985. Techniques for inducing summer patch symptoms on Poa pratensis. Plant Disease 69:482-484.

Smiley, R. W., M. Craven Fowler, and L. Buchanan. 1985. Bioassay of toxins associated with healthy and patch disease-affected Poa pratensis turfgrass. pp. 619-628. In (F. Lemaire, ed.) Proceedings Fifth International Turfgrass Research Conference (Avignon). INRA Publications, Versailles, France. 870 p.

Smiley, R. W., M. C. Fowler, and R. T. Kane. 1985. Temperature and osmotic potential effects on Phialophora graminicola and other fungi associated with patch diseases of Poa pratensis. Phytopathology 75:1160-1167.

Smiley, R. W., M. Craven Fowler, R. T. Kane, A. M. Petrovic, and R. White. 1985. Fungicide effects on thatch depth, litter decomposition rate, and growth of Kentucky bluegrass. Agronomy Journal 77:597-602.

Smiley, R. W., R. T. Kane and M. Craven Fowler. 1985. Identification of Gaeumannomyces-like fungi associated with patch diseases of turfgrasses in the cool-humid zone of North America. pp. 609-618. In (F. Lemaire, ed.) Proceedings Fifth International Turfgrass Research Conference (Avignon). INRA Publications, Versailles, France. 870 p.

Smiley, R. W. and D. C. Thompson. 1985. Soil and atmospheric moistures associated with Fusarium crown rot and foliar blight of Poa pratensis. Plant Disease 69:294-297.

Taylor, P. A., R. G. Clarke, K. Kelley, and R. W. Smiley. 1985. Root rot of irrigated subterranean clover in northern Victoria: significance and prospects for control. pp. 271-273. In (C. A. Parker et al. eds.) Ecology and Management of Soilborne Plant Pathogens. American Phytopathology Society, St. Paul, MN. 358 p.

Wilkins, D. E. 1985. Machinery development for conservation tillage. p. 5. Proceedings of Fourth Annual Inland Empire Conservation Tillage Conference. Soil Conservation Society of America, Pullman, WA. (Abstract)

Wilkins, D. E., R. R. Allmaras, J. M. Kraft, and R. E. Ramig. 1985. Machinery systems for pea and winter wheat production in the Pacific Northwest. In Proceedings of International Conference of Soil Dynamics. 3:582-591. Auburn, AL.

Zuzel, J. F. 1985. Joint distributions of rain on seasonally frozen soils. Cold Regions Hydrology Symposium, Fairbanks, Alaska. (Abstract)

Zuzel, J. F. and R. N. Greenwalt. 1985. Probability distributions of rain on snow for northcentral Oregon. Proceedings Western Snow Conference, Boulder, Colorado. pp. 37-43.

# Description of Cereal Grain Varieties Commonly Grown in Northeastern Oregon

Charles R. Rohde[1]

The selection of a cereal variety depends on the particular problems that commonly occur in the area where the variety is to be grown. For example, if winterkilling is a common problem, the grower should select a variety with a high level of winterhardiness. Or if Cephalosporium stripe is a disease that occurs frequently, then the grower should select a variety that is most tolerant to this disease. Another factor to consider is the date the variety will be seeded. Early seedings, for example, favor most diseases that occur in northeastern Oregon, therefore, it would be important to choose a variety that is resistant to most of these diseases and be prepared to apply fungicides or insecticides to control those diseases to which the selected variety may be susceptible.

Tables 1 through 4 give summaries of several agronomic and disease characteristics of a number of winter and spring wheat and winter and spring barley varieties adapted for growing in northeastern Oregon.

Table 1. Agronomic and disease characteristics of several soft white winter wheat varieties

| Variety | Emergence index[1] | Winter hardiness | Maturity | Test weight | Plant height[2] | Foot rot[3] | Common bunt | Dwarf bunt | Stripe rust | Leaf rust | Cephlasporium stripe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Stephens | 5 | 3 | early | 6 | SD-M | R | R | S | R | MS | S |
| Hill 81 | 5 | 5 | medium | 7 | M | S | R | S | MR | MR | MR |
| Lewjain | 6 | 6 | late | 7 | SD | MR | R | R | R | MS | MR |
| Dusty | 5 | 5 | med-late | 7 | SD-M | S | R | S | MR | MS | MS |
| Daws | 4 | 8 | medium | 7 | SD-M | MS | R | S | MR | MS | MS |
| | | | | CLUB VARIETIES | | | | | | | |
| Crew | 6 | 6 | medium | 6 | SD-M | S | R | S | MR | MR | MS |
| Tyee | 5 | 5 | medium | 5 | SD-M | MR | MR | S | MS | S | MS |
| Tres | 6 | 5 | medium | 7 | M | MS | MR | S | MR | MR | MS |
| Faro | 5 | 6 | med-early | 6 | SD | MS | MR | S | MS | S | MS |
| Jacmar | 6 | 5 | med-early | 4 | SD | MR | MR | MR | S | S | MS |

[1] 1 = poor, 10 = excellent

[2] SD = semidwarf, M = medium

[3] R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible

[1] Professor of agronomy, Oregon State University, Columbia Basin Agricultural Research Center, Pendleton, Oregon, 97801.

Table 2. Agronomic and disease characteristics of several spring wheat varieties

| Variety | Heading date | Test weight (lbs./bu.) | Plant height (inches) | Stripe rust[1] | Leaf rust[1] |
|---|---|---|---|---|---|
| | | SOFT WHITE | | | |
| Twin | June 21 | 55.9 | 27 | R | S |
| Dirkwin | June 20 | 55.0 | 28 | R | S |
| Waverly | June 20 | 56.9 | 26 | MR | R-MR |
| Owens | June 18 | 58.6 | 27 | R | S |
| Fieldwin | June 20 | 57.4 | 26 | S | MS |
| | | HARD RED | | | |
| Wared | June 20 | 58.4 | 28 | MR | MR |
| Wampum | June 20 | 56.8 | 30 | R | R |
| McKay | June 20 | 59.0 | 28 | R | R |

[1]R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible

Table 3. Agronomic characteristics of several winter barley varieties

| Variety | Heading date | Test weight (lbs./bu.) | Plant height (inches) | Winterhardiness[1] |
|---|---|---|---|---|
| Scio | May 26 | 50.4 | 34 | 6 |
| Hesk | May 28 | 49.8 | 34 | 6 |
| Mal | May 30 | 49.8 | 33 | 6 |
| Boyer | May 28 | 50.0 | 34 | 6 |
| Steptoe | May 24 | 50.4 | 42 | 3 |
| Wintermalt | May 20 | 51.9 | 36 | 5 |
| Kamiak | May 22 | 52.8 | 38 | 7 |
| Hudson | May 22 | 52.9 | 39 | 7 |

[1]1 = poor, 10 = excellent

Table 4. Agronomic characteristics of several spring barley varieties

| Variety | Heading date | Test weight (lbs./bu.) | Plant height (inches) |
|---|---|---|---|
| | | FEED | |
| Steptoe | June 14 | 47.9 | 28 |
| Gus | June 17 | 49.5 | 26 |
| Micah | June 20 | 50.2 | 24 |
| Advance | June 10 | 49.2 | 26 |
| Gem | June 8 | 48.4 | 26 |
| Flynn 37 | June 8 | 46.9 | 26 |
| | | MALTING | |
| Kimberly | June 22 | 51.4 | 29 |
| Klages | June 19 | 51.5 | 29 |
| Morex | June 14 | 50.2 | 30 |

A brief description of varieties commonly grown in northeastern Oregon follows.

## WINTER WHEAT

### Stephens

Stephens is a bearded, white-chaffed, semi-dwarf wheat released by Oregon State University (OSU) in 1977. Heads are distinctly coarse in appearance with beards that tend to flare. Stephens has only a minimal level of winterhardiness and is susceptible to Cephalosporium stripe. This variety is resistant to stripe rust and has some resistance to leaf rust. Stephens has a very wide adaptation and yields well in low rainfall areas, high rainfall areas, and under irrigation.

### Hill 81

Hill 81 is bearded, white-chaffed medium height variety released by OSU in 1981. It is more winterhardy than Stephens and is recommended for those areas where the winterhardiness of Stephens has not been adequate. Hill 81 is more tolerant to Cephalosporium stripe than Stephens, therefore, it is recommended in those areas where this disease is a problem.

Lewjain

Lewjain is a bearded, white-chaffed, semi-dwarf variety released by Washington State University (WSU) in 1982. It is a late season variety with very good winterhardiness. This variety is resistant to dwarf bunt, tolerant to Cephalosporium stripe, and is recommended especially in thoseareas where dwarf bunt is a problem. In most areas its yield potential is not equal to that of Stephens.

Daws

Daws is a bearded, white-chaffed, semi-dwarf variety released by WSU in 1976. This variety is very winterhardy and is recommended in areas where winterkilling commonly occurs. Emergence is only adequate, therefore, it is not recommended where it is necessary to seed deep in moist soil.

Dusty

Dusty is a bearded, white-chaffed, semi-dwarf variety released by WSU in 1985. This variety has good winterhardiness, is later in maturity than Stephens, but has yielded well at many locations in northeastern Oregon. Limited amounts of foundation and registered seed will be available this fall.

Crew

Crew is a multiline club variety released by WSU in 1983. This variety was developed to lessen the vulnerability of the region's club wheat to stripe rust. It is made up of 10 separate lines, each of which possess different genetic resistance to stripe rust. Crew is mid-season in maturity, has a mixture of brown and white chaff colors, and exhibits irregular plant height. Yield potential of Crew in traditional club wheat areas is good.

Tyee

Tyee is a beardless, semi-dwarf, white-chaff club variety released by WSU in 1979. It is taller than Faro but has good resistance to lodging. Tyee is moderately susceptible to stripe rust so a grower must watch the variety closely and be prepared to apply a fungicide when stripe rust begins to appear. In the absence of stripe rust, Tyee yields quite well.

Tres

Tres is a beardless, semi-dwarf, white-chaffed club variety released by WSU in 1984. Its name means three, signifying its resistance to three foliar diseases - stripe and leaf rust, and powdery mildew. Tres is one of the 10 components of Crew. It appears to have a similar yield potential to Crew, but has none of the heterogeneities found in Crew.

## Faro

Faro is a beardless, brown-chaffed club variety released by OSU in 1976. It has good emergence and winterhardiness, is early to mid-season, and has adequate test weight. This variety is susceptible to stripe rust, and a grower should be prepared to apply a fungicide as soon as this disease appears.

## Jacmar

Jacmar is a privately developed, semi-dwarf, brown-chaffed club variety released in 1979. This variety is very susceptible to current races of stripe rust, and a grower must be prepared to apply a fungicide as soon as stripe rust appears.

# SPRING WHEAT

## Dirkwin

Dirkwin is a beardless, white-chaffed, soft white, semi-dwarf variety released by the University of Idaho (U of I) in 1978. It is a very widely adapted variety, yielding well under both droughty and high-producing conditions. The test weight of Dirkwin tends to be somewhat low. This variety is resistant to stripe rust, but is susceptible to leaf rust.

## Twin

Twin is a beardless, white-chaffed, soft white, semi-dwarf variety released by the U of I in 1971. It is very similar to Dirkwin in plant height, test weight, heading date, and resistance to stripe rust. This variety is also susceptible to leaf rust.

## Waverly

Waverly is a bearded, semi-dwarf, white-chaffed, soft white variety released by WSU in 1981. This variety is moderately resistant to stripe rust and leaf rust. Its test weight is superior to that of Dirkwin, however, it usually does not yield as high as Dirkwin.

## Owens

Owens is a bearded, semi-dwarf, white-chaffed, soft white variety released by the U of I in 1981. It is resistant to stripe rust and moderately resistant to leaf rust. The test weight of Owens is significantly higher than Dirkwin, however, it usually does not yield as high as Dirkwin.

## Fieldwin

Fieldwin is a bearded, semi-dwarf, white-chaffed, soft white variety released by the U of I in 1977. This variety is susceptible to stripe rust, therefore, a grower should be prepared to apply a fungicide as soon as this disease appears. In the absence of stripe rust, Fieldwin yields very well and produces grain with good test weight.

Wared

Wared is a bearded, semi-dwarf, white-chaffed, hard red variety released by WSU in 1974. It is moderately resistant to both stripe and leaf rust. The test weight of Wared is quite high. Wared appears to be best adapted to lower yielding areas of northeastern Oregon.

Wampum

Wampum is a bearded, mid-tall, white-chaffed, hard red variety released by WSU in 1978. This variety is resistant to stripe rust and moderately resistant to leaf rust. It is best adapted to the higher yielding areas of northeastern Oregon. Wampum has a special quality of being able to grow as a seedling when soil temperatures are quite low.

McKay

McKay is a bearded, semi-dwarf, white-chaffed, hard red variety released by the U of I in 1981. This variety is resistant to both stripe and leaf rust. The test weight of its grain is usually very high.

## WINTER BARLEY

Hesk

Hesk is a 6-row, feed barley variety released by OSU in 1980. It is medium height, medium to mid-late in maturity, resistant to lodging, and has adequate test weight. Hesk has fairly good winterhardiness. This variety is well adapted for growing in the higher yielding areas of northeastern Oregon.

Mal

Mal is a 6-row, feed barley variety released by OSU in 1980. This variety is medium late in maturity, mid-height, with good resistance to lodging. It is fairly winterhardy and produces grain with adequate test weight. Mal is well adapted in Union, Wallowa, and Baker counties, and is especially well suited for the flood irrigated areas of Malheur County.

Scio

Scio is a 6-row, feed barley variety released by OSU in 1981. It is medium short, midseason in maturity, and has fairly good winterhardiness. This variety is very stiff-strawed and well adapted to high rainfall and irrigated areas.

Kamiak

Kamiak is a 6-row, feed barley variety released by WSU in 1971. This variety is early maturing, has good winterhardiness, produces grain with high test weight, and is best adapted in the lower rainfall areas of northeastern Oregon.

### Hudson

Hudson is a 6-row, feed barley variety released by Cornell University, New York, in 1951. This variety is early maturing, produces grain with high test weight, has good winterhardiness, but is moderately susceptible to lodging. It is best adapted in the lower rainfall areas of northeastern Oregon.

