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Introduction to the Fourth Edition* of the
Wyoming Agricultural Experiment Station Field Days Bulletin

B.W. Hess

†Director, Wyoming Agricultural Experiment Station.

Introduction

Last year’s introduction to the Wyoming Agricultural Experiment Station (WAES) Field Days Bulletin briefly explained how WAES has disseminated the results of its field investigations to the public from the 1890s to the present. Continuing our efforts to inform Wyoming citizens and others of the research being done at the Research and Extension Centers, and in the UW College of Agriculture and Natural Resources, WAES has made a few modifications to the 4th edition of the Bulletin.

Field Days

WAES works with its affiliated Research and Extension Centers (R&E centers) to support their hosting of summer field days. This year’s field days are June 14 at the Sheridan R&E Center, July 17 at the Powell R&E Center, August 21 at the James C. Hageman Sustainable Agriculture R&E Center near Lingle, and August 28 at the Laramie R&E Center. Attendees of the field days learn about research and experiments being conducted at the R&E centers through a combination of field tours, oral presentations, and displays. Participants of the field days will find themselves learning about new activities occurring on the centers as well as research projects in various stages.

The WAES Field Days Bulletin

Four years ago, WAES began publishing the Field Days Bulletin in an effort to make our constituents aware of research and other activities being conducted at the R&E centers. This annual publication is a collection of reports that summarize experiments and other activities in a standardized, simple format that is reader-friendly. The bulletin is not intended to be a comprehensive report of each experiment, and up until this year, the publication included numerous two-page summaries of projects being conducted by scientists and students. Authors of these two-page, peer-reviewed reports address the high points of their specific projects and provide contact information in case readers wish to receive more in-depth information about a particular topic.

Beginning with this edition, the WAES Field Days Bulletin will include a series of very short reports on work that is being conducted on the R&E centers or off-site. This shortened format is intended for authors

*The complete Fourth Edition will be available on our website at www.uwyo.edu/uwexpstn, select “Publications” on the left.
to describe a project that is soon to begin or has only recently begun. This short format permits authors to report on projects where it is premature to summarize early and/or major findings. Although these short reports do not undergo peer review, they, like the more in-depth papers, undergo a fairly extensive editorial process in which authors may need to address editor questions for clarifications and/or revisions. The short format requires authors to be brief and succinct to explain the issues, goals, objectives, and potential impacts of their work.

The intent of the WAES Field Days Bulletin is to demonstrate an array of activities that may be of interest to a wide variety of citizens. Regardless of format, reports should be written for a general, non-scientific audience avoiding use of uncommon scientific terms, acronyms, and jargon. Furthermore, authors are asked to include a maximum of three key words per report. These key words are then used to create an index to help readers easily search for reports by topic area. Key words typically should include research topic, research subject, and commodity, when applicable.

**Linking to the Production Agriculture Research Priorities**

Another significant change to the 2014 WAES Field Days Bulletin, when relevant, authors will be indicating which of the Wyoming Production Agriculture Research Priorities (PARP) is/are addressed in their report. PARP was developed to document agriculture research needs in Wyoming. The PARP document began by gathering input from R&E Center Advisory Boards regarding subjects they would be interested in having researched. This information formed the basis of an outline. With the assistance of Ron Pulley, a retired producer who farmed and ranched near Huntley, the outline was then sent for comment to numerous producers throughout the state. The producer distribution list was developed by enlisting the assistance of UW Extension.

Specifically, members of the Profitable and Sustainable Agricultural Systems State Initiative Team, as well as the Sustainable Management of Rangeland Resources State Initiative Team, each provided contact information for five producers. The major producer associations in Wyoming also were invited to provide five producer contacts. Comments received by producer contacts were then incorporated into the final version of the PARP, which will be continually updated as additional priorities are identified. An electronic copy of the PARP document is located on the WAES webpage under “Important Links” at www.uwyo.edu/uwexpstn/.

**Acknowledgments**

Thank you to all the contributors to WAES bulletins. The tremendous efforts of bulletin editors Joanne Newcomb and Robert Waggener are greatly appreciated.

**Contact Information**

Bret Hess at 307-766-3667 or brethess@uwyo.edu.
Introduction to the Powell Research and Extension Center

C. Reynolds¹, A. Pierson¹, and A. Garcia y Garcia¹,²

¹Powell Research and Extension Center; ²Department of Plant Sciences.

Introduction

The Powell Research and Extension Center (PREC) is located one mile north of Powell at 747 Road 9 at an elevation of 4,378 feet. PREC has 200 irrigated acres, including 2.5 acres with on-surface drip, 1.2 acres with sub-surface drip, 54 acres under sprinkler, and about 142 acres under surface irrigation using gated pipes. Research focuses on irrigation, weed control, cropping systems, protected agriculture (hoop houses), variety trials, and alternative crops. We serve northwestern Wyoming, including Big Horn, Fremont, Hot Springs, Park, and Washakie counties.

The staff at PREC currently includes one researcher, a farm manager, a research associate, two assistant farm managers, and an office associate.

There are many new and exciting developments and changes going on at the center. One of the biggest changes includes three new staff members: an office associate (Samantha Fulton), a research associate (Andrea Pierson), and a farm manager (Camby Reynolds). Also, we’ll soon have a new faculty member joining us (Assistant Professor Gustavo Sbatella starts July 31)! In addition to the new staff, we have also been able to acquire some new equipment and finished a hoop house (Figure 1), which will facilitate research here at the center. We are also very excited about several new research projects being conducted here in Powell and look forward to sharing the results in coming years.

2013 Growing Season

Weather conditions during the growing season were summarized in pentads (periods of five days; if a 31-day month, the last pentad corresponds to six days). For each pentad, air temperature was averaged and rain and reference evapotranspiration (ETo) correspond to totals. (ETo is an indicator of the water needs of plants.) The 2013 growing season was characterized as relatively long, with 152 frost-free days, from May 4 to October 2. Overall, the growing season was wet and cool. Rainfall started early in the season,
most occurring in September and October. In fact, rainfall in 2013 occurred every single month. From April through October, PREC received 6.50 inches of rainfall. Of this, 30, 22, and 33% fell in May, July, and September, respectively. As a consequence, the development of end-season diseases, including mold in dry beans and sunflowers, was favored and harvest activities were delayed. The average air temperature was low much of April then increased by mid-May followed by a couple weeks of low temperature until the end of May. This contributed to a slow start of the growing season. The highest air temperatures were recorded in July and August. The highest ETo occurred from mid-May to the beginning of August, with peaks of around 0.23 inches (1.1 inches in a five-day period) at the beginning and at the end of July, and around August 20 (Figure 2).

2013 Highlights

The PREC’s field day on July 19, 2013, was attended by producers, industry representatives, UW personnel, and others. Graduate students from the Department of Plant Sciences showed their work during the event (Figure 3).

Contact Information

Camby Reynolds at sreynol3@uwyo.edu or 307-754-2223
1. Production characteristics of malting varieties of barley for MillerCoors

Investigators: Andrea Pierson, Camby Reynolds, and Gary Moss

Issues: MillerCoors seeks information to identify varieties of malting barley suitable for production in the Bighorn Basin.

Goals: The goal is to evaluate production characteristics of different varieties of malting barley tested at the Powell Research and Extension Center that are provided by MillerCoors.

Objectives: Specific objectives are to determine lodging scores, straw breakdown, head nod, and plant maturity prior to harvest. (Lodging is when stems bend over to near ground-level. Head nod occurs when plant matter dries, causing the plant to bend below the head.)

Impacts: Data collected will assist in the selection of barley varieties grown for MillerCoors by producers in the Bighorn Basin.

Contact: Gary Moss, gm@uwyo.edu or 307-766-5374.

Key Words: malting barley, variety trial

PARP: VIII:1

2. Effects of conservation tillage, cover crops, and limited irrigation on soil fertility

Investigators: Jay Norton, Axel Garcia y Garcia, Urszula Norton, Sandra Frost, and Caleb Carter

Issues: Conversion from flood-irrigation systems to overhead sprinklers, and conventional tillage practices to conservation tillage present opportunities for improved crop nutrient management. Altering irrigation and tillage without changing fertilizer practices, however, can reduce crop yield and quality. Many areas in Wyoming do not receive adequate irrigation water so understanding interactions among conservation tillage, water supply and use, and nutrient management is needed.

Goals: Goals are to 1) develop improved nitrogen (N) and phosphorus (P) fertilizer recommendations for sprinkler irrigation and conservation tillage under adequate and inadequate water supply, and 2) evaluate the benefits of cover crops in sugarbeet-bean-barley cropping systems.

Objectives: Specific objectives include description of soil organic matter, water use, and N and P uptake; development of revised N and P fertilizer recommendations; and evaluation of cover crop effects under sprinkler irrigation and strip-till practices.

Impacts: Results should help growers improve soil fertility and soil quality under sprinkler irrigation. Effects of two combinations of cover crops under both sprinkler and furrow irrigation will be quantified.

Contact: Jay Norton, jnorton4@uwyo.edu or 307-766-5082.

Key Words: sugarbeet, strip-till, fertilizer

PARP: I:1,7,9, II:5,7,9
3. Production characteristics of conventional sugarbeets for Betaseed

**Investigators:** Andrea Pierson, Camby Reynolds, and Gary Moss

**Issues:** Betaseed Inc., based in Shakopee, Minnesota, seeks information to identify production characteristics of different varieties of sugarbeets.

**Goals:** The goal is to characterize production characteristics of sugarbeet varieties tested at the Powell Research and Extension Center that are provided by Betaseed.

**Objectives:** Specific objectives are to determine stand counts and yields of varieties of sugarbeets provided by Betaseed.

**Impacts:** Data collected could help producers raise higher quality sugarbeets that yield more tons per acre.

**Contact:** Gary Moss, gm@uwyo.edu or 307-766-5374.

**Key Words:** sugarbeet, variety trial

**PARP:** I:2

---

4. Production characteristics of malting varieties of barley for Briess

**Investigators:** Camby Reynolds, Andrea Pierson, and Gary Moss

**Issues:** Briess Malt & Ingredients Co., based in Chilton, Wisconsin, seeks information needed to identify new varieties of malting barley that are well suited to specific production areas.

**Goals:** The goal is to identify varieties of malting barley suited for production in the Bighorn Basin and surrounding areas. Trials are being conducted at the Powell Research and Extension Center.

**Objectives:** Specific objectives are to evaluate production characteristics (lodging scores, head nod, and plant maturity) and protein levels in varieties of malting barley supplied by Briess Malt & Ingredients Co. (Lodging is when stems bend over to near ground-level. Head nod occurs when plant matter dries, causing the plant to bend below the head.)

**Impacts:** Data collected should assist in the selection of barley varieties to be contracted locally and should provide producers with increased production alternatives.

**Contact:** Gary Moss, gm@uwyo.edu or 307-766-5374.

**Key Words:** malting barley, variety trial

**PARP:** VIII:1
5. Evaluating production characteristics of GoldenHarvest Corn varieties for J.R. Simplot

**Investigators:** Camby Reynolds, Andrea Pierson, and Gary Moss

**Issues:** Production data is requested by J.R. Simplot Co. to identify varieties of GoldenHarvest Corn best suited for production in the Bighorn Basin and surrounding areas. GoldenHarvest hybrids are distributed by J.R. Simplot Co. in the Bighorn Basin and other areas of the West. J.R. Simplot is a large food and agribusiness company based in Boise, Idaho.

**Goals:** The goal is to provide data to help producers select varieties of GoldenHarvest Corn suitable for production in the Bighorn Basin and surrounding areas.

**Objectives:** Specific objectives are to evaluate yield, plant height, and feed value of GoldenHarvest Corn varieties grown for livestock feed.

**Impacts:** Data collected should help local producers select varieties of Golden Harvest Corn best suited to their operations.

**Contact:** Gary Moss, gm@uwyo.edu or 307-766-5374.

**Key Words:** corn, variety trial, livestock feed

**PARP:** VIII:1

6. Production of green leaf lettuce in high tunnels

**Investigators:** Austen Samet and Axel Garcia y Garcia

**Issues:** Little is known about the relationship between nitrogen (N) fertilization and irrigation in green leaf lettuce produced in protected growing conditions such as high tunnels placed in an environment matching the Bighorn Basin.