### Boyer

Boyer is a 6-row, feed barley variety released by WSU in 1975. It is medium in height, medium to mid-late in maturity, resistant to lodging, and has fairly good winterhardiness. The test weight of its grain is adequate. This variety is best adapted to the higher rainfall areas of northeastern Oregon.

### Wintermalt

Wintermalt is a 6-row, malting variety developed at Cornell University. It is medium in height, early in maturity, with only fair lodging resistance. This variety has good winterhardiness and produces grain that has a fairly high test weight. To produce grain suitable for malting purposes, it should be grown in areas that have a high probability of producing large plump kernels.

## SPRING BARLEY

### Steptoe

Steptoe is a 6-row, feed barley variety released by WSU in 1973. It is medium tall in height, medium early in maturity, and susceptible to lodging. Grain test weight is somewhat low especially when the crop is stressed during the time kernels are filling. Although Steptoe is a spring variety, it does possess some winterhardiness, and is fall-seeded in areas where winterkilling is not a common problem. Winterhardiness of Steptoe often causes problems, when rotated with winter wheat, because volunteer plants will survive in the wheat. Steptoe is a very widely adapted variety, producing high yields of grain during droughty years as well as during years of abundant rainfall.

### Advance

Advance is a 6-row, malting barley variety released by WSU in 1979. It is medium in height, fairly early in maturity, and produces grain adequate in test weight. This variety is susceptible to lodging but usually lodges less than Steptoe. Advance is not winterhardy, therefore, it does not produce a problem when rotated with winter wheat.

### Gus

Gus is a privately developed 6-row feed variety. It is a medium short, medium late maturing, stiff-strawed variety that is well adapted for growing under irrigation. This variety performs poorly when stressed.

## Micah

Micah is a new 6-row, feed barley variety released by OSU in 1985. It is a late maturing, stiff-strawed, semi-dwarf variety that is adapted for growing in high production areas of eastern Oregon. Because of its very stiff straw, it is especially well adapted for growing under irrigation. Limited amounts of foundation seed will be available from the Oregon State University Foundation Seed Project.

## Gem

Gem is a 6-row, feed barley variety released by U of I in 1947. It is an early maturing, medium height variety with moderately stiff straw. The test weight of Gem is slightly higher than Steptoe. This variety is not winterhardy, therefore, does not cause volunteer problems when rotated with winter wheat. Gem is best adapted in the lower yielding areas of northeastern Oregon.

## Flynn 37

Flynn 37 is a 6-row, feed barley variety released by OSU in 1941. It is an early maturing, medium height variety with straw that will lodge in higher producing areas. The test weight of its grain tends to be low because the awns do not thresh readily from the kernel. Flynn 37 is not winterhardy, therefore, does cause a problem with volunteer plants when rotated with winter wheat. It is best adapted in the lower yielding areas of northeastern Oregon.

## Klages

Klages is a 2-row, malting barley variety released by the U of I in 1972. This variety produces grain with a high test weight, and its height is mid-tall, but quite resistant to lodging. It is best adapted under irrigation or the higher rainfall areas of northeastern Oregon. The malting quality of Klages is excellent.

## Kimberly

Kimberly is a 2-row, malting barley variety released by U of I in 1977. Grain test weight is high and malting quality is very good. This variety is mid-tall, and medium in maturity, being slightly earlier than Klages. It is best adapted for irrigated areas or areas of higher rainfall.

## Morex

Morex is a 6-row, malting barley variety released by North Dakota State University about 1978. This variety is mid-tall in height and mid-season in maturity. Its straw has only adequate resistance to lodging. The test weight of its grain is fairly high, however, it shatters from the head rather easily and should be harvested as soon as it is ripe. The variety has excellent malting quality, and is best adapted in the higher rainfall areas of northeastern Oregon.

# Performance of Cereal Varieties in Northeastern Oregon

Charles R. Rohde and Kathleen Van Wagoner[1]

The selection of the best cereal variety to grow depends on the adaptability of the variety to the area in which it is to be grown. To determine the adaptability of different varieties, they are tested in areas which represent climatic and soil types that occur in northeastern Oregon. Summaries of the yield data obtained from these tests are presented in Tables 1 through 8.

Table 1. Summary of yield data of winter wheat varieties tested in the lower yielding areas of northeastern Oregon, 1981-85

| Variety | Moro | Arlington | Condon 1/ | Lexington | Heppner | Pilot Rock | Echo | Average |
|---|---|---|---|---|---|---|---|---|
| | | | | (bushels per acre) | | | | |
| Stephens | 60.9 | 46.1 | 37.8 | 52.0 | 48.9 | 50.4 | 39.9 | 48.0 |
| Lewjain 2/ | 59.1 | 45.5 | 37.9 | 50.9 | 42.0 | 47.9 | 35.6 | 45.6 |
| Dusty 3/ | 56.9 | 39.4 | 39.1 | 50.2 | 42.9 | 48.0 | 37.7 | 44.9 |
| Daws | 58.5 | 43.0 | 37.4 | 45.9 | 42.7 | 44.2 | 35.5 | 43.9 |
| Hill 81 | 56.4 | 42.4 | 35.4 | 44.9 | 41.0 | 43.7 | 37.1 | 43.0 |
| | | | | CLUB VARIETIES | | | | |
| Crew | 57.7 | 46.6 | 36.8 | 48.5 | 41.4 | 44.8 | 40.1 | 45.1 |
| Tyee | 57.4 | 41.2 | 34.1 | 46.7 | 43.8 | 47.4 | 35.3 | 43.7 |
| Tres 4/ | 58.4 | 45.2 | 34.5 | 47.3 | 38.6 | 41.7 | 39.2 | 43.6 |
| Faro | 56.4 | 44.1 | 33.9 | 48.3 | 42.0 | 41.3 | 38.8 | 43.5 |
| Jacmar | 54.0 | 46.1 | 32.8 | 42.5 | 38.7 | 44.2 | 36.5 | 42.1 |

1/ No test in 1985

2/ Not tested in 1981 and 1985

3/ Tested only in 1984 and 1985

4/ Not tested in 1981 and 1982

[1] Professor and research assistant, Oregon State University, Columbia Basin Agricultural Research Center, Pendleton, Oregon, 97801.

Table 2. Summary of yield data of winter wheat varieties tested in the higher yielding areas of northeastern Oregon, 1981-85

| Variety | Pendleton | Holdman | Weston | Hermiston 1/ | LaGrande | Summerville 1/ | Flora 1/ | Baker 2/ | Average |
|---|---|---|---|---|---|---|---|---|---|
| | | | | (bushels per acre) | | | | | |
| Stephens | 80.1 | 58.5 | 86.8 | 102.5 | 72.6 | 59.4 | 61.3 | 74.4 | 74.4 |
| Hill 81 | 80.4 | 54.0 | 84.6 | 98.2 | 74.3 | 63.9 | 65.8 | 68.4 | 73.7 |
| Daws | 76.2 | 55.0 | 82.5 | 88.2 | 68.0 | 61.3 | 57.5 | 82.4 | 71.4 |
| Lewjain 3/ | 75.0 | 58.5 | 85.2 | 90.2 | 70.8 | 54.9 | 63.6 | | 71.2 |
| Dusty 4/ | 82.2 | 51.5 | 89.1 | 91.2 | 70.5 | 58.5 | 62.7 | 56.6 | 70.3 |
| | | | | CLUB VARIETIES | | | | | |
| Tyee 5/ | 78.7 | 63.2 | 89.1 | 83.6 | 69.4 | 55.0 | 50.8 | 82.7 | 71.6 |
| Tres 6/ | 82.0 | 55.3 | 85.9 | 96.6 | 76.8 | 58.4 | 69.4 | 40.2 | 70.6 |
| Crew 7/ | 77.8 | 59.0 | 85.2 | 86.7 | 67.0 | 56.5 | 68.7 | 60.7 | 70.2 |
| Faro | 71.7 | 54.6 | 81.3 | 79.0 | 66.9 | 45.3 | 52.0 | 72.6 | 65.4 |
| Jacmar 8/ | 71.8 | 57.7 | 77.3 | 75.9 | 63.3 | 51.0 | 51.8 | 44.5 | 61.7 |

1/ No tests conducted in 1985

2/ Tests conducted only in 1981 and 1985

3/ Not tested in 1981 and 1985

4/ Tested only in 1984 and 1985

5/ Not tested in 1985

6/ Tested only in 1983 and 1985

7/ Not tested in 1981

8/ Not tested in 1984

Table 3. Summary of yield data of spring wheat varieties tested in the lower yielding areas of northeastern Oregon, 1981-85

| Variety | Moro | Echo 1/ | Lexington | Heppner 2/ | Arlington | Condon 3/ | Average |
|---|---|---|---|---|---|---|---|
| | | | | (bushels per acre) | | | |
| Twin | 41.0 | 16.5 | 38.8 | 33.6 | 33.6 | 23.1 | 31.1 |
| Dirkwin | 39.5 | 17.5 | 35.8 | 34.8 | 33.5 | 22.5 | 30.6 |
| Waverly | 38.1 | 17.3 | 30.6 | 30.6 | 28.3 | 21.7 | 27.8 |
| Owens | 37.9 | 15.4 | 30.6 | 29.8 | 30.6 | 20.9 | 27.5 |
| Fieldwin 4/ | 31.6 | 12.7 | 29.1 | 28.5 | 25.5 | 19.3 | 24.4 |
| | | | HARD RED VARIETIES | | | | |
| Wared | 39.2 | 18.3 | 35.9 | 29.8 | 30.0 | 21.6 | 29.1 |
| Wampum | 32.4 | 16.3 | 29.5 | 34.6 | 28.2 | 23.4 | 27.4 |
| McKay | 39.3 | 14.2 | 29.6 | 29.8 | 28.2 | 20.5 | 26.9 |

1/ No tests in 1984 and 1985

2/ Tested only in 1981 and 1982

3/ No tests in 1981 and 1985

4/ Not tested in 1985

Table 4. Summary of yield data of spring wheat varieties tested in the higher yielding areas of northeastern Oregon, 1981-85

| Variety | Pendleton | Weston 1/ | Holdman 2/ | LaGrande 3/ | Joseph 4/ | Baker 5/ | Average |
|---|---|---|---|---|---|---|---|
| | | | | (bushels per acre) | | | |
| Dirkwin | 38.7 | 40.9 | 35.1 | 52.5 | 70.8 | 27.8 | 44.3 |
| Waverly | 34.7 | 38.2 | 35.0 | 53.8 | 70.7 | 32.6 | 44.2 |
| Twin | 37.8 | 40.6 | 32.0 | 51.3 | 71.8 | 26.7 | 43.4 |
| Owens | 35.6 | 40.0 | 33.1 | 54.8 | 68.6 | 27.2 | 43.2 |
| | | | HARD RED VARIETIES | | | | |
| Wampum | 32.9 | 37.5 | 33.1 | 53.7 | 71.6 | 29.4 | 43.0 |
| McKay | 33.0 | 37.2 | 31.0 | 51.0 | 59.3 | 31.7 | 40.5 |
| Wared 5/ | 32.1 | 34.5 | 29.9 | 45.2 | 61.2 | 36.9 | 40.0 |

1/ Not tested in 1983 and 1984

2/ Not tested in 1981 and 1982

3/ Not tested in 1982

4/ Not tested in 1981 and 1984

5/ Not tested in 1985

Table 5. Summary of yield data of winter barley varieties tested in lower yielding areas of northeastern Oregon, 1981-85

| Variety | Moro | Arlington 1/ | Condon 2/ | Lexington | Heppner | Pilot Rock | Echo | Ave. |
|---|---|---|---|---|---|---|---|---|
| | | | | (pounds per acre) | | | | |
| Mal 3/ | 3958 | 3073 | 3271 | 3826 | 3251 | 3225 | 2989 | 3370 |
| Hesk | 4058 | 3203 | 2478 | 3592 | 3066 | 3212 | 2976 | 3226 |
| Scio | 3778 | 3028 | 2310 | 3612 | 3347 | 3313 | 3003 | 3199 |
| Steptoe 4/ | 3020 | 3322 | 3011 | 3366 | 2937 | 2952 | 2621 | 3033 |
| Kamiak 5/ | 3508 | 2893 | 2154 | 3179 | 2755 | 2936 | 2932 | 2908 |
| Wintermalt | 2966 | 2966 | 1900 | 3289 | 2966 | 2866 | 2905 | 2837 |
| Hudson 6/ | 3078 | 2759 | 1811 | 3362 | 2211 | 2242 | 3119 | 2655 |

1/ No test in 1984

2/ No test in 1982 and 1985

3/ Not tested in 1983 and 1985

4/ Not tested in 1983 and 1984

5/ Not tested in 1984 and 1985

6/ Tested only in 1981 and 1982

Table 6. Summary of yield data of winter barley varieties tested in the higher yielding areas of northeastern Oregon, 1981-1985

| Variety | Pendleton | Holdman | Weston | Hermiston[1/] | LaGrande[1/] | Summerville[1/] | Flora[2/] | Baker[3/] | Average |
|---|---|---|---|---|---|---|---|---|---|
| | | | | (pounds per acre) | | | | | |
| Scio | 5856 | 4328 | 5349 | 5878 | 4641 | 4728 | 3109 | 2764 | 4582 |
| Hesk | 5620 | 4330 | 5265 | 5598 | 4518 | 4343 | 2398 | 3446 | 4440 |
| Mal[4/] | 5620 | 4460 | 4129 | 5423 | 4452 | 4490 | 2758 | 2280 | 4202 |
| Boyer[5/] | 5772 | 3735 | 4741 | 4824 | 4215 | 4708 | 2714 | 2637 | 4168 |
| Steptoe[5/] | 4902 | 3900 | 4259 | 4468 | 4186 | 3988 | 2672 | 3270 | 3956 |
| Wintermalt | 4982 | 3139 | 3955 | 5005 | 4088 | 3877 | 2607 | 2864 | 3815 |