**Goals:** The goal is to better understand the effects of N fertilization and irrigation strategies in reference to green leaf lettuce quality and production.

**Objectives:** Specific objectives are to evaluate 1) plant nutrition for human consumption, 2) soil quality for plant growth, and 3) irrigation requirements of green leaf lettuce produced in a protected agricultural environment.

**Impacts:** Results should assist growers in developing management practices for conserving N fertilizer and water. We also hope to gain a better understanding of the relationship of N fertilizer and water application, and how it affects the nutritional value of green leaf lettuce.

**Contact:** Austen Samet, asamet@uwyo.edu, or Axel Garcia y Garcia, axel.garcia@uwyo.edu or 307-754-2223.

**Key Words:** nitrogen, high tunnel, lettuce

**PARP:** I:1, II:8, IV:2, X:2
7. Study focuses on vining tomato production in high tunnels

Investigators: Austen Samet and Axel Garcia y Garcia

Issues: High tunnels and other structures that help protect vegetables (including tomatoes) from the elements are gaining popularity across Wyoming, including the Bighorn Basin. Little research has been done, however, to determine best management practices (BMPs) for vegetables grown in high tunnels in the basin. Information about proper fertilization and drip-irrigation strategies for optimal production of tomatoes grown in a protected environment is also lacking.

Goals: Our goal is to establish BMPs for indeterminate—or “vining”—tomatoes grown in a high tunnel. (Indeterminate tomatoes bear fruit all season long.)

Objectives: Specific objectives are to determine the best combination of drip irrigation and fertilization for optimum tomato yield and quality.

Impacts: Results should help farmers and other commercial growers, in addition to home gardeners, produce better quality tomatoes and higher yields in the Bighorn Basin and surrounding areas.

Contact: Austen Samet, asamet@uwyo.edu, or Axel Garcia y Garcia, axel.garcia@uwyo.edu or 307-754-2223.

Key Words: high tunnel, indeterminate tomatoes, drip irrigation
PARP: I:1, II:8, IV:2, IV:4, X:2

8. Best management practices for spinach production in high tunnels

Investigators: Austen Samet and Axel Garcia y Garcia

Issues: Little research has been done to determine best management practices (BMPs) for vegetable production under protected growing conditions such as high tunnels placed in an environment matching the Bighorn Basin. Research on proper fertilization and drip-irrigation strategies for optimal production of spinach under a protected structure is also needed.

Goals: The goal is to develop BMPs for spinach produced in a high tunnel.

Objectives: Specific objectives are to determine the best combination of fertilization and irrigation under a drip system for optimum spinach quality and yield.

Impacts: Results from this study should help commercial spinach producers and home gardeners in the Bighorn Basin and surrounding areas produce better quality spinach and higher yields.

Contact: Austen Samet, asamet@uwyo.edu, or Axel Garcia y Garcia, axel.garcia@uwyo.edu or 307-754-2223.

Key Words: high tunnel, drip irrigation, BMPs for spinach
PARP: I:1, II:8, IV:2, IV:4, X:2
9. Evaluating production characteristics of confectionary sunflowers for SunOpta

**Investigators:** Camby Reynolds, Andrea Pierson, and Gary Moss

**Issues:** SunOpta Inc., with main offices in Ontario, Canada, and Minnesota, seeks information needed to identify varieties of confectionary sunflowers suitable for production in the Bighorn Basin and nearby regions.

**Goals:** The goal is to collect data needed for the selection of confectionary sunflower varieties suitable for production in the Bighorn Basin. “Confectionary” refers to sunflower seeds used primarily for food.

**Objectives:** Specific objectives are to determine plant height, days to maturity, test weight (lbs/bushel), seed yield, seed size, and harvest moisture of varieties of confectionary sunflowers provided by SunOpta and grown at the Powell Research and Extension Center.

**Impacts:** Data collected should provide information needed to identify varieties suitable for production in the Bighorn Basin. This information could help producers more efficiently raise high quality confectionary sunflower seeds.

**Contact:** Gary Moss, gm@uwyo.edu or 307-766-5374.

**Key Words:** sunflowers, variety trial

**PARP:** I:2

10. Carrot and corn salad varieties for seed production in the Bighorn Basin

**Investigators:** Andrea Pierson, Camby Reynolds, and Gary Moss

**Issues:** The Bighorn Basin is ideally suited to seed production by numerous plants, provided those species can survive potentially severe winter conditions. The basin’s isolation diminishes the likelihood of transmitting seeds of other varieties in other seed-producing regions as well as weeds and diseases. The arid environment of the basin, however, requires precise control of irrigation.

**Goals:** The goal is to determine if selected varieties of carrots and corn salad (also known as mache) can survive winter conditions at the Powell Research and Extension Center.

**Objectives:** Specific objectives are to evaluate winter survival and bloom dates of corn salad and carrot varieties.

**Impacts:** Data collected may help local producers by providing additional crops to consider for seed production in their farming operations.

**Contact:** Gary Moss, gm@uwyo.edu or 307-766-5374.

**Key Words:** carrots, corn salad

**PARP:** I:2
11. The five most dangerous hand tools on the ranch and farm

Investigator: Randy Weigel

Issues: Tools make work easier, faster, and even more precise; yet tools—especially power tools—can cause injuries. Table saws, nail guns, chain saws, and circular saws, along with ladders, have been found to be particularly prone, if not used correctly, to cause accidents and injury.

Goals: The goal of this outreach effort is to describe the extent of accidents caused by these tools and provide safety tips to minimize the occurrence of injury.

Objectives: Objectives include describing the scope of the problem, outlining safety tips for each tool, and providing references for detailed hand tool safety procedures.

Impacts: Make sure you are familiar with the tools, and use them only for the projects for which they were designed. Make sure that the tools are in top working order and all safety guards are on. Never use these tools when you are in a hurry, with little sleep, or after you have been drinking alcohol or using drugs (including prescription) that alter thought processes and motor skills. And always wear appropriate safety equipment.

Contact: Randy Weigel, weig@uwyo.edu or 307-766-4186.

Key Words: hand tools, accidents, safety

PARP: N/A
Effect of Irrigation and Nitrogen Application on Yield of Corn for Silage

A. Nilahyane\textsuperscript{1}, A. Garcia y Garcia\textsuperscript{1,2}

\textsuperscript{1}Department of Plant Sciences; \textsuperscript{2}Powell Research and Extension Center.

\textbf{Introduction}

Corn for silage is a valuable energy feed source for cattle. As a warm-season crop, corn for silage requires both warm soil and high air temperature. Moreover, good crop and silage management practices, such as proper irrigation and nitrogen (N) applications, are required so that the crop achieves top yields and high quality, resulting in maximum profit.

Irrigation management is about controlling frequency, amount, and timing of applied irrigation water in a planned and efficient manner. With good irrigation management, a silage corn crop can have high yield and quality potential; however, water stress greatly affects fresh silage yield and quality and can lead to great losses in dry matter produced per acre.

N is an essential nutrient for corn growth and development. Thus, N fertilization is one of the most important practices in crop production.

For optimum use, the best rate of N and the irrigation amounts required for maximum growth rate and top forage quality should be known. N and irrigation requirements for silage corn production can be determined by involving different rates of N fertilizer with irrigation treatments.

\textbf{Objectives}

The objective is to determine the best combination of N rate and irrigation water to produce higher yields of corn for silage.

\textbf{Materials and Methods}

The study was conducted at the Powell Research and Extension Center (PREC) on clay-loam soil. Almost half of the average rainfall per year (6.9 inches) is received during May to August.

The hybrid Pioneer ‘P8107HR’ was planted on a sprinkler-irrigated field using a randomized complete block in a split-plot arrangement with three replications. Irrigation was the main treatment and N rates the sub-treatments. Four irrigation treatments, including 100% crop evapotranspiration (100ET≈17 in.), 80%, 60%, and 50% were evaluated. Each main plot consisted of 240 rows that were 135 ft long. Within a plot, three N rates (N1=65, N2=115, and N3=175 lbs/acre) were used in sub-plots 145 ft by 45 ft. The fertilization strategy consisted of 65 lbs/A applied at planting in all three treatments. The N1 treatment was all applied at planting; N2 was applied at planting (65 lb/A) and side-dressed (50 lbs/A) when the plant was at V5; and, N3 was applied at planting (65 lb/A) and side-dressed (65 lb/A and 60 lb/A)
The two central rows were harvested on September 16, 2013, and fresh weighed to determine forage yield. Whole plant samples from each plot were chopped and dried at 140°F for 48 hours to determine dry matter yield. Analysis of variance was calculated using the SAS statistical program.

**Results and Discussion**

The results showed significant yield differences (P=0.0006) among irrigation treatments (Table 1), but no interactions between irrigation and N rates (Figure 1). The best combinations of irrigation x N were 100ET water x 175 lbs/A N and 80ET water x 115 lbs/A N. This resulted in 17,288 and 17,250 lbs/A of biomass, respectively (Figure 1). Preliminary results indicate that full irrigation and 80ET produce higher yields, and there was little difference between them (Table 1). There is no significant difference among different levels of N, probably because of earlier harvesting due to environmental conditions.

First year results showed that 80ET irrigation x 115 lbs/A of N resulted in yield of silage corn that was nearly as high as yield obtained with 100ET irrigation and 175 lbs/A of N. For conditions in the Powell area, farmers may be able to use 80ET of maximum crop water requirements to irrigate corn for silage with little to no reduction in yield. This study is being repeated in 2014.

**Acknowledgments**

Appreciation is extended to the field and lab assistants at the Powell R&E Center.

**Contact Information**

Abdelaziz Nilahyane at anilahya@uwyo.edu, or Axel Garcia y Garcia at axel.garcia@uwyo.edu or 307-754-2223.

**Key words**: irrigation, nitrogen, fertilization

PARP: I:2, II:2, IV:3, IV:4

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**Table 1. Average yield of corn for silage at different irrigation treatments.**

<table>
<thead>
<tr>
<th>Irrigation</th>
<th>Yield (lbs/acre)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>100ET</td>
<td>15,452 A</td>
</tr>
<tr>
<td>80ET</td>
<td>15,298 A</td>
</tr>
<tr>
<td>60ET</td>
<td>11,282 B</td>
</tr>
<tr>
<td>50ET</td>
<td>11,159 B</td>
</tr>
</tbody>
</table>

LSD 287

* Means with the same letter are not significantly different at α=0.05.
2013 Spring Barley Variety Performance Evaluation

A. Pierson\textsuperscript{1}, J. Christman\textsuperscript{1}, M. Moore\textsuperscript{2}

\textsuperscript{1}Powell Research and Extension Center; \textsuperscript{2}Wyoming Seed Certification Service.

Introduction
The Wyoming Agricultural Experiment Station at Powell conducts barley variety performance trials as part of an ongoing research program. In cooperation with the Western Spring Barley Nursery and private seed companies, WAES evaluates a wide range of germplasm each year.

Materials and Methods
The experiment was located at the Powell Research and Extension Center (PREC) during 2013. Fertilizer was applied on March 11, at the rate of 120 pounds/acre of nitrogen (N) and 50 pounds/acre of P\textsubscript{2}O\textsubscript{5} in the form of urea (46-0-0) and diammonium phosphate (11-52-0). The experimental design of all trials was randomized complete block with three replications. On April 4, a total of 31 barley varieties were established in plots 7.3 by 20 feet using double disk openers set at a row spacing of 7 inches. The seeding depth was 1.5 inches, and the seeding rate was 100 pounds of seed per acre. Weeds were controlled by a post application of a tank mixture of methyl chlorophenoxy acetic acid (MCPA) (3 pt Bronate Advanced\textsuperscript{TM}) and pinoxaden (3.4 pt Axial\textsuperscript{®} XL) broadcast at 0.50, and 0.05 pounds active ingredient/acre on June 4. Furrow irrigations were June 6, June 17, June 26, July 12, and July 21. Measurements included height, heading date, lodging, grain yield, test weight, and kernel plumpness. Subplots, 5.3 by 18 feet, were harvested August 10 using a Wintersteiger plot combine.