1/ No test in 1985

2/ No test in 1984 and 1985

3/ Tested only in 1981 and 1985

4/ Not tested in 1985

5/ Not tested in 1983 and 1984

Table 7. Summary of yield data of spring barley varieties tested in the lower yielding areas of northeastern Oregon, 1981-85

| Variety | Moro | Echo[1/] | Lexington | Heppner[1/] | Arlington | Condon[2/] | Average |
|---|---|---|---|---|---|---|---|
| | | | (pounds per acre) | | | | |
| Steptoe | 2978 | 1449 | 2997 | 2343 | 2275 | 2236 | 2380 |
| Gus[3/] | 2820 | 1851 | 2757 | 2325 | 2087 | 1858 | 2283 |
| Flynn 37[4/] | 2729 | 1265 | 2849 | 2030 | 2311 | 2003 | 2198 |
| Gem | 2692 | 1114 | 2809 | 2066 | 2154 | 2243 | 2180 |
| Advance[5/] | 2647 | 1193 | 2734 | 2151 | 2008 | 2136 | 2145 |

1/ No tests in 1984 and 1985

2/ No tests in 1985

3/ Not tested in 1981

4/ Not tested in 1982

5/ Not tested in 1984 and 1985

Table 8. Summary of yield data of spring barley varieties tested in the higher yielding areas of northeastern Oregon, 1981-85

| Variety | Pendleton | Weston[1/] | Holdman[2/] | LaGrande[1/] | Joseph[3/] | Baker[4/] | Ave. |
|---|---|---|---|---|---|---|---|
| | | | (pounds per acre) | | | | |
| Steptoe | 4082 | 3203 | 2401 | 4431 | 4796 | 3449 | 3727 |
| Gus[5/] | 4169 | 2972 | 2328 | 3648 | 4719 | 3386 | 3537 |
| Kimberly | 3803 | 3105 | 2055 | 3671 | 4544 | 2965 | 3357 |
| Klages | 3725 | 3022 | 2216 | 3435 | 4231 | 3037 | 3278 |
| Micah[6/] | 3695 | 2460 | 1789 | 3844 | 4562 | ---- | 3270 |
| Advance | 3570 | 2682 | 1943 | 3710 | 4436 | 2867 | 3201 |
| Morex[7/] | 3333 | 2368 | 1996 | 3124 | 3872 | 2928 | 2937 |
| Cayuse (Oats) | 4216 | 2323 | ---- | 2876 | ---- | 3268 | |

1/ No tests in 1984

2/ No tests in 1981 and 1982

3/ No tests in 1981

4/ Tests only in 1981 and 1982

5/ Not tested in 1981

6/ Not tested in 1981 and 1982

7/ Not tested in 1985

# Wheat Varietal Development: Pendleton, 1985

S. L. Broich, N. Scott, A. E. Corey, R. Knight, and W. E. Kronstad[1]

The goal of Oregon State University's Cereal Breeding Project is the development of high yielding wheat and barley cultivars adapted to the wide range of climatic conditions found in Oregon. Realization of this goal requires that early generation selection as well as yield trials be conducted at a number of locations and in a range of environments throughout the state. The OSU Cereals Project maintains major experimental sites at three locations: Hyslop Crop Science Field Laboratory in the Willamette Valley, the Sherman Branch Experiment Station near Moro, and the Barnett-Rugg Ranch east of Pendleton. The purpose of this report is 1) to describe briefly the wheat breeding program of the OSU Cereals Project, 2) to describe the role that the Pendleton experimental site plays in this effort, and 3) to review the results obtained at the Pendleton experimental site during the 1984-85 crop year.

## THE WHEAT BREEDING PROGRAM

Winter wheat breeding populations are handled by the Pedigree Breeding Method. Single, 3-way, and double crosses among inbred wheat lines are made on the Hyslop Laboratory near Corvallis. $F_1$ plant rows and $F_2$ populations are also grown and evaluated in the Willamette Valley. $F_3$ plant rows are planted at the Pendleton experimental site, $F_4$ plant rows are planted in the Willamette Valley the following year. $F_5$ seed harvested from individual $F_4$ plants is divided and planted into two rows 20 feet long at each of the three experimental sites (Hyslop, Moro, and Pendleton). $F_5$ plant rows tend to be near uniform in appearance, and it is possible to evaluate the potential of this uniform line in three very different environments. The most promising plant rows are cut and seed from all plants in that row are bulked to be advanced into yield trials.

Initial yield testing is done in large unreplicated Preliminary Yield Trials (PYT's). The best lines from the PYT's are advanced into Replicated Preliminary Nurseries (RPN's); selections from the RPN's are advanced the following year into Replicated Advanced Nurseries (RAN's), and from there the most promising lines are advanced into the Elite Yield Trials (ELT's). There is a separate series of yield trials for Soft White Winter Wheat and Hard Red Winter Wheat and all yield trials are grown at the Hyslop, Moro, and Pendleton locations.

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[1] Research associate, senior instructor, research assistant, research assistant, and professor, Crop Science Department, Oregon State University, Corvallis, Oregon 97331.

In cooperation with the superintendents of the State Agricultural Experiment Stations, elite yield trials are also grown on the Central Oregon Experiment Station (at Madras), the Hermiston Experiment Station, the Klamath Experiment Station, the Malheur Experiment Station (at Ontario), and the Southern Oregon Experiment Station (at Medford). The most promising lines in the elite yield trials are also placed into either the Western Regional Winter Wheat Nursery or the Western Regional Hard Red Winter Wheat Nursery planted throughout the Pacific Northwest by cooperators in Oregon, Washington, Idaho, and Utah.

Preliminary data have also suggested that, in addition to a wide range of climates, future varieties must be developed with specific tillage practices in mind. In cooperation with Floyd Bolton, an OSU dryland agronomist working at the Sherman Branch Experiment Station near Moro, 28 unreleased elite lines are now being tested under three different management practices: 1) no till, 2) stubble mulch, and 3) moldboard plowing. Both Soft White and Hard Red Winter Wheats are included in this trial and a number of specific responses such as stand establishment, winter survival, early spring growth, and differential response to diseases, as well as yield and other agronomic characteristics are being studied.

The breeding program outlined here has been termed "shuttle breeding" in that populations undergoing segregation and selection are "shuttled" between environments so breeders can identify genotypes adapted to a wide range of environmental conditions. This provides not only for high yield, but also for yield stability over locations and years.

## 1985 PENDLETON NURSERIES

Umatilla County contains almost one quarter of the winter wheat acreage in Oregon and produces more than 25% of the total winter wheat yield for the state. The OSU Cereals Breeding Project has maintained nurseries on the Barnett-Rugg ranch for more than 10 years. A map of this experimental site east of Pendleton as planted during the 1984-85 crop year is displayed in Figure 1.

Almost one-half (48%) of the 12.8 acres planted were covered by $F_3$ and $F_5$ segregating populations. The two row plots in this 6.1 acre field represented the progeny of some 5,800 individual plants selected the previous year. The remaining 6.7 acres consisted of yield trials and special studies; acreage percentages devoted to the various programs are listed in Table 1.

The Soft White Winter Wheat (SWW) breeding program represents the largest single component in the Cereals Breeding Project. Soft white winter wheat yield trials occupied about one-third of the yield trial acreage at Pendleton in 1985 and 596 unreleased SWW breeding lines were yield tested this year. Yields ranged from 70-100 bu/a; 'Stephens' and 'Hill 81' averaged about 87 and 90 bu/a, respectively, throughout the four levels of yield trials. Yield data for the most promising SWW elite lines are shown in Table 2. Grain yields in 1985 were lower than the long-term averages for these lines at the Pendleton site but it is evident that, in reference to the check varieties, there are a number promising lines under development.

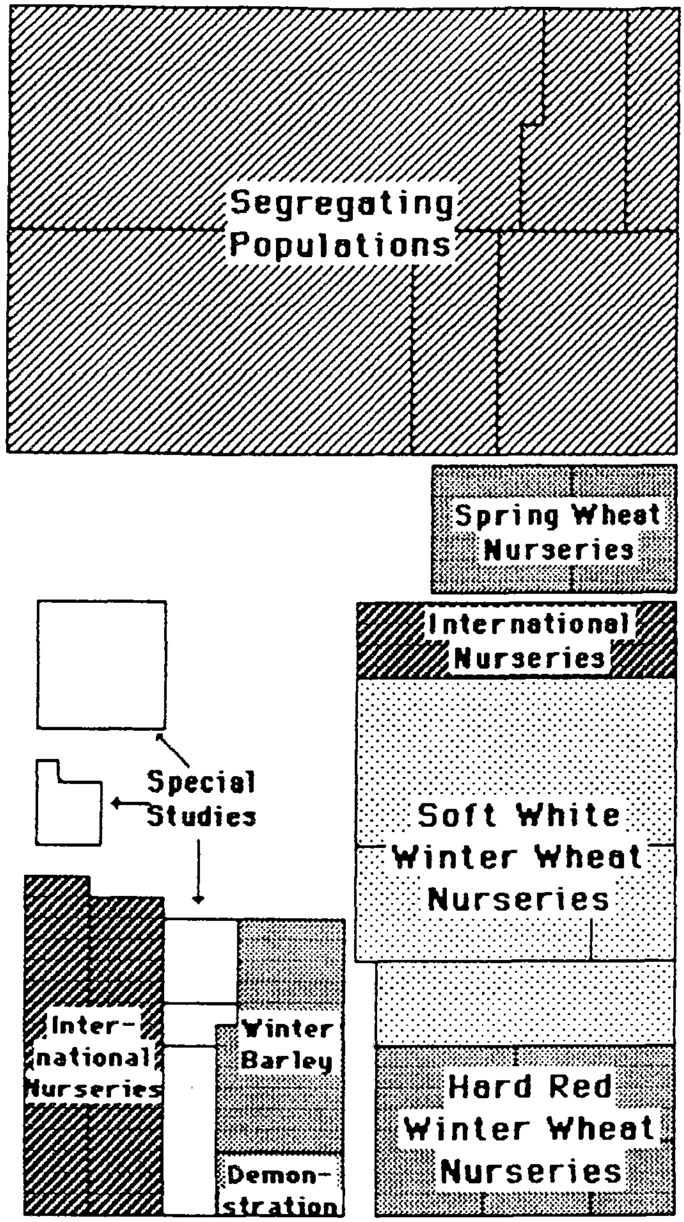


Figure 1. Map of the OSU Cereal Project experimental plots planted at the Barnett-Rugg Ranch east of Pendleton in 1984-1985.

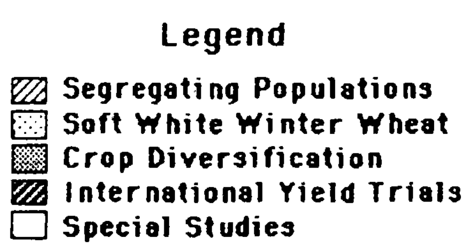

Table 1. Acreage and acreage percentages of the various components of the OSU Cereals Project as grown at Pendleton, Oregon, during the 1984-85 crop year

| Program | Acreage | % of Yield Trials |
|---|---|---|
| Soft White Winter Wheat | 2.5 | 37.3 |
| Hard Red Winter Wheat | 1.0 | 14.9 |
| Winter Barley | 0.6 | 9.0 |
| Hard Red Spring Wheat | 0.3 | 4.5 |
| Durum Wheat | 0.3 | 4.5 |
| International Nurseries | 1.3 | 19.4 |
| Special Studies | 0.7 | 10.4 |
| Sub Total | 6.7 | |
| Segregating Populations | 6.1 | |
| Total | 12.8 | |

Table 2. 1985 and long-term yields of varieties and selections in the Soft White Winter Wheat Elite Yield Trial at the Pendleton experimental site

| Variety or Selection | 1985 Yield* | Long-term Yield* |
|---|---|---|
| Stephens | 80.2 | 91.8 |
| Hill 81 | 86.5 | 93.3 |
| Malcolm | 90.6 | 88.4 |
| Jackmar | 76.8 | 74.8 |
| Dusty | 82.0 | |
| OR CW 8314 | 84.3 | 96.1 |
| OR CW 8417 | 93.6 | 96.5 |
| OR CW 8421 | 80.3 | 103.2 |
| OR CW 8517 | 87.1 | 93.6 |
| OR CW 8518 | 70.7 | 98.4 |
| OR CW 8519 | 82.3 | 100.4 |
| OR CW 8520 | 76.5 | 96.9 |
| OR CW 8521 | 83.5 | 95.0 |
| OR CW 8522 | 88.2 | 106.3 |
| lsd .05 | 9.68 | |

* Bushels/acre

Data from previous years indicate that the baking quality of these lines is acceptable to excellent.

An additional one-third of the yield trial acreage was devoted to varietal development for crop diversification in the Pendleton area. These nurseries included yield trials of several market classes: Hard Red Winter Wheat (HRW), Winter Feed Barley, Winter Malting Barley, and, for the first time, Hard Red Spring Wheats (HRS), and Durum wheats. Hard Red Winter wheat lines and barley lines under test here were derived from crosses made at OSU; Hard Red Spring Wheat lines and Durum lines were obtained through cooperation with the CIMMYT wheat breeding project in Mexico.

About 15% of the yield trial acreage was planted to Hard Red Winter Wheats; a total of 216 unreleased lines were yield tested in 1985. Yields of experimental lines ranged from 60-100 bu/a with the check varieties 'Wanser' and 'Centura' (a great plains HRW line) averaging 60 and 68 bu/a, respectively. More importantly, grain protein percentages this year at Pendleton ranged from 12.5-14.0%. Yield data for the most promising HRW lines in the elite yield trial are given in Table 3. Grain from these and other promising HRW lines have been submitted to the Western Wheat Quality Laboratory for complete milling and baking tests.

Winter Barley was tested on 9.0% of the yield trial acreage. A total of 32 unreleased feed barley lines were yield tested on the Pendleton site during 1985. Yields for feed barleys ranged from 2.4-3.1 tons/a; 'Scio', 'Boyer', and 'Kamiak' yielded 2.5, 2.4, and 2.4 tons/a, respectively. Yields of malting barley lines ranged from 2.0-3.0 tons/a. Grain from malting lines with the most promising yields and agronomic characteristics has been sent to the USDA Cereals Crops Research Unit in Madison, Wisconsin, for malting quality tests.