Results and Discussion
Results are presented in Table 1. The highest yielding malting entry was ‘2B10-4465’ at 109.85 bushels/acre while the highest yielding feed/food entry was ‘09WA-231.5’ at 122.56 bu/acre. Results are posted annually at www.uwyo.edu/uwexpstn/variety-trials/index.html

Acknowledgments
Appreciation is extended to the Powell R&E Center staff for their assistance during 2013. Thanks goes to Riverland Ag Corp. for providing entries for testing.

Contact Information
Andi Pierson at apierso1@uwyo.edu or 307-754-2223.

Key words: barley, variety trial
PARP: VIII:1
Table 1. Agronomic performance of spring barley genotypes grown at PREC during 2013.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Row Type</th>
<th>Grade</th>
<th>Height inches</th>
<th>Heading Date days from Jan 1</th>
<th>Lodging 1–9*</th>
<th>Grain Yield bu/acre</th>
<th>Test Weight lb/bu</th>
<th>Plump 6/64</th>
<th>Plump 5.5/64</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2B10-4465</td>
<td>2</td>
<td>malting</td>
<td>35.3</td>
<td>176</td>
<td>2.3</td>
<td>109.85</td>
<td>48.16</td>
<td>92.4</td>
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LOCATION MEAN 35.05 175.29 2.68 102.02 46.96 91.94 96.16
LSD (.05)     18.68 3.20 3.39 4.13
CV %          4.72 10.80 4.02 6.50 3.70

*Lodge=1 upright–9 flat; **F=food, H=hulless
On-Farm Water Management for Optimum Grain Yield in Confection Sunflower

A. Samet\textsuperscript{1,2}, V.R. Joshi\textsuperscript{1}, and A. Garcia y Garcia\textsuperscript{1,2}

\textsuperscript{1}Department of Plant Sciences; \textsuperscript{2}Powell Research and Extension Center.

Introduction

Confection sunflower is becoming more commonly grown and an increasingly more important cash crop to Wyoming farmers, especially many in the Bighorn Basin. Although the number of acres put into sunflower each year has continued to increase, there are still many questions regarding how and when to irrigate to obtain maximum production in the typical growing conditions of Wyoming. In the Bighorn Basin, sunflower is typically irrigated every 10–14 days, with the last irrigation usually occurring around September 1. Past research has determined that sunflower is moderately tolerant to water stress and may be an excellent crop for limited irrigation strategies without compromising grain yield and quality.

Objectives

Objectives were to determine the effects of different water-management practices on sunflower grain yield and quality and to develop a water-management strategy that could allow reducing irrigation events while producing the highest grain yield.

Materials and Methods

The study was conducted at the Powell Research and Extension Center (PREC) during the 2010 growing season. The sunflower variety ‘Dalhgreen7969’ was planted May 4, 2010, in clay-loam soil of a furrow-irrigated field using a randomized complete block design with four replicates. Each plot measured 22 by 50 feet. After the crop was planted, an initial establishment irrigation was applied to all treatments. Then, different irrigation strategies were applied at different stages of growth. The treatment strategies included full (F), start irrigation when a miniature floral head was observed (stage R1, no new leaves), start irrigation when the head began to open (stage R4) (Figure 1), and rainfed (R).

After the initial establishment irrigation, F continued to be irrigated whenever

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure1.png}
\caption{Sunflower at the two stages of growth chosen to begin irrigation.}
\end{figure}
needed, R1 was not irrigated again until a miniature floral head was observed, R4 treatment was not irrigated again until the head began to open, and R (irrigation to establish only) relied completely on rainfall during the growing season. At harvest, information on total yield and the 20/64 “big seed” sieve yield was obtained.

Results and Discussion
Our results showed significant differences ($p<0.05$) on total yield between the three irrigation treatments and the rainfed treatment. The yield results were similar in lbs/acre among the three irrigation treatments: F, R1, and R4. The results, however, were even more interesting when comparing these three strategies while looking at the total grain yield versus the 20/64 sieve yield. The highest total average yield was in the crop under full irrigation, then R1, then R4 (Figure 2). The highest average yield in the 20/64 sieve was in the crop under the R4 irrigation treatment, then R1, then full irrigation.

Irrigation water from planting may enhance the total amount of grain yield over rainfed application alone. Our results suggest, however, that irrigation water application beginning at the later stages of sunflower growth may produce a higher percentage of “big seeds” measured using a 20/64 sieve. Because there was slight to no difference between the full, R1, and R4 irrigation treatments, irrigation application may be reduced during early stages of vegetative growth with little to no reduction to the high yield. This suggests that limited irrigation to confection sunflowers may be a viable option. This study is being repeated in 2014.

Acknowledgments
We thank PREC field crews and our summer helpers for assistance in plot establishment, plant processing, and harvesting. This study is supported by the Department of Plant Sciences.

Contact Information
Austen Samet at asamet@uwyo.edu, or Axel Garcia y Garcia at axel.garcia@uwyo.edu or 307-754-2223.

Key words: water management, application time, sunflower

Figure 2: Yield results from October 13, 2010, sunflower grain harvest. Means of total yield with the same uppercase letter are not significantly different ($p<0.05$). Means of 20/64 yield with the same lowercase letter are not significantly different ($p<0.05$).
Phosphorus Fertilizer Management in Sugarbeets

N.Y. Kusi1, A. Mesbah1*, B. Stevens2, A. Kniss1, J. Norton3, A. Garcia y Garcia1,4

1Department of Plant Sciences; 1* Currently at New Mexico State University; 2 U.S. Department of Agriculture, Agricultural Research Service, Sidney, Montana; 3Department of Ecosystem Science and Management; 4Powell Research and Extension Center.

Introduction

Because sugarbeet is a high-input crop (with fertilizer one of the highest inputs), profitable sugarbeet production depends, in part, on high root/sugar yield and high sucrose content. Phosphorus (P) is one of the essential plant nutrients, enhancing root growth in crops as well as increasing sugar and starch production. Two common methods of P application are banding (placing nutrients near the seed or seedling at planting), and broadcasting (uniform distribution of fertilizer on a field). Banding of P typically results in more efficient root uptake, so it is commonly recommended that the P application rate be reduced by 30–50% when banding versus broadcasting. A major problem with P is that it gets “fixed” in soils making it unavailable for plant uptake. In alkaline soils, typically found in Wyoming, P fixation is caused by calcium. Additives are available that are advertised to increase P uptake efficiency by inhibiting soil reactions that tie up P, and with the rising cost of fertilizer, growers are interested in these and other practices that may help to reduce input costs.