A dryland yield trial of Hard Red Spring Wheat included 7 checks and 25 experimental lines. Yields under non-irrigated conditions ranged from 47 to 55 bu/a; Wampum, Borah and Westbred 906R yielded 53, 51, and 51 bu/a, respectively. Grain protein content ranged from 14.5 to 16.5% among lines in this nursery.

In response to interest by the Pendleton Grain Growers co-op, 35 spring planted Durum Wheat lines were also tested this year. Yields under non-irrigated conditions ranged from 39 to 48 bu/a.

About 19% of the yield trial acreage was devoted to international nurseries including preliminary yield trials on Hard White Winter Wheat (113 entries) and Soft Red Winter Wheat (153 entries), the Fourth International Yield Trial (25 entries), the Fourth International Yield Trial (25 entries) and an unreplicated planting of the 13th International Screening Nursery (194 entries). While lines in these nurseries are not of an appropriate market class for release in Oregon, they are often a valuable source of disease resistance which can be incorporated into SWW and HRW varieties developed for the state.

Special Studies, which covered 10.4% of the yield trial acreage, included graduate student thesis work and several agronomic trials. Of particular interest is a fertility trial, conducted in cooperation with

Vance Pumphrey, CBARC, which included SWW and HRW lines and tested the effects of eight different fertilizer treatments on grain yield and grain protein content. Data from this trial are shown in Table 4. Yield and grain protein content were not affected by the fertilizer treatments applied during this particular crop year but there were significant differences among the four varieties for both traits. An unreleased HRW line, OR CR 8313, yielded on the average, 7.6 bu/a more than 'Stephens' at 0.7% greater grain protein content.

Development of cereal varieties for a state with such climatic diversity as Oregon requires that selection and testing take place over an extensive network of experimental sites and the interdisciplinary cooperation of many individuals and units within the state agricultural research system. We are pleased to acknowledge the valuable assistance of: Quinten Rugg, Steve Anderson, Larry Kaseberg, Kenny Holmes, and Jim Lind for providing well managed off-station experimental sites for our breeding efforts; the superintendents of the various Agricultural Experiment Stations for testing elite lines throughout the state; and Chuck Rohde, Matt Kolding, Vance Pumphrey, and Floyd Bolton for their scientific input and the overall team approach we enjoy in keeping the Oregon grower in the most competitive position possible in the market place.

Table 3. 1985 yields, % grain protein content and long-term yields of varieties and selections of Hard Red Winter Wheat as grown at Pendleton

| Variety or Selection | 1985 Yield* | 1985 % Protein | Long-term Yield* |
|---|---|---|---|
| Wanser | 58.5 | 13.1 | 47.5 |
| Centura | 73.0 | 13.1 | 57.8 |
| Hatton | 81.2 | 13.3 | 57.4 |
| OR CR 8313 | 89.0 | 13.2 | 88.0 |
| OR CR 8320 | 71.0 | 13.1 | 92.4 |
| OR CR 8414 | 77.7 | 13.2 | 81.9 |
| OR CR 8511 | 79.5 | 13.0 | 92.8 |
| OR CR 8512 | 75.8 | 13.1 | 82.8 |
| OR CR 8513 | 78.9 | 13.1 | 92.7 |
| ISN-B2 | 71.2 | 13.2 | 88.1 |
| lsd .05 | 9.69 | | |

* Bushels/Acre

Table 4. Grain yields and percent grain protein content for four winter wheat varieties grown in a fertilizer trial at Pendleton in 1985

| Variety/Selection | Market Class | Mean* Yield (bu/a) | Mean %* Grain Protein |
|---|---|---|---|
| Stephens | SWW | 84.8 | 12.5 |
| OR CR 8313 | HRW | 92.4 | 13.4 |
| OR CR 8414 | HRW | 77.7 | 14.3 |
| *Siouxland** | HRW | 69.2 | 14.5 |
| lsd .05 | | 5.69 | 0.70 |

* Over three replications and nine fertilizer treatments = 27 plots.
** A HRW variety from Nebraska.

# A Search For Winter Cereals Adapted to the Dwarf Bunt (Tilletia controversa Kuen) Production Areas in and Bordering Oregon

Mathias F. Kolding, Warren E. Kronstad, and Connie Love[1]

Dwarf bunt (Tilletia controversa Kuehn, = TCK) is found in herbarium specimens collected in 1861 in New York, and in 1921 in Oregon (Duran, 1956). Trione (1982) reports that dwarf bunt infections may occur on small acreages, but the problem is enhanced because the dustlike spores become contaminates of boxcars, ships, trucks and elevators. Heavily infested fields are not always infested in subsequent years, primarily because a persistent snowcover is required for successful TCK infections. Though some feel that TCK may have found its way to wheat via grass species such as Agropyron spp., it is likely to have evolved together with wheats for thousands of years in the Middle East near the center of wheat's origin.

Conditions favorable for TCK infections to develop are nearly the same as for various snowmolds. Bruehl (1982) notes that this is especially so when snow has fallen on unfrozen or lightly frozen ground and persists until spring. The insulating effect of the snowcover favors growth of other pathogenic species of Fusarium, Pythium, and Typhula. Each species, however, has a specialized set of conditions most favorable to it. Consequently, the dominant fungi may change from year to year and further complicate the search for new adapted cereal varieties.

Plants resistant to TCK and snowmold fungi are often lost during cold open winters or to soil heaving caused by freezing and thawing of saturated soils. If they survive the soil heaving which causes root injury, Cephalosporium stripe can become a problem.

Since 1973, several locations near Flora, Oregon, have been sites for the cereal breeding program. New crosses with tolerance to snowmolds, frost heaving, and winter freezes usually were susceptible to the endemic dwarf bunt races, were ravaged by Cephalosporium, or had severe root rot infections. The poorly adapted types produced nearly useless progeny, whether from single, top, back, or double crosses. Some lines such as Thule III, CI 14106, SM-11, SM-4, CI 178201, and CI 178210 survived and are now the primary progenitor of the present successful wheat crosses.

## OBJECTIVES

Screening trials were started near Flora, Oregon, to a) discover those winter wheat, barley, and triticale cultivars having tolerance or resistance to diseases, and other environmental stresses found in the Flora cereal production system; b) use those cultivars in new crosses with adapted varieties; and c) select, test, and release new varieties to growers.

[1]Senior instructor, Hermiston Agricultural Research and Extension Center, Hermiston, Oregon 97878; professor and research assistant, Crop Science Department, Oregon State University, Corvallis, Oregon 97331.

## METHODS

Winter cereal selections were regularly screened for adaption on several sites near Flora, Oregon. Survivors were planted at the Hermiston Agricultural Research and Extension Center for seed increase or disease evaluations. Seed from the increases was usually planted at Flora, sent to Corvallis, and/or put into the smut trials at the Columbia Basin Agricultural Research Center near Pendleton. Hybridizations, selection, testing, and seed increase were performed on the Hermiston station where: a) irrigation water is available to insure fall stands, b) less snow gives better chances of plant exposure to cold air, c) root diseases abound, and d) the possibility exists to measure a selection's maximum yield potential. As time progressed, promising lines were sent to Dr. J. A. Hoffmann at Utah State University for his dwarf smut trials at Logan and Blue Creek.

## RESULTS

The Flora yield trials were started in 1973. Dwarf smut resistance lines came from germplasm inventories gathered by Dr. Robert Metzger, (retired) ARS, USDA, Corvallis, Oregon. A result of that cooperation is a recently released winter triticale 'Flora'. Flora is adapted to high elevation and sandy soil sites. Diseases were of very low importance in the triticale. They survived the Flora winter problems very satisfactorily. In 1985 that was not the case (Table 1). The examples given, except M81-8046, are lines which had more than 80 percent winter survival rates for more than five years. This trial had 18 triticale.

Winter barleys usually did not survive more than one season. In 1985, several F-2 bulk populations survived at very satisfactory levels (Table 2). Ninety-two winter wheat bulks were examined in the Flora trials during 1984-85. Some had zero survival; others had all plants infected with smut.

Tables 3, 4, 5, and 6 describe and typify frustrations which were encountered in the quest for dwarf smut resistant winter wheats adapted to Oregon's overall wheat production acreage. Dwarf smut incidence was low in winter wheat (Table 3). FW79405 is a prime example of bunt resistance coupled to a high yield potential at other locations. The highest ranking 3 of 24 are the results of the vigorous screening research at Flora. FW81454-301 is being tested in the Western Regional White Winter trials (Table 4). It appears to yield comparatively to Stephens and Malcolm at Hermiston, but does not have their yield potential. FW771697G08 is a white seeded line especially adapted to the irrigated sands. The Stephens*2/Sm-4 cross has good resistance (Table 5) to dwarf bunt, but poor yields because of winter stand losses. The cross has a very high yield potential in superior managed trials (Table 6) as well as in highly stressed trials (Table 7). The Daws/Sm-4/2/Mdm/SM-11 cross, however, has a better probability of success, since both Daws and Sm-11 have a better survival record in the Flora trials than Stephens or Sm-4.

Table 1. Eastern Oregon Winter Triticale, 1985--yield, rank in trial, and average survival of several triticale grown near Flora, Oregon

| Entry | Pedigree | Grain yield (bu/acre) | Rank | Survival (%) |
|---|---|---|---|---|
| M75-8645YD2 | Kiss/Elt. | 6 | 18 | 9 |
| M75-8646YD1 | Kiss/274-193 | 10 | 15 | 19 |
| M81-8046 | Daws/Antelope/2/6TA 876 | 44 | 1 | 81 |
| FT 6292 | Kiss/Elt | 15 | 5 | 38 |
| PI 478305 | Flora | 24 | 3 | 36 |

Table 2. Pedigrees of winter wheat and winter barley kept as bulks and planted near Flora as a selection source in 1986

| Wheat | Barley |
|---|---|
| 1. Luke*2/PI178210/Stephens | 1. FB130EEB/Schuyler/4/DR1608/ Lakeland/2/Schuyler/3/FB130E |
| 2. Stephens*2/FW75536F701 | 2. Alpine/DR67-1623/2/NE76138/ FB130EEB |
| 3. FW8390/Lewjain | 3. FB79019/FB77818HY/2/FB73258 |
| 4. Stephens*2/Thule III/2/FW83830 | |
| 5. Stephens*2/Thule III/2/FW81439 | |
| 6. Stephens*2/FW75536F701/2/FW81439 | |
| 7. Stephens*2/FW75536F701/2/Lewjain | |
| 8. Stephens*2/FW75536F701/2/FW74706 | |

Table 3. Flora Repeat White Winter Wheat Trial, 1985--yield and rank in trial of several winter wheats grown near Flora, Oregon

| Entry | Pedigree | Grain yield (bu/acre) | Rank |
|---|---|---|---|
| Greer | CI 17725 | 30.2 | 12 |
| Weston | CI 17727 | 26.5 | 14 |
| Daws | CI 17419 | 24.8 | 13 |
| ID 3518 | WA7465/3/BZ/2/Burt/PI178383 | 42.0 | 6 |
| FW79405 | P-101/Triticum Timopheevi/P-101 | 11.5 | 18 |
| FW82652 | Stephens/Sm-4 | 54.8 | 1 |
| Smut B-303 | 3047 Bulk | 49.8 | 2 |
| FW81454-301 | Daws/Sm-4/2/Mdm/Sm-11 | 43.8 | 3 |

Table 4. Eastern Oregon Irrigated White Winter Wheat, 1985--yield, rank in trial, and test weight of several winter wheats in a trial grown near Hermiston (H), and Boardman (B), Oregon

| Entry | Pedigree | Grain yield -(bu/acre)- | | Rank of 18 | | Test Weight (pounds) | |
|---|---|---|---|---|---|---|---|
| | | (H) | (B) | (H) | (B) | (H) | (B) |
| Stephens | CI 17596 | 118 | 157 | 4 | 2 | 60 | 62 |
| Malcolm | CW8113 | 118 | 148 | 5 | 5 | 61 | 62 |
| FW81454-301 | Daws/Sm-4/2/Mdm/Sm-11 | 115 | 131 | 7 | 6 | 57 | 60 |
| FW771697G08 | Cama/JJG/2/FW-127 | 133 | 160 | 1 | 1 | 61 | 61 |

Table 5. Flora Preliminary White Wheat, 1985--grain yield, common smut and dwarf smut evaluations by Dr. Metzger (common at Pendleton (P), and Dr. Hoffman (dwarf at Logan (L) and Blue Creek (BC), grown near Hermiston (H) and Flora (F), Oregon

| Entry | Pedigree | Grain yield (bu/acre) | | Common smut Metzger (%) | Dwarf smut Hoffman (%) | |
|---|---|---|---|---|---|---|
| | | (H) | (F) | (P) | (L) | (BC) |
| Winridge | CI17902 | 106 | 36 | 25 | 18 | OT |
| FW81464-311 | Stephens*2/SM-4 | 118 | 8 | 4 | 6 | 0 |
| FW81464-351 | Stephens*2/Sm-4 | 122 | 7 | 2 | 0 | 0 |
| FW81454-303 | Daws/S4/Mdm/S11 | 95 | 50 | 15 | 0 | 0 |

Table 6. Hermiston Irrigated Winter Wheat, 1985--yield and test weights of three winter wheats tested in a yield trial near Hermiston, Oregon

| Entry | Pedigree | Grain yield (bu/acre) | Test weight (pounds) |
|---|---|---|---|
| Stephens | CI 17596 | 142 | 58.0 |
| FW81463-308 | Stephens*2/SM-4 | 174 | 57.0 |
| FW81463-319 | Stephens*2/SM-4 | 158 | 58.0 |

Table 7. Eastern Oregon Dryland Winter Wheat, 1985--yield and heading date of several winter wheats grown near Pendleton (P) and near Hermiston (H)*

| Entry | Pedigree | Grain yield (bu/acre) | | Heading date (50% heads) | |
|---|---|---|---|---|---|
| | | (P) | (H) | (P) | (H) |
| Sturdy | CI 13684 | 54 | 26 | 5-25 | 5-16 |
| Centura | PI476974 | 57 | 27 | 5-24 | 5-16 |
| Stephens | CI17596 | 61 | 31 | 5-28 | 5-21 |
| WA 6816 | ID 5012/WA5866 | 54 | 25 | 6-03 | 5-21 |
| UT132712 | Kr/Sve/Rdt///It/4/... | 54 | 28 | 5-24 | 5-20 |
| FW81464-301 | Stephens*2/Sm-4 | 67 | 35 | 5-28 | 5-18 |

## DISCUSSION

During the past several years an intensive effort funded by a special USDA, ARS regional grant with the acronym TRADE has given Oregon researchers some assistance in testing new wheats.

Flora, Hermiston, and Corvallis are still primary sites for developing, testing, and evaluating new material, but the number of promising lines generated require more land space and personnel as adapted lines appear in advanced generations. For example, a trial at Flora has 660 entries. These 660 are at Washington State University, Pullman, Washington, for micromilling and at Corvallis for foliar disease evaluations. There are 24 trials at Flora which range from early generation selection bulks to advanced yield trials. Chevron has given permission to use a systemic fungicide for evaluation in one trial. In another, Dr. Trione will evaluate dwarf smut mycelium development in a very susceptible hardy line. Winter triticale, barley, and oats are studied in the expectation that these resistant cereals could offer the grower an alternate crop to rotate with wheat and, therefore, reduce inoculum levels of pathogens in soil.

Both white and red seeded wheats are in advanced yield trials to estimate their adaptation to Oregon. The better lines are, or will be, crossed to advanced breeding material emanating from the Barley Yellow Dwarf Virus program at Hermiston.

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# Pea Yield Response to High Temperatures During Blooming and Pod Filling

F. V. Pumphrey and R. E. Ramig[1]

## INTRODUCTION

Favorable temperatures for growing peas are warmer than our average temperatures for emergence and early vegetative growth followed by maximum temperatures not exceeding 80 to 83° F. Unfortunately, temperatures often exceed 90° during blooming, pod set, and pod filling. The loss in yield that above-optimum temperature imposes on pea yield can be determined by relating the yields from past seasons to temperatures which occurred while the peas were growing. The object of this report is to present the relationship between historic pea yields and temperatures from the initiation of bloom through pod fill and to use that relationship to evaluate the effect of high temperature on pea yield.

## MATERIALS AND METHODS

Fresh pea yield data from 1945 through 1977 were obtained from the Columbia Basin Agricultural Research Center, Pendleton and from two locations within 10 miles of the Center. These locations used similar cultural practices to produce peas in a pea-winter wheat rotation. Peas were planted between April 1 and 15, bloomed after May 10, and were usually harvested between June 15 and July 1; sometimes harvests were as late as July 10. The cultivar 'Dark Skinned Perfection' was grown except in earlier years when 'Perfection' was grown.

Air temperatures used in this study were those recorded at the Columbia Basin Agricultural Research Center, Pendleton. Late spring frosts damaged plantings in 1947 and 1966; consequently, yields for these years were omitted.

Multiple regression was used to evaluate the effects of precipitation from October through June and temperatures from April through harvest to pea yields (2). This analysis indicated differences in precipitation between seasons and years accounted for 38% of the variation in yield between years. Air temperatures expressed as heat degree-day sums above 78° F during flowering and pod filling accounted for 27% of the variation in yield. Adjusting pea yields to mean October through June precipitation (3) to remove variations resulting from year-to-year variation in water supply allowed intensive analysis of the relationship between maximum daily temperatures and pea yields.

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[1] Professor of agronomy, Oregon State University, Columbia Basin Agricultural Research Center and soil scientist, USDA-ARS, Columbia Plateau Conservation Research Center, Pendleton, Oregon, 97801.

Heat degree-day sums were used as a measure of the accumulation of heat occurring above selected base temperatures during the reproductive growth stage. A heat degree-day was one degree of temperature above the selected base temperature. For example, a maximum temperature of 91° on one day would produce 10 heat degree-days using a base temperature of 81°. The heat degree-day sum for this analysis was the sum of the heat degree-days occurring between May 10 and harvest. The heat degree-days were summed for this interval each year for each location. Base temperatures used were 69, 72, 75, 78, 81, 84, 87, 90, and 93°. Simple regression analysis was used to calculate a regression equation of pea yield and heat degree-day sums.

Each regression equation (Table 1) is composed of two parts -- the intercept and the regression coefficient. The intercept indicates the yield (in pounds per acre) produced at the base temperature. The coefficient is the yield (in pounds per acre per heat degree-day) lost for each heat degree-day above the base temperature.

Table 1. Means, ranges, and regression equations for heat degree-day sums and pea yields, 1945-1977[1]

| Base temperature | Heat degree-day sums | | Regression equation[2] | |
|---|---|---|---|---|
| | Mean | Range | | |
| °F | | | intercept | regression coefficient |
| 69 | 246 | 124-401 | 2945 | - 2.0 |
| 72 | 187 | 92-355 | 2783 | - 2.1 |
| 75 | 135 | 56-283 | 2697 | - 2.5 |
| 78 | 96 | 31-179 | 2937 | - 4.9 |
| 81 | 63 | 16-137 | 2850 | - 6.8 |
| 84 | 41 | 3-105 | 2720 | - 8.7 |
| 87 | 22 | 1- 77 | 2591 | - 12.7 |
| 90 | 12 | 0- 52 | 2447 | - 17.3 |
| 93 | 5 | 0- 33 | 2334 | - 27.3 |

[1] 1947 and 1966 years not included.

[2] Pounds per acre for the intercept and pounds per heat degree-day above base temperature for regression coefficient.

## RESULTS AND DISCUSSION

Average fresh pea yield for the 1945-1977 period was 2340 pounds per acre; most of the yields were between 1530 and 3150 pounds. The highest yield during these years was 4340 pounds and the lowest was 350 pounds. At least two-thirds of this large variation in yield can be accounted for by conditions other than the grower's cultural practices (2).

Average heat degree-day sums decreased as the base temperature increased (Table 1) indicating maximum daily temperatures do not plateau at any level from May 10 into early July. The wide range in heat degree-day sums at each base temperature level expresses the great variation in maximum daily temperatures which occurred among years.

The intercepts of the regression equations are reasonably constant from base temperatures 69 through 84° (Table 1) which indicates degree-days occurring from the lower temperatures are favorable from pea growth. Temperatures of 78 to 81° might be considered to be optimum when viewed from the ability of lower temperatures to counter (in this method of analysis) the adverse effects of higher daily maximum temperatures. Intercepts steadily declined as the base temperatures increased above 78° indicating the degree-days resulting from the higher temperatures are adverse to pea production.

The signs of all regression coefficients were negative indicating temperatures above the base temperature had a negative effect on yield (Table 1). Regression coefficients were equal for base temperatures below 78° but increased for each additional increment of base temperature. The extremely curvilinear adverse effect of the higher temperatures on pea yield is shown graphically in Figure 1. For example, each base 93 heat degree-day reduced yield by 27 pounds per acre which is three times the yield reduction of 8.7 pounds from the base 84 degree-day.

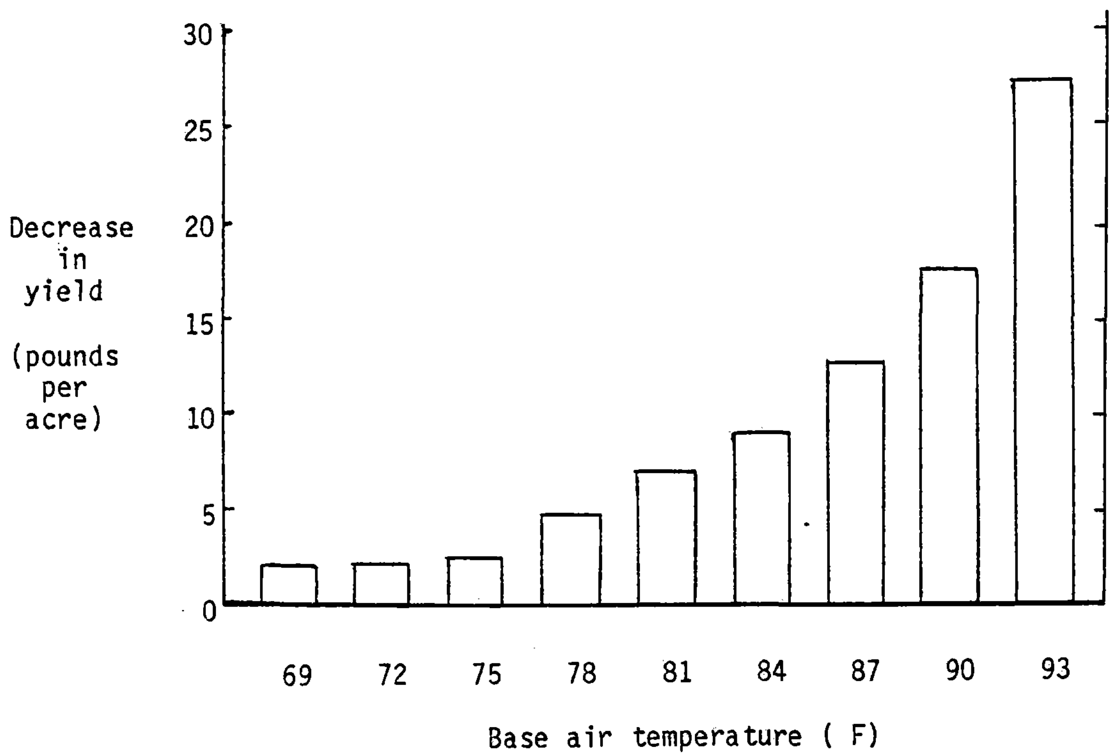


Figure 1. Decrease in yield per heat degree-day above base air temperature.

Respiration in peas increases rapidly as temperatures increase above the optimum for growth (1). The pea plant, during blooming and pod filling, is not tolerant of high respiration and deteriorates rapidly as more energy is used in respiration. Cultural practices and temperatures which promote rapid growth and early harvest reduce the chance of exposing the crop to yield-decreasing heat during pod filling.

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# Root Development in Legume Plants

Betty Klepper, F. Vance Pumphrey, and T. R. Toll[1]

A healthy, vigorous root system is essential to high levels of production in peas. Healthy root systems provide plentiful supplies of moisture and fertilizer nutrients, anchor the plant, and may provide important hormones and vitamins to shoots. Legume root systems also provide sites for Rhizobium to form nodules and fix nitrogen which can become available to shoots. This article describes some field research done in 1983 and 1984 to relate root and shoot development patterns for legumes and describes the morphology of legume root systems over time.

## ROOT SYSTEM DESCRIPTION

The legume root system consists of a taproot from which lateral roots emerge as the root matures. The zones present in the tap root include an actively-dividing meristematic zone covered by a cone-shaped root cap, a zone of rapid elongation which provides the force needed for roots to penetrate soil, a mature zone with root hairs, and an older zone which has lateral roots. Each lateral root has a similar sequence of zones. It takes about 200 degree days for a segment of newly elongated root to produce first-order laterals and another similar period of time for these first-order laterals to produce second-order laterals. Table 1 shows the expected order of branching for five varieties of legumes as related to main stem leaf number and cumulative degree days from emergence.

## NODULATION

Young lateral roots provide sites for Rhizobium entry into root systems. In the presence of rhizobial invasion, lateral roots develop into nodules. Generally, under growing conditions at the Pendleton Experiment Station in 1983 and 1984, nodules appeared coincidentally with lateral roots and entered a phase of activity as shown by the presence of red pigment in the nodule about a week after appearance. However, nodule activity was brief, only 2 to 3 weeks for most varieties, and nodules generally decayed during or soon after pod set.

Table 2 gives some phenological data for above- and below-ground plant development. Data were relatively consistent between years for calendar days to emergence, degree days to first flower, and leaf number at first flower. There is considerable difference between years for most other factors. The differences in height are unexpected. By first flower, the root system has penetrated to nearly 3 feet.

[1] Plant physiologist, USDA-ARS, Columbia Plateau Conservation Research Center, Pendleton, OR., 97801, professor of agronomy, Oregon State University, Columbia Basin Agricultural Research Center, Pendleton, OR., 97801, and biological technician, USDA-ARS, Columbia Plateau Conservation Research Center, Pendleton, OR., 97801.

## SUMMARY AND CONCLUSIONS

Pea root systems penetrate to different depth because of the elongation of the taproot. Exploration of soil at any one depth results from growth of lateral roots and their branches. Branches and nodules can appear about 200 GDD after a piece of root has been produced.

Table 1. Relationship between root branching habit and main stem leaf development

| Species | Taproot upper 10 cm Order of branching 1 | 2 | 3 | Taproot upper 10 cm Order of branching 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| | Main stem leaf number | | | Degree days after emergence | | |
| Peas -- Latah | 4 | 5 | 9 | -- | 244 | 478 |
| Peas -- Dark Skin Perfection | 5 | 5 | 9 | -- | 254 | 478 |
| Fababean | 5 | 7 | 11 | -- | 350 | 525 |
| Lentils | 6 | 7 | 11 | -- | 294 | 525 |
| Garbanzo | 6 | 9 | 13 | -- | 350 | 478 |

Table 2. Phenological data for green peas (`Dark Skinned Perfection')

| | Emergence 1983 | Emergence 1984 | Five-leaves 1983 | Five-leaves 1984 | Ten leaves 1983 | Ten leaves 1984 | First flower 1983 | First flower 1984 |
|---|---|---|---|---|---|---|---|---|
| Calendar days from planting | 16 | 18 | 22 | 26 | 39 | 49 | 60 | 72 |
| Degree days from planting | 155 | 123 | 215 | 228 | 401 | 494 | 768 | 828 |
| Leaf number | --- | --- | 5 | 5 | 10 | 10 | 18 | 17 |
| Estimated depth[1] of rooting (cm) | 9 | 6 | 16 | 17 | 38 | 50 | 83 | 89 |
| Height (cm) | 0 | 0 | --- | 4.3 | 14.5 | 24.2 | 45 | 62.4 |

[1] Estimated on assumption that roots grow 0.12 cm per degree day and 80 degree days are required for germination.