Objectives

Our objectives are to determine: 1) the effect of P fertilizer placement and formulation on sugarbeet root/sugar yield, 2) the optimum P rate for banded and broadcast application for sugarbeet production in the Bighorn Basin, and 3) the effect of Avail® on P availability in soils.

Materials and Methods

This study was established in 2013 under furrow irrigation at the Powell Research and Extension Center (PREC). The experimental design was a randomized complete block design split-plot, with four replications. Plots measured 11 by 50 feet. Fertilizer product was the main-plot treatment and fertilizer rates the split-plot treatments. Dry monoammonium phosphate (MAP, formulation 11-52-0) was broadcast in spring on tilled plots at 0, 30, 60, 120, 180, 240, and 300 lb P2O5 per acre. Liquid ammonium polyphosphate (APP, formulation 11-37-0, density 12 lb/gal) was banded at a depth of 3 inches below, and 3 inches beside the seeds just prior to planting, at the same rates as the broadcast fertilizer applications. To one complete set of banded P treatments, Helena
Nucleus® O-Phos (formulation 8-24-0), a low-salt liquid popup starter fertilizer (pop), was applied at a rate of 5 gal/acre (12.78 lb P₂O₅ per acre). Avail® (a P availability enhancer) was applied in some treatments to prevent P fixation. The sugarbeet variety Syngenta ‘HM 9120’ was planted from April 18–19. Plants were sampled in mid-June and mid-July to determine early-season response to P fertilizer and harvested in September to determine final root yield. Initial soil P test results were 14 and 6 ppm, at the 0–12 inch and 12–26 inch soil depths, respectively.

Results and Discussion

The results showed a significant root/sugar yield response to fertilizer application rate (p<0.05) (Figure 1). Sugarbeet root yields increased linearly from 25 tons/ac at the 0 lb/ac rate to 27.2 tons/ac at the 300 lb/ac rate. For fertilizer product formulation, APP + pop was significantly different from the other fertilizer product treatments (Figure 2). Avail was seen to have no effect on yield of broadcast-fertilized plots. The optimum P application rate cannot be determined since yield increase was linear from the 0-lb rate to the 300-lb rate. Higher P₂O₅ rates corresponded to slightly higher yields. Further studies are being conducted this season to ascertain the effect of P formulation and rates on sugarbeet root yield. The best P application method was APP + pop as it produced the highest root yield.

Acknowledgments

We thank the Western Sugar Cooperative, PREC staff, and the 2013 summer crew.

Contact information

Nana Yaw Kusi at nkusi@uwyo.edu, or Axel Garcia y Garcia at axel.garcia@uwyo.edu or 307-754-2223.

Key words: sugarbeets, phosphorus, sugar yield.

PARP: I:2, II:1
Yield of Confection Sunflower as Affected by Planting Date and Irrigation

V.R. Joshi\textsuperscript{1}, K. Hansen\textsuperscript{2}, and A. Garcia y Garcia\textsuperscript{1,3}

\textsuperscript{1}Department of Plant Sciences; \textsuperscript{2}Department of Agricultural and Applied Economics; \textsuperscript{3}Powell Research and Extension Center.

Introduction

Confection sunflower is a relatively new crop to Wyoming farmers. Due to its good market and adaptability to several agricultural production areas in Wyoming, its importance is increasing. Besides diversifying the cropping system, it can be a viable option for alternative income.

Research done in 2010 and 2011 at the Powell Research & Extension Center (PREC) showed that little to no irrigation reduces sunflower yield by as much as 60 percent. Therefore, irrigation management is important for profitable sunflower production. Early termination of irrigation is one practice to manage water use, thereby decreasing production costs while increasing irrigation water-use efficiency.

Objectives

The objectives of this study were to determine the best planting dates and the best combination of planting date and early irrigation termination that will result in higher grain yield and better quality of confectionary sunflower.

Materials and Methods

The experiment was conducted in 2012 and 2013 at PREC, in a randomized complete block design set in a split plot arrangement with three replications. Planting date was the main treatment, and irrigation (IR) was the sub-treatment. ‘Dahlgren D-9569’, a confection sunflower hybrid, was planted on a furrow-irrigated field. In 2012, planting dates were May 1, May 10, May 20, May 30, June 10, June 20, and June 29. The 2013 planting dates were May 3, May 9, May 23, June 4, and June 10. In both years, irrigation treatments were: irrigation until R5.5 stage (50% flowering, IR1), R6 stage (complete flowering, IR2), and R7 stage (change color on the back head, IR3).

Results and Discussion

Early termination of irrigation: Results from 2012 showed significant effect of irrigation on total yield whereas no effect on 20/64 yield (seeds left after screening on 20/64-inch sieve). The total yield was comparable (no significant differences at $p \leq 0.05$) between IR1 and IR3 treatments. In 2013, however, the effect of irrigation was found to be non-significant in both total yield and 20/64 yield.

Planting date: Both total yield and 20/64 yield were significantly affected by planting date in the 2012 and 2013 growing seasons. The highest yield in 2012 was obtained from planting on May 30,
while the highest yield in 2013 was obtained from planting on June 10 (Tables 1 and 2).

Interaction of planting date and irrigation:
In 2012, significant differences in yield were observed due to the interaction effect of planting date and irrigation. The highest yield was obtained with a May 30 planting date receiving irrigation until the R5.5 stage. In contrast, no such interaction effect was seen in 2013.

Results from 2012 and 2013 show that: planting date from the last week of May to the first week of June and irrigation until the R5.5 growth stage are promising management practices for optimum sunflower production in the Bighorn Basin.

Acknowledgments
This project was funded by the Department of Plant Sciences and Wyoming Agricultural Experiment Station.

Contact information
Vijaya Joshi at vjoshi1@uwyo.edu, or Axel Garcia y Garcia at axel.garcia@uwyo.edu or 307-754-2223

Key words: irrigation management, planting date, confection sunflower

PARP: I:1, I:2; IV:3; IV:4

Table 1. Yield of confection sunflower at different planting dates (2012).

| Planting date | Total Yield (lb/A) | Yield 20/64*
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Within columns, means with the same letter (a–d) are not significantly different at p ≤ 0.05.