# A Breakthrough for Selective Cheatgrass Control in Winter Wheat

D. J. Rydrych[1]

## INTRODUCTION

For the last 60 years, eastern Oregon farmers have tried many cultural and chemical innovations to eliminate cheatgrass in cereal grains (wheat and barley). Cheatgrass is a problem in almost all grain fields, therefore, farmers must manage their cultural practices and planting dates to coincide with cheatgrass germination. This often causes delays in planting or loss of moisture from seedbeds which results in loss of income.

Compounds that help control cheatgrass, such as trifluralin (Treflan), diclofop (Hoelon), or metribuzin (Sencor or Lexone), have to be either soil incorporated (trifluralin and diclofop) before planting or applied post-emergence (Sencor and Lexone) after wheat has developed crown roots. Ethyl metribuzin (Tycor or Siege) is a promising preemergence or postemergence compound that may help solve the cheatgrass problem.

## MATERIALS AND METHODS

Field experiments have been conducted since 1983 in a wheat-fallow production system on the OSU - Columbia Basin Agricultural Research Center at Pendleton, and three nearby locations (Holdman, Echo, and Ione). Yearly precipitation averaged 16.1 inches at Pendleton, 9.8 inches at Holdman, 11.0 inches at Echo, and 8.7 inches at Ione. A randomized block design with three replications was used at each location. Wheat (54 lbs/acre) was planted 2.5 inches deep in October with rows spaced 14 inches apart. Ethyl metribuzin and metribuzin were applied preemergence, or early postemergence when wheat had one to three tillers. Plots were harvested in July from 6.5 feet of two center rows of each plot. Cheatgrass was removed manually from each hand-weeded control.

## RESULTS AND DISCUSSION

Tables 1 and 2 give comparisons of cheatgrass control and wheat yields from plots treated with metribuzin and ethyl metribuzin. Ethyl metribuzin has been evaluated since 1983 for selective cheatgrass control in winter wheat at four locations in Umatilla and Morrow counties. Experiments have been conducted on cheatgrass since 1975 on funds provided by the Oregon Wheat Commission. Ethyl metribuzin was compared with metribuzin to evaluate comparable crop injury and weed response. Excellent chemical tolerance was demonstrated on wheat in the 1 to 3-leaf stage (Table 1). The experiment

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[1] Professor of agronomy, Oregon State University, Columbia Basin Agricultural Research Center, Pendleton, Oregon 97801.

was conducted at three locations (Echo, Holdman, and Ione) in 1984. Metribuzin reduced yield on small wheat (3-leaf) except at low rates of application (.12 lb/A). Ethyl metribuzin was safe on small wheat regardless of chemical rate.

Cheatgrass control was excellent in 1985, using ethyl metribuzin when it was applied before the weeds had 1 to 2 tillers. Treatments on well tillered cheatgrass resulted in poor weed control (Table 2). Metribuzin was less efficient on cheatgrass that had 1 to 2 tillers. Crop safety is marginal when metribuzin is applied on wheat from preemergence to 3-leaf, but excellent with ethyl metribuzin.

Table 1. Ethyl metribuzin (Ethiozine) for downy brome control in seedling winter wheat at three eastern Oregon locations - 1984 (OSU- CBARC)

| Treatment 1/ | Rate (lb/A) | Downy brome control (%) Echo | Holdman | Ione | Avg. | Winter wheat yield 2/ (lb/A) Echo | Holdman | Ione | Avg. |
|---|---|---|---|---|---|---|---|---|---|
| Metribuzin | .12 | 91 | 90 | 88 | 90 | 3580 b | 2050 a | 3120 a | 2920 a |
| Metribuzin | .25 | 98 | 99 | 91 | 96 | 3630 b | 1570 a | 2600 a | 2600 b |
| Ethyl metribuzin | .50 | 84 | 81 | 70 | 78 | 4040 a | 2170 a | 3280 a | 3160 a |
| Ethyl metribuzin | 1.00 | 99 | 98 | 95 | 97 | 4360 a | 1920 a | 3250 a | 3180 a |
| Weeded control | ---- | 100 | 100 | 100 | 100 | 4150 a | 2100 a | 3200 a | 3150 a |
| Control | ---- | 0 | 0 | 0 | 0 | 2680 c | 1290 b | 2090 b | 2020 c |

1/ Treatments - Post - November 1983 (Winter wheat 1 to 3 leaf).

2/ Means within each column containing the same letter are not significantly different using the DMR test.

Table 2. Ethyl metribuzin (Ethiozine) and metribuzin timing trial in Stephens winter wheat - OSU - CBARC - Pendleton, Oregon - 1985

| Treatment 1/ | Time | Rate (lb/A) | Downy brome control (%) | Broadleaf control (%) | Crop injury (%) | Wheat yield (lb/A) 2/ |
|---|---|---|---|---|---|---|
| Metribuzin | Pre | .50 | 99 | 99 | 60 | 1380 |
| Metribuzin | 3-leaf | .50 | 99 | 100 | 18 | 2510 |
| Metribuzin | 1-2 tiller | .50 | 75 | 95 | 6 | 3180 |
| Metribuzin | 3-4 tiller | .50 | 25 | 96 | 2 | 2190 |
| Ethyl metribuzin | Pre | 1.00 | 99 | 99 | 0 | 3160 |
| Ethyl metribuzin | 3-leaf | 1.00 | 99 | 95 | 3 | 3630 |
| Ethyl metribuzin | 1-2 tiller | 1.00 | 60 | 88 | 0 | 3380 |
| Ethyl metribuzin | 3-4 tiller | 1.00 | 20 | 96 | 0 | 3040 |
| Weeded control | ---- | ---- | 100 | 100 | 0 | 3090 |
| Control | ---- | ---- | 0 | 0 | 0 | 2220 |

1/ Treatments - Pre - October 18, 1984, 3-leaf - November 29, 1984, 1-2 tiller - March 20, 1985, 3-4 tiller - April 10, 1985.

2/ Wheat yield average for 3 replications.

Ethyl metribuzin has excellent wheat tolerance and crop safety when applied to wheat regardless of growth stage (Table 2). It is one of the most selective triazine herbicides tested in eastern Oregon since 1975. Ethyl metribuzin is highly selective on wheat that is in the early seedling stage, so it can be applied soon after wheat emergence when cheatgrass is most sensitive. Since it is less efficient on cheatgrass that is well tillered (Table 2), spring application (March to April) is not as effective. Ethyl metribuzin is also active on broadleaf weeds such as fiddleneck, false flax, blue mustard, tumble mustard, and prickly lettuce. Ethyl metribuzin will be called Tycor (Mobay) or Siege (DuPont) when it is released for commercial application.

## CONCLUSION

This research breakthrough will be good news for eastern Oregon farmers and other growers in the Pacific Northwest who have been looking for a downy brome control program that works. Weed control practices can be applied in the fall at planting or shortly after wheat and cheatgrass emergence. Farmers will have effective cheatgrass control with good crop safety on fall-planted winter wheat.

Research results in 1985 also show that ethyl metribuzin is an effective and safe selective herbicide for cheatgrass control in wheat and barley. Other experiments, since 1983, have shown that it is partially effective on jointed goatgrass, bulbous bluegrass, ripgut brome, and many broadleaf weeds. Ethyl metribuzin may very well turn out to be the broad spectrum weed herbicide of the 1980's.

# Effect of Paraplowing on Winter Wheat Growth

D. E. Wilkins, P. E. Rasmussen, and J. M. Kraft[1]

## INTRODUCTION

Hard pans in the root zone can limit plant growth and increase runoff and soil erosion. Hard pans are created by tilling when soil is wet, excessive secondary tillage, and wheel traffic (Voorhees and Lindstrom, 1983). Because of the increase in agricultural equipment weight there is concern about traffic-induced hard pans.

There is particular concern for the region in the Columbia Plateau where fresh processing peas (*Pisum sativum* L.) are raised. Intensive tillage, in preparation for seeding peas in early spring when the soil is moist and ideal for compaction, and the high amount of traffic by heavy equipment at harvest time make this system highly susceptible to creating hard pans in the root zone. Allmaras et al. (1982) and Wilkins et al. (1985) showed that soil compaction accentuates pea root rot diseases *Pythium ultimum*, Trow and *Fusarium solani* (Mart.) Sacc. f. sp. *pisi* (Jones) Snyd. & Hans.

An Integrated Pest Management (IPM) research project was started to find solutions to pea yield constraints caused by root rots (Wilkins et al., 1985). Soil compaction is a primary variable in the IPM studies. Tillage treatments to shatter the hard pans in and below the plow layer were incorporated into these IPM field studies to determine the influence of compaction on pea production.

Winter wheat (*Triticum aestivum* L.) is grown alternate years in rotation with peas on the IPM sites. If eliminating the hard pans through tillage improves pea production, what is the impact of this tillage on the wheat crop? This report describes the influence of hard pans, at the IPM sites, on winter wheat growth for the 1984-85 growing season.

## MATERIALS AND METHODS

The three IPM sites, Meiners, Ferrel, and Kirk, represent Palouse, Walla Walla, and Athena silt loam soils, respectively. Average annual precipitation is 22 inches at Meiners, 16 inches at Ferrel, and 19 inches at Kirk.

After pea harvest but before planting winter wheat, half the plots were paraplowed 13 inches deep to break up the hard pan. Fertilizer applied was 120-0-15, 100-0-8, 60-0-15 (N-P-S lbs/A), respectively, for Meiners, Ferrel, and Kirk. Stephens winter wheat was seeded October 18 at Meiners,

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[1] Agricultural engineer and soil scientist, USDA-ARS, Columbia Plateau Conserv. Research Center, Pendleton, OR., 97801; and plant pathologist, USDA-ARS, Irrigated Agricultural Research and Extension Center, Prosser, WA, 99350.

October 24 at Ferrel, and October 16 at Kirk at the rate of 60 lbs/A. Cone index (resistance to penetration of a 30 degree cone with a 0.30-square inch base) and soil water in the top two feet of the soil profile were measured in early May.

The number of wheat heads were counted in a 10 square foot area of each plot. Bundle samples were collected at harvest, threshed, and weighed to determine wheat and straw yield for each plot.

## RESULTS AND DISCUSSION

Soil strength in the top two feet of soil, as indicated by cone index, at Meiners, Ferrel, and Kirk is shown in Figure 1. Soil water content profiles were the same for the moldboard and paraplow tillage treatments at the time cone index was measured (5% level of probability). Therefore, differences in cone index values for the tillage treatments in Figure 1 reflect differences in soil strength from tillage.

Cone index increased with depth and there was no distinct hard pan at the Meiners site (Figure 1). At Kirk and Ferrel, there were hard pans at 5 inches which were created after the primary tillage. The Kirk site had a second tillage pan from 12 to 14 inches which the paraplow shattered. The Ferrel site had the most distinct deep tillage pan which ranged from 10 to 16 inches deep. The paraplow tillage treatment shattered the deep tillage pan and reduced the cone index by more than 30 percent.

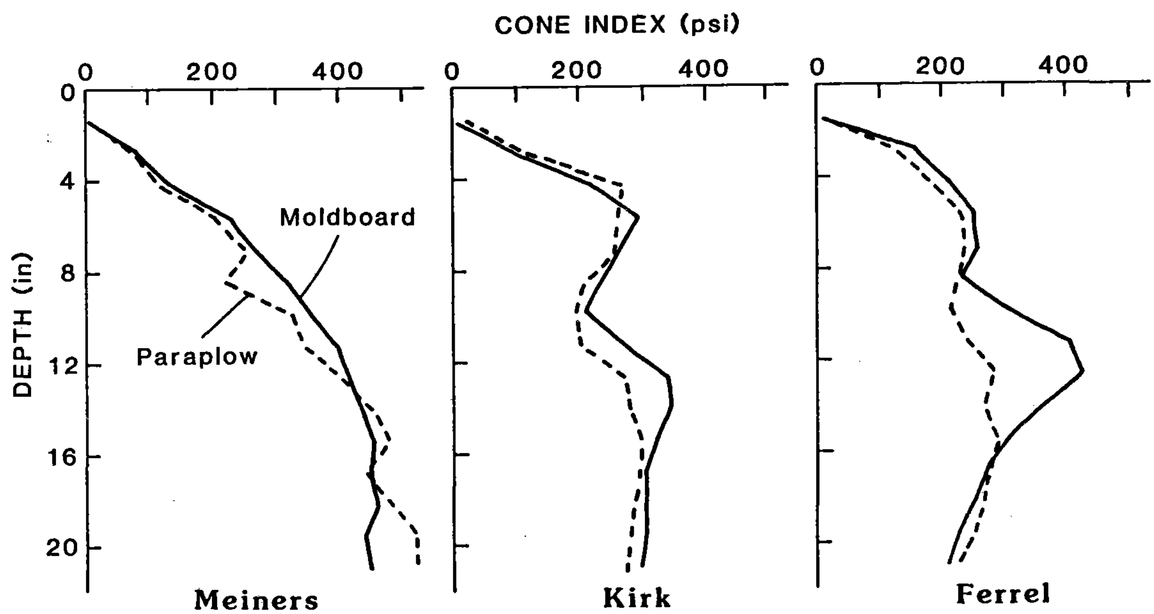


Figure 1. Influence of primary tillage on cone index, at three sites.

Table 1. Influence of primary tillage on number of wheat heads, straw yield, and grain yield

| Location | Primary Tillage | Heads | Straw | Grain |
|---|---|---|---|---|
| | | Heads/ft$^2$ | lbs/A | Bu/A |
| Meiners | Moldboard plowed | 35.8 | 5640 | 79.0 |
| | Paraplowed | 33.2 | 5639 | 75.5 |
| Ferrel | Moldboard plowed | 33.4 | 5672 | 77.5 |
| | Paraplowed | 31.2 | 5277 | 74.4 |
| Kirk | Moldboard plowed | 39.7 | 5495 | 73.3 |
| | Paraplowed | 39.1 | 6114 | 70.8 |
| Mean | Moldboard | 36.3 A | 5602 A | 76.6 A |
| | Paraplowed | 34.5 A | 5677 A | 73.6 B |

* Means within a column followed by the same letter are not significantly different at the 5% level of probability.

Wheat yield characteristics are summarized in Table 1. Number of heads produced per square foot were not significantly different (5% level of probability), although the trend was toward lower head production at all sites for the paraplow tillage. Straw production was not significantly different for the two types of tillage. Grain yield was significantly lower for the paraplow tillage as compared to the moldboard tillage. This may have been caused by more soil water lost through evaporation in the paraplow tillage than in the moldboard tillage. Additional information on soil water status is needed to assess the impact of breaking hard pans in the Columbia Plateau silt loam soils on wheat production.

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# Influence of Type and Placement of Fertilizer on Tillering, Components of Yield, and Yield of Recropped Winter Wheat

Robert E. Ramig and L. G. Ekin[1]

Annual cropping small grains is one of the most effective soil and water conservation practices in the Pacific Northwest. This practice is particularly successful in those areas where over winter precipitation will recharge the shallow or coarse textured soil profile. Recent development and release of new herbicides provide good control of weeds. Wilkins et al. (1982) development of the USDA modified deep furrow grain drill opener permits satisfactory seeding into minimum or no-tilled seedbeds with band placement of fertilizer two inches below the seed. Klepper et al. (1983) discussed fertilizer placement for cereal root access and Ramig and Ekin (1985) reported fertilizer response for minimum tilled and no-till annual cropped small grains. Klepper et al. (1982) developed a method for quantitative characterization of vegetative development of small grain cereals. The method reveals that small grain plants are sensitive to stresses such as water, herbicide damage, and lack of nutrients. Yield response of recropped winter wheat to some plant nutrients such as phosphorus and sulfur has been erratic.

This research reports the response of early growth and tillering, components of yield, and grain yield of recrop winter wheat to application of nitrogen, phosphorus, and sulfur fertilizer and to band or broadcast placement of the fertilizer.

## METHODS

Fallow wheat stubble (approximately 8200 pounds per acre) was flailed and disked twice with a heavy disk on the Newtson farm near Pilot Rock in September 1984. To prevent the excess loose residue on the surface from forcing disk drills out of the ground or causing deep furrow drills to clog, the non soil-covered residue was burned and the land cultivated. Sufficient rains after mid-October provided adequate seedbed moisture. Stephens winter wheat was seeded at 80 pounds per acre on October 31 using a Noble DK-5 drill with USDA modified furrow openers that simultaneously banded liquid fertilizer 2 inches below the seed. Row spacing was 10 inches. Combinations of nitrogen, phosphorus, and sulfur fertilizers were used and one treatment of dry fertilizer was broadcast on the surface immediately after seeding. The McKay silt loam soil contained 12, 32, and 20 pounds of available nitrogen, phosphorus, and sulfur, respectively, in the first foot, and 23, 120, and 276 pounds, respectively, in the 3-foot profile. Surface soil pH was 7.5. Thus, the land was deficient in nitrogen, borderline in phosphorus, and adequate in sulfur.

[1] Soil scientist and agricultural research technician, USDA-ARS, Columbia Plateau Conservation Research Center, Pendleton, Oregon, 97801.

Adequate erosion protection was provided by the 2000 pounds of residue per acre remaining on the surface after seeding. Tycor applied at 1.5 pounds (ai) per acre on March 11, 1985, satisfactorily controlled weeds. Crop year precipitation was 13.36 inches, or 69% of the long-time average.

Plant samples were taken May 8, 1985, to evaluate the wheat crop tillering response to the plant nutrients and again on July 10 to determine components of yield. Plots were harvested July 22.

## RESULTS AND DISCUSSION

Fertilizer significantly increased main stem Haun value, height, and percentage T1, T2, and T3 tillers (Table 1). There was no effect of fertilizer application on plant density (as expected) or percentage T4 tillers. The combination of NPS banded below the seed increased percentage T0 tillers significantly. P or S alone showed some increase in percentage T0 tillers, but the increases were not significant because of variability among the small samples. The combination fertilizer (NPS) banded below the seed gave the highest response when there were significant differences.

Table 1. Early growth and tiller development response of annual cropped Stephens winter wheat to amount, kinds, and placement of fertilizers[1]

| Fertilizer N-P-S lbs/acre | Fertilizer[2] placement | Plants per square yard | Main stem Haun value | Main stem height inches | Percentage plants having following tillers: T0 | T1 | T2 | T3 | T4 |
|---|---|---|---|---|---|---|---|---|---|
| 80-9-14 | Band | 180 a | 7.5 a | 16.6 a | 32 a | 94 a | 95 a | 84 a | 3 a |
| 80-9- 0 | Band | 170 a | 7.3 ab | 15.4 a | 10 b | 66 b | 86 a | 74 ab | 21 a |
| 80-0-14 | Band | 170 a | 7.3 ab | 12.8 b | 8 b | 62 b | 76 ab | 58 bc | 4 a |
| 80-9-14 | Broadcast | 220 a | 7.3 ab | 13.1 b | 6 b | 52 b | 73 ab | 43 cd | 3 a |
| 80-0- 0 | Band | 180 a | 6.9 b | 12.6 b | 4 b | 49 b | 55 b | 30 d | 6 a |
| 0-0- 0 | --- | 170 a[3] | 6.2 c | 9.2 c | 0 b | 3 c | 10 c | 21 d | 2 a |

[1] Seeded October 31, 1984; sampled May 5, 1985.

[2] Band = banded as liquid fertilizer 2 inches below seed at seeding.
Broadcast = broadcast as dry fertilizer on surface after seeding.

[3] Figures in the same column not marked with the same letter or letters are significantly different at the .05 level of probability according to Duncan's Multiple Range Test.

Banding the NPS nutrients below the seed was superior to surface broadcasting after seeding for main stem height and percentage T0, T1, and T3 tillers (Table 1). Using the summation of tillers T0-T4, banding 80 pounds of N per acre below the seed increased tillers 108%; addition of 9 pounds of P gave an additional tiller increase of 106%; and addition of 14 pounds of S increased the tillers another 58%. The banded combination of NPS increased the T0-T4 tillers 272% above the non-fertilized check. The same quantities of NPS broadcast on the surface after seeding increased the T0-T4 tillers only 141% or approximately one-half as much as banded NPS.

The effects of fertilizers on some components of yield, harvest index, yield, and test weight are presented in Table 2. All fertility treatments significantly increased the number of heads per square yard above the check treatment. Although not significant, addition of phosphorus and sulfur, or both, increased the head density above nitrogen alone. There was no difference in head density from placement of the NPS fertilizer. Assuming every tiller present on May 8 had developed a head, the head number at maturity was approximately 70%, indicating a 30% abortion of heads, regardless of fertilizer treatment.

Table 2. Yield components, harvest indices, and yield response of annual cropped Stephens winter wheat to amount, kinds, and placement of fertilizers[1]

| Fertilizer N-P-S lbs/acre | Placement[2] | Components of yield: Heads/ sq.yd. | Components of yield: Weight of 1000 seeds | Harvest[3] index | Yield | Test weight |
|---|---|---|---|---|---|---|
| | | No. | Grams | | Bu/acre | Lbs/bu |
| 80-9-14 | Band | 410 a | 39 ab | .42 c | 55.4 a | 57.6 a |
| 80-9- 0 | Band | 450 a | 40 ab | .43 bc | 50.5 ab | 57.8 a |
| 80-0-14 | Band | 430 a | 39 ab | .41 c | 46.6 b | 57.6 a |
| 80-9-14 | Broadcast | 450 a | 34 b | .42 c | 38.5 c | 57.4 a |
| 80-0- 0 | Band | 340 a | 45 a | .47 a | 34.4 c | 58.2 a |
| 0-0- 0 | --- | 170 b[4] | 45 a | .46 ab | 11.8 d | 57.9 a |

[1] Seeded October 31, 1984; harvested July 22, 1985.

[2] Band = banded as liquid fertilizer 2 inches below seed at seeding. Broadcast = broadcast as dry fertilizer on surface after seeding.

[3] Harvest index is the ratio of grain weight to total dry matter weight (plant plus grain).

[4] Figures in the same column not marked with the same letter or letters are significantly different at the .05 level of probability according to Duncan's Multiple Range Test.

Seed weight per thousand seeds ranged from 45 grams for the check and banded nitrogen treatment to 34 grams for the broadcast NPS treatment (Table 2). Banded nitrogen alone and the check treatment had the greatest harvest indices. The combination fertilizer treatments increased plant growth more than grain weight, thus lowering the harvest index.

Fertilizers increased yields of recrop Stephens winter wheat as much as fivefold (Table 2). Banding nitrogen and phosphorus below the seed gave yields of 50 bushels per acre. Addition of sulfur increased the yield to 55 bushels. Banding nitrogen alone produced 34 bushels per acre and with sulfur 47 bushels. Broadcasting dry NPS fertilizer immediately after seeding (38 bushels per acre) was only 69% as effective as banding the same rate of fertilizers two inches below the seed (55 bushels per acre) in this year of below normal precipitation.

The recrop Stephens winter wheat yield of 55 bushels per acre with 80 pounds of nitrogen, 9 pounds of phosphorus, and 14 pounds of sulfur per acre banded below the seed at seeding equaled the yield of Stephens winter wheat seeded two weeks earlier on fallow that had been fertilized with 75 pounds of nitrogen and 10 pounds of sulfur injected into the fallow. This yield (55 bushels per acre) was slightly better than no-till seeded Stephens winter wheat seeded the same day with a Yielder drill in standing stubble treated with metribuzin (52 bushels per acre).

## CONCLUSIONS

1. Banding 80 pounds of nitrogen per acre two inches below the seed increased tillering 108% above the check treatment; addition of 9 pounds of phosphorus per acre gave an additional tiller increase of 106%; and addition of 14 pounds of sulfur per acre increased tillering another 58%. This was about twice as many tillers compared to broadcasting the same treatment after seeding.

2. Fertilizers increased heads per square yard but had little effect on seed weight.

3. Banding 80 pounds of nitrogen per acre 2 inches below the seed at planting increased the yield of recropped Stephens winter wheat 22 bushels per acre. Addition of 9 pounds P (20 pounds $P_2O_5$) per acre gave an additional increase of 16 bushels per acre. A further addition of 14 pounds S per acre produced an additional 5 bushels per acre. Banding all three (NPS) increased yield 43 bushels per acre above the check yield of 12 bushels per acre.

4. Banding the NPS below the seed produced 17 bushels per acre more than broadcasting the same quantity of NPS on the surface after seeding.

5. Response of winter wheat to phosphorus and sulfur is often erratic, especially when soil test phosphorus is borderline and sulfur adequate. The high yield (82 bushels per acre) of the previous crop, recropping instead of fallow, late seeding (October 31), and a cold, dry winter were factors that contributed to this winter wheat response to fertilizers. A similar response can be expected when all or most of these conditions exist.

6. Recrop Stephens winter wheat with adequate fertilization on shallow soils (20 to 40 inches) that are recharged with available water over winter can yield as much as wheat after fallow. Approximately 150,000 acres of these soils (Walla Walla, Pilot Rock, Morrow, McKay, and Waha series) occur in Umatilla County.

7. Annual cropping uses water efficiently and controls soil erosion.

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# Jointed Goatgrass Cultural Control in Cereal Grains in Eastern Oregon

D. J. Rydrych[1]

## INTRODUCTION

Jointed goatgrass is a winter annual weed that has become established in all wheat-producing counties of eastern Oregon and the Pacific Northwest. It can be found in wheat fields and along roadsides, waterways, and fence lines. Goatgrass is spread by seed from contaminated seed lots, mixtures in combines and trucks, or from runoff water along natural drainageways.

There are no highly effective selective chemical controls for goatgrass. Although control levels of 70 to 80% have been obtained with fall application of ethiozine, these control levels will not suppress goatgrass in winter wheat.

Several cultural methods are effective for control and eradication of jointed goatgrass. Experience in other areas (1) has shown that crop rotations using spring-planted crops, perennial crops (such as alfalfa, grass, and clover), double fallow, and crop rotations control or eradicate goatgrass seed in the soil. This research was conducted to explore cultural methods that could be used in eastern Oregon to control goatgrass.

## MATERIALS AND METHODS

A large scale field experiment was established on the OSU - Columbia Basin Agricultural Research Center in the fall of 1983. Four management treatments on winter wheat (Stephens) were annual cropping, wheat-fallow, wheat-double fallow, and no-till. Spring wheat (Dirkwin) was planted as an annual spring crop. Precipitation averaged 15 inches per year at the Pendleton site. A randomized block design with four replications was used on 24 by 100 foot plots. Cereal was planted in an area infested with jointed goatgrass. Wheat varieties were planted 2 inches deep in October or February with rows spaced 14 inches apart. Nitrogen fertilizer was applied to all plots at 70 lb/A (ammonium nitrate). Metribuzin plus chlorsulfuron (.38 lb. + .25 oz.) was applied on established winter wheat in March to remove volunteer cheatgrass and broadleaf weeds. Metribuzin is not active on goatgrass. Bromoxynil plus MCPA (.38 lb. + .38 lb) was applied to spring wheat in May to remove any broadleaf weeds. The double-fallow treatment was not planted in the series, but will be established in 1986. The results of the experiment for 1985 are recorded in Table 1.

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[1] Professor of agronomy, Oregon State University, Columbia Basin Agricultural Research Center, Pendleton, Oregon, 97801.

## RESULTS AND DISCUSSION

There was a dramatic decrease in jointed goatgrass contamination in the spring wheat rotation (Table 1). More than 99% control was obtained the first year of the experiment. The winter wheat planted in no-till, wheat fallow, or annual crop all remained highly infested with jointed goatgrass. Best grain yield was obtained from the wheat-fallow rotation, but a considerable amount of goatgrass seed was produced. Little goatgrass seed was produced in the double-fallow rotation. Preliminary evaluations of the double-fallow rotation are encouraging with almost 99% goatgrass control. Jointed goatgrass seed production will be controlled most effectively by a spring wheat rotation or a double-fallow system. Seed production would flourish in areas that were planted to winter grain. All experiments will be continued for several seasons to see which method (cultural or chemical) will be the most effective for goatgrass eradication.