* Seeds left after screening on 20/64-inch round hole sieve are considered large seeds and have higher market value. The higher the percentage of large seeds, the greater the profit potential.

§ Data incorrectly reported in 2013 WAES Field Days Bulletin.

Table 2. Yield of confection sunflower at different planting dates (2013).

| Planting date | Total Yield (lb/A) | Yield 20/64
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Within columns, means with the same letter (a–d) are not significantly different at p ≤ 0.05.
Planting Date Effect on Corn Yield and Water Productivity in the Bighorn Basin

M. Abritta and A. Garcia y Garcia

1Department of Plant Sciences; 2Powell Research and Extension Center.

Introduction

Wyoming’s short growing season (on average 125 freeze-free days in the Bighorn Basin) poses a challenge to agriculture. To avoid crop exposure to harsh weather (conditions that can result in yield loss), farmers need to plant in a timely manner. Corn planting in Wyoming typically occurs between April 25 and June 6 and hits its peak between May 3‒21 (NASS, 2010). Interestingly, little research is found backing the current planting practice. Field studies typically only last a few years so may be limited in determining the long-term effects of management practices. Crop models, on the other hand, enable researchers to evaluate changes over several seasons. Determining optimal planting dates for corn can increase the efficacy of the production system and profitability, as weather conditions have significant impact on yield and water productivity.

Objectives

This study evaluates the impact of planting dates on corn yield and water productivity. (Water productivity is the ratio of marketable yield—in this case, corn—to water use [evapotranspiration]).

Materials and Methods

Corn was planted May 16, 2011, on a subsurface drip irrigated field at the Powell Research and Extension Center (PREC), and it was maintained at optimal conditions of growth. Weather conditions were monitored using an automated weather station deployed at the experimental field, and plant samples were collected for growth analysis. The experimental data were used to calibrate the cropping system model (Decision Support System for Agrotechnology Transfer; Hoogenboom, 2010). DSSAT’s seasonal analysis tool was used to simulate corn growth across a 30-year period (1980‒2009) and 10 different planting dates, ranging from March 30 to June 30. The simulation triggered irrigation at 50% soil-available water, with an application efficiency of 100%, and was set to unlimited nutrient uptake. This isolated the effects of the planting dates on corn growth.

Results and Discussion

The results from simulations showed that average corn grain yield across a 30-year period was higher when planting around April 20, steadily decreasing for later planting dates (Figure 2). Water
Figure 1. Average simulated corn yield and water productivity for climate data between 1980–2009.

productivity decreases for the two earliest planting dates, March 30 and April 10, as well as for the latest planting date on June 30, but it plateaus close to 900 pounds of corn per acre-inch of water for the remaining planting dates (Figure 1). Decreased water productivities were driven by higher probability of crop failure and lower productivity during the earlier and later planting dates. Despite the high average yields for corn planted on March 30 and April 10, the risk of crop failure for corn planted at those dates is high (Figure 2). Planting later than June 10 also increased the probability of crop failure and decreased the likelihood of obtaining high yields (Figure 2).

The simulations indicate that farmers may benefit from earlier planting dates through increases in yield. Crop exposure to early frost and irrigation water availability, however, are important limitations to early planting. According to our results, the period between April 30 and May 20 appears to be the most appropriate for corn planting in the Bighorn Basin, as yield and water productivity are at the higher end of our simulation. These results are in agreement with the overall current practice of planting between May 3 and May 21 in the state (NASS, 2010), highlighting the effects of early planting for maximum yield if the aversion to weather-related risks is low.

Acknowledgments

Thanks to PREC’s field crew as well as Andrea Pierson and all our summer helpers for their support.

Contact Information

Marcelo Abritta at mabritta@uwyo.edu, or Axel Garcia y Garcia at axel.garcia@uwyo.edu or 307-754-2223.

Key words: corn, planting dates, modeling

PARP: I:1, X:1, X:2

References

Inter-Annual Weather Variation at Powell R&E Center

B.B.V. Almeida\textsuperscript{1,2,3} and A. Garcia y Garcia\textsuperscript{1,2}

\textsuperscript{1}Department of Plant Sciences; \textsuperscript{2}Powell Research and Extension Center; \textsuperscript{3}College of Agriculture, University of São Paulo, Brazil.

Introduction

The Powell Research and Extension Center (PREC) is the smallest in terms of acreage of the four University of Wyoming R&E centers. Rainfall is scarce and highly variable with almost half of the annual average (6.9 inches) received from May to August. Because the region is arid, irrigation is generally a necessity for most farming. Due to the importance of irrigation to the region, PREC has been informally designated the Irrigation R&E Center of the University of Wyoming. Available resources to support high-quality irrigation research include 2.5 acres under on-surface drip, 1.2 acres under subsurface drip, 54 acres under sprinkler, and about 142 acres under surface irrigation using gated pipes and siphons. Research at the center focuses on crop irrigation (water use, water stress, and limited irrigation), weed control, cropping systems, protected agriculture (high tunnels), variety trials, and alternative crops.

The development of sound irrigation strategies requires soils, crops, and weather information. The Wyoming Agricultural Weather Network (www.wawn.net) was created in 2010 to support research and to fulfill a much needed, near-real time weather information system for producers in Wyoming. The automated weather stations of WAWN measure air temperature, solar radiation, rainfall, relative humidity, soil temperature, and soil moisture (2-, 4-, 8-, and 20-inch depths). The reference evapotranspiration (ET\textsubscript{o}), an indication of the water needs of plants, and other derived variables are also provided.

Objectives

Our objective is to summarize almost four years of continuous environmental monitoring using the automated weather station data available at www.wawn.net.

Materials and Methods

Daily data from 2010 to 2013 obtained at PREC and recorded with an automated weather station, which is part of WAWN, were analyzed for the period from April to October. All results are presented graphically as an average of five-day periods (pentads) for air temperature, rainfall, and ET\textsubscript{o} (Figure 1).