Tillage and rotation systems are effective in reducing jointed goatgrass populations in the soil if seedlings are not allowed to mature for two years. If eradication is desired, the 2-year rotation must be extended to 3 or 4 years by using a spring crop or some other method (2). Even though tillage and rotations may not be totally desirable for eastern Oregon because of lower grain yields from spring wheat or increased erosion potential from double-fallowing, the fact remains that eradicating goatgrass takes 3 to 4 years and is the only solution to the problem at this time. The search for effective chemical control will continue.

Table 1. Jointed goatgrass cultural control in cereal grains, OSU-CBARC, 1985

| Treatment[1] | Crop rotation | Goatgrass control (%) | Grain[2] yield (lb/A) |
|---|---|---|---|
| Spring wheat | Annual | 99 | 2260 |
| Winter wheat | Annual | 3 | 3590 |
| Winter wheat | Fallow | 18 | 4210 |
| Winter wheat | No-till | 8 | 3620 |
| Winter wheat | Double-fallow | 99 | ---- |

[1] Treatments - Winter wheat - metribuzin + chlorsulfuron (.38 lb. + .25 oz), March 9, 1985.
Spring wheat - bromoxynil + MCPA (.38 lb. + .38 lb.), May 6, 1985.

[2] Double-fallow wheat to be harvested in 1986.

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# Yield Development-rate Correlations for Winter Wheat

R. W. Rickman, E. L. Klepper, and C. R. Crampton[1]

Leaf development rates measured using Haun stage for development and degree-days for "time" were found to be slightly different between varieties (5%) and more different between locations (10%) in the 1983-84 crop year near Pendleton, Oregon (Crampton et al., 1985). A second year of observations in 1984-85 revealed similar variety and location differences but provided much larger differences in development rates (25%) between seasons and a correlation with yield. The purpose of this paper is to present the observed development rate differences and discuss their variation with variety, location, season, and yield.

## METHODS

Two of 17 ongoing Oregon State University variety test sites were sampled nine times during the 1984-85 crop year for Haun stage, cumulative growing degree days, and final yield of five cultivars. Table 1 contains the climatic and cultural characteristics of the two sites.

Table 1. Precipitation and cultural characteristics of nursery sites

| Site | Elevation | Previous Crop | Average Precipitation | Planting Date |
|---|---|---|---|---|
| | (feet) | | (inches) | |
| Holdman | 1500 | Fallow | 16 | 5 Oct 1984 |
| Weston | 2100 | Peas | 20 | 5 Oct 1984 |

The nurseries were arranged in a completely randomized block with four replications. Three to five plants were collected from each replication of each variety for each sampling. Air temperatures at the sites were used to compute degree days with a 0° C base (Rickman and Klepper, 1984). Haun stages were regressed on degree days accumulated from planting for each cultivar. The slope of the linear regression (leaves/degree day) was inverted to provide the degree days per leaf or phyllochron interval for the cultivar.

## RESULTS AND DISCUSSION

Phyllochron interval (development rate in degree days required to elongate each leaf) and yield for each cultivar and location for both years are reported in Table 2. Comparing the two growing seasons 1983-84 and 1984-85, the average phyllochron interval changed from 101 to 70 at Holdman and from 112 to 83 at Weston, a drop to 69% and 74% of the previous year's value, respectively. The average yields in 1984-85, at the two locations dropped

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[1] Soil scientist and plant physiologist, USDA-ARS, Columbia Plateau Conservation Research Center, Pendleton, Oregon, 97801; and research assistant, Oregon State University, Corvallis, Oregon, 97331.

to 68% and 74%, respectively, of the 1983-84 values. Cultivars responded in some recognizable groups. In 1984-85, those with the largest yields (Daws, Stephens, and ORCW8113) changed the most with a drop to 65% of the 1983-84 yield levels at both locations. The two lower yielding cultivars dropped to an average of 83% of 1983-84 values. Faro was the only cultivar that responded differently between locations. At Holdman, Faro yield dropped to 68% but produced 98% of 1983-84 at Weston.

For the cultivars compared, longer phyllochrons are correlated with larger yields, particularly for the newer highly productive releases. Location definitely influenced the phyllochron yield relations but at a given site, a longer phyllochron was related to higher yield. Yields of the club variety Faro and hard red SWM754651 were less sensitive to the phyllochron changes.

Comparisons of phyllochron-yield relationships at more extreme climatic sites need to be completed to discover whether the correlation can be established during a single growing season or whether two extremely different seasons like the 1983-84 and 1984-85 years are needed to characterize the varieties. Further analysis of variety yield components also must be completed to provide insight into the reasons for the large change in yield between seasons while phyllochrons and yield remained related.

This unexpected correlation may provide the opportunity to project yield at a site from a phyllochron determined very early in the growing season. It also may provide another selection tool for differentiating between newly created cultivars at one location and projecting their yield behavior to different locations.

Table 2. Phyllochron and yield for five cultivars at two locations for the 1983-84 and 1984-85 growing seasons

| | Location | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Holdman | | | | Weston | | | |
| | Phyllochron | | Yield | | Phyllochron | | Yield | |
| Variety | 1984 | 1985 | 1984 | 1985 | 1984 | 1985 | 1984 | 1985 |
| | (degree days) | | (bu/acre) | | (degree days) | | (bu/acre) | |
| Daws | 103 | 66 | 77 | 49 | 114 | 78 | 127 | 79 |
| Faro | 99 | 64 | 71 | 48 | 106 | 83 | 103 | 98 |
| SWM754651 | 96 | 68 | 62 | 52 | 109 | 84 | 102 | 88 |
| Stephens | 107 | 73 | 77 | 52 | 117 | 93 | 108 | 70 |
| ORCW8113 | 102 | 78 | 72 | 45 | 114 | 78 | 126 | 86 |
| Average | 101 | 70 | 72 | 49 | 112 | 83 | 113 | 84 |
| 1984/85 value | .69 | | .68 | | .74 | | .74 | |

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# Precipitation Summary - Pendleton

CBARC - Pendleton Station - Pendleton, Oregon
(Crop year basis, ie; September 1 through August 31 of following year.)

| Crop Yr. | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 57 Year Average | .76 | 1.38 | 1.94 | 2.19 | 1.90 | 1.51 | 1.67 | 1.48 | 1.35 | 1.31 | .33 | .47 | 16.29 |
| 1966-67 | .46 | 1.10 | 2.30 | 2.86 | 2.80 | .32 | 1.51 | 1.60 | .95 | .55 | .04 | 0 | 14.49 |
| 1967-68 | .56 | 1.17 | 1.30 | .76 | .74 | 2.39 | 1.04 | .21 | .65 | 1.11 | .34 | .77 | 11.04 |
| 1968-69 | .83 | 1.36 | 2.71 | 2.65 | 2.62 | .78 | .43 | 2.31 | 1.26 | .75 | .06 | 0 | 15.76 |
| 1969-70 | .65 | 1.41 | .44 | 2.39 | 5.23 | 1.50 | 1.87 | 1.05 | .62 | .85 | .11 | .05 | 16.17 |
| 1970-71 | 1.02 | 1.40 | 2.22 | 1.02 | 1.44 | .77 | 1.28 | 1.65 | 1.66 | 3.14 | .63 | .33 | 16.56 |
| 1971-72 | 1.42 | 1.72 | 3.14 | 3.93 | 1.15 | 1.70 | 2.11 | 1.35 | 1.50 | .91 | .76 | .35 | 20.04 |
| 1972-73 | .49 | .66 | 1.14 | 2.47 | .89 | .89 | 1.27 | .58 | 1.03 | .12 | 0 | .09 | 9.63 |
| 1973-74 | 1.77 | 1.24 | 5.86 | 4.40 | 1.29 | 2.00 | 1.50 | 3.64 | .38 | .33 | 1.30 | 0 | 23.71 |
| 1974-75 | .02 | .35 | 1.56 | 1.76 | 3.73 | 1.68 | .97 | 1.72 | .68 | .69 | .05 | 1.38 | 14.59 |
| 1975-76 | 0 | 2.16 | 1.47 | 3.40 | 2.13 | 1.09 | 1.69 | 1.65 | 1.21 | .58 | .04 | 2.58 | 18.00 |
| 1976-77 | .44 | .53 | .47 | .59 | .90 | .57 | 1.72 | .46 | 1.70 | .31 | .12 | 2.21 | 10.02 |
| 1977-78 | 1.54 | .69 | 1.79 | 3.19 | 2.27 | 1.71 | 1.40 | 3.50 | .81 | 1.27 | .59 | 1.37 | 20.13 |
| 1978-79 | 1.61 | 0 | 1.68 | 2.28 | 1.31 | 1.54 | 1.74 | 1.82 | 1.15 | .18 | .12 | 2.08 | 15.51 |
| 1979-80 | .17 | 2.56 | 2.31 | 1.05 | 2.85 | 1.55 | 2.12 | 1.20 | 2.45 | 1.42 | .23 | .18 | 18.09 |
| 1980-81 | 1.24 | 2.96 | 1.81 | 1.99 | 1.26 | 2.31 | 2.30 | 1.29 | 2.30 | 2.12 | .40 | .02 | 20.00 |
| 1981-82 | 1.51 | 1.62 | 2.41 | 3.27 | 2.61 | 1.86 | 1.99 | 1.54 | .48 | 1.12 | 1.02 | .50 | 19.93 |
| 1982-83 | 1.68 | 2.68 | 1.46 | 2.69 | 1.63 | 2.97 | 3.90 | 1.23 | 2.08 | 1.92 | 1.00 | .68 | 23.92 |
| 1983-84 | .82 | .91 | 2.79 | 3.44 | .99 | 2.56 | 3.23 | 2.37 | 2.11 | 2.05 | .05 | 1.25 | 22.57 |
| 1984-85 | .98 | 1.18 | 3.43 | 1.96 | .69 | 1.49 | 1.33 | .65 | .89 | 1.42 | .05 | .98 | 15.05 |
| *1985-86 | 1.54 | 1.34 | 2.66 | 1.27 | 2.38 | 3.04 | 1.94 | | | | | | |
| 19 Year Average | .91 | 1.35 | 2.12 | 2.43 | 1.92 | 1.56 | 1.76 | 1.57 | 1.26 | 1.10 | .36 | .78 | 17.12 |

*Not included in 19 year average figures.

# Precipitation Summary - Moro

CBARC - Sherman Station - Moro, Oregon
(Crop year basis, ie; September 1 through August 31 of following year.)

| Crop Yr. | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 74 Year Average | .47 | .77 | 1.65 | 1.72 | 1.81 | 1.04 | 1.00 | .72 | .85 | .65 | .24 | .42 | 11.34 |
| 1966-67 | .47 | .74 | 3.14 | 1.84 | .91 | .03 | .55 | 1.47 | .39 | .32 | 0 | 0 | 9.86 |
| 1967-68 | .26 | .74 | .84 | .54 | .97 | 1.04 | .16 | .10 | .74 | .10 | .15 | 1.52 | 7.16 |
| 1968-69 | .33 | 1.04 | 2.67 | 2.09 | 1.93 | .44 | .63 | .84 | .84 | 1.99 | 0 | 0 | 12.80 |
| 1969-70 | .52 | .76 | .53 | 2.00 | 3.96 | 1.27 | .88 | .38 | .33 | .22 | 0 | 0 | 10.85 |
| 1970-71 | .13 | .68 | 2.36 | 1.21 | 1.63 | .12 | 1.28 | .84 | .93 | .81 | .20 | .09 | 10.28 |
| 1971-72 | 1.36 | .45 | 1.50 | 1.03 | 2.25 | .26 | 1.44 | .40 | .45 | 1.70 | .07 | .55 | 11.46 |
| 1972-73 | .57 | .43 | .83 | 1.62 | 1.09 | .34 | .40 | .21 | .34 | .25 | 0 | .07 | 6.15 |
| 1973-74 | .90 | .85 | 3.70 | 3.99 | 1.29 | .97 | 1.30 | 1.18 | .38 | .02 | .41 | 0 | 14.99 |
| 1974-75 | 0 | .37 | 1.02 | 1.39 | 2.01 | 1.47 | 1.25 | .46 | .53 | .84 | .40 | 1.26 | 11.00 |
| 1975-76 | 0 | 1.17 | 1.34 | 1.26 | 1.25 | .93 | .95 | 1.06 | .14 | .06 | .79 | 1.17 | 10.12 |
| 1976-77 | .04 | .10 | .43 | .20 | .18 | .63 | .50 | .08 | 2.70 | .28 | .37 | .90 | 6.41 |
| 1977-78 | .88 | .22 | 2.00 | 3.22 | 2.80 | 1.31 | .74 | 1.42 | .43 | .44 | .59 | 1.32 | 15.37 |
| 1978-79 | .33 | .01 | .79 | .69 | 1.59 | 1.54 | .99 | 1.06 | .28 | .10 | .07 | 1.05 | 8.50 |
| 1979-80 | .53 | 2.59 | 2.23 | .65 | 3.41 | 1.83 | .94 | .89 | 1.27 | 1.37 | .16 | .11 | 15.98 |
| 1980-81 | .42 | .79 | 1.73 | 2.95 | 1.52 | 1.22 | .65 | .41 | 1.06 | 1.15 | .20 | 0 | 12.10 |
| 1981-82 | .92 | .82 | 1.99 | 4.73 | 1.10 | .72 | .55 | 1.45 | .37 | 1.15 | .21 | .40 | 14.41 |
| 1982-83 | 1.42 | 1.96 | 1.08 | 1.89 | 1.40 | 2.43 | 2.74 | .61 | 1.96 | .39 | .80 | .60 | 17.28 |
| 1983-84 | .52 | .62 | 2.45 | 2.31 | .17 | 1.07 | 2.34 | 1.32 | .97 | 1.09 | .17 | 0 | 13.03 |
| 1984-85 | .53 | .86 | 3.18 | .41 | .27 | .97 | .44 | .14 | .63 | .92 | .05 | .14 | 8.54 |
| *1985-86 | 1.11 | 1.09 | 1.19 | 1.12 | 1.84 | 2.39 | .98 | | | | | | |
| 19 Year Average | .53 | .80 | 1.78 | 1.79 | 1.56 | .98 | .99 | .75 | .78 | .69 | .24 | .48 | 11.38 |

*Not included in 19 year average figures.

## Growing Degree Days Summaries