Results and Discussion

The four years of environmental monitoring provided valuable information for agriculture-related research and
decision-making among producers. During the four-year period, the growing season (number of frost-free days) was as short as 126 days in 2010 and as long as 152 days in 2013. During the 2012 growing season, rainfall was less than 2 inches, while in 2011 and 2013 more than 6.5 inches were recorded. The 2011 growing season was the wettest of the four years with most rainfall in May. Rainfall during the 2013 growing season was higher than usual in July, September, and the beginning of October; the end-of-season rainfall brought some disease problems and harvest delays. The 2012 growing season was the driest and warmest of all four years, but crop yield was very good. This shows the importance of irrigation for the sustainability of agriculture in the state. ETo peaks from mid-June to the end of July, with a maximum around 1.2 inches in a five-day period; that’s 0.24 inches/day. On average, ETo during the peak period should be increased 20% to estimate water needs of major crops.

Overall, frost days may be expected as early as mid-September and as late as mid-May while water needs are greatest from mid-June to the end of July.

Acknowledgments

The www.wawn.net is supported by the University of Wyoming Department of Plant Sciences, Wyoming Sugar Company LLC, Washakie County Conservation District, and Heart Mountain Irrigation District.

Contact Information

Axel Garcia y Garcia at axel.garcia@uwyo.edu or 307-754-2223.

Key words: weather, evapotranspiration, temperature, growing season

PARP: I:2, II:2, VI:8
Short- and Long-Term Weather Variation at the Powell R&E Center

B.B.V. Almeida\textsuperscript{1}, M.A. Abritta\textsuperscript{2}, and A. Garcia y Garcia\textsuperscript{1,2}

\textsuperscript{1}Department of Plant Sciences; \textsuperscript{2}Powell Research and Extension Center.

Introduction
Weather plays a major role in agricultural production. The Wyoming Agricultural Weather Network (www.wawn.net) was created in 2010 to implement a much needed, near-real time weather information system for researchers and producers in Wyoming.

Objectives
The objective of this study was to compare short- and long-term weather variations for conditions at the Powell Research and Extension Center (PREC).

Materials and Methods
Monthly averages of four years (2010–2013) of weather data from PREC were used to compare with monthly normals calculated using historical weather data from the National Oceanic and Atmospheric Administration’s (NOAA) Climate Data Online (www.ncdc.noaa.gov/cdo-web). The daily data from WAWN and NOAA were previously assessed to make sure comparisons were possible (results not shown). As for NOAA’s definition, “normal” is the dominant set of weather conditions calculated over a 30-year period. For the purposes of this document, daily weather data from the period 1980–2009 were used to calculate the normals.

Results
Weather conditions from the 2010 growing season through the 2013 season ranged from extremely dry and warm in 2012 to relatively wet and cool in 2013. Overall, conditions from 2010 to 2013 were warmer than normal. The normal maximum air temperature in the region during the growing season characterizes May through June as the coolest period and July through August as the warmest period. Within a month—and as compared to normal—the average minimum air temperature tended to increase every year. Rainfall was very variable; May and June were the wettest months while August and October were the driest. The solar radiation was practically the same in all years. The reference evapotranspiration (ET\textsubscript{o}), an indication of plants’ water needs, peaks in July, with the next highest totals in June and August. Both solar radiation and E\textsubscript{T}o had no historical records for comparison with normals (Table 1).

The short-term weather conditions obtained with a WAWN automated weather station at PREC showed not only the within-season variations, but also a tendency of conditions above normal during June, July, August, and September.
Table 1. Summary of monthly weather conditions at PREC as compared to monthly normals. The 2010–2013 data were obtained with an automated weather station as part of the WAWN (www.wawn.net).

<table>
<thead>
<tr>
<th>Month</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Normal</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Normal*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr</td>
<td>57.5</td>
<td>53.3</td>
<td>64.2</td>
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<td>1.0</td>
<td>0.2</td>
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<td>0.5</td>
</tr>
<tr>
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<td>60.7</td>
<td>59.2</td>
<td>68.4</td>
<td>68.5</td>
<td>67.1</td>
<td>1.1</td>
<td>3.1</td>
<td>0.8</td>
<td>1.8</td>
<td>1.3</td>
</tr>
<tr>
<td>Jun</td>
<td>76.5</td>
<td>76.0</td>
<td>84.9</td>
<td>80.7</td>
<td>75.2</td>
<td>0.8</td>
<td>0.2</td>
<td>0.3</td>
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</tr>
<tr>
<td>Jul</td>
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<td>91.3</td>
<td>87.8</td>
<td>84.6</td>
<td>0.2</td>
<td>0.1</td>
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<td>78.9</td>
<td>74.2</td>
<td>72.6</td>
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<td>2.0</td>
<td>0.7</td>
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<tr>
<td>Oct</td>
<td>66.1</td>
<td>62.5</td>
<td>57.4</td>
<td>52.4</td>
<td>59.1</td>
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<td>0.2</td>
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**Average Monthly Temperature (°F)**

<table>
<thead>
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<th>2012</th>
<th>2013</th>
<th>Normal</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Normal*</th>
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<td>54.6</td>
<td>56.1</td>
<td>53.9</td>
<td>23.4</td>
<td>18.7</td>
<td>23.4</td>
<td>22.1</td>
<td></td>
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<tr>
<td>Jun</td>
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<td>68.8</td>
<td>65.8</td>
<td>61.3</td>
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<td>Jul</td>
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<td>73.4</td>
<td>74.5</td>
<td>71.9</td>
<td>68.9</td>
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<td></td>
</tr>
<tr>
<td>Aug</td>
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<td>70.1</td>
<td>70.0</td>
<td>70.8</td>
<td>67.7</td>
<td>22.2</td>
<td>23.1</td>
<td>22.6</td>
<td>21.6</td>
<td></td>
</tr>
<tr>
<td>Sep</td>
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<td>60.8</td>
<td>61.6</td>
<td>60.4</td>
<td>56.8</td>
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<tr>
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<td>44.6</td>
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**Average Monthly Minimum Temperature (°F)**

<table>
<thead>
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<th>2012</th>
<th>2013</th>
<th>Normal</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Normal*</th>
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<tr>
<td>Apr</td>
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<td>28.7</td>
<td>34.1</td>
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<td>30.4</td>
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<td>3.4</td>
<td>2.6</td>
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</tr>
<tr>
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<td>40.7</td>
<td>3.9</td>
<td>3.3</td>
<td>4.4</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Jun</td>
<td>49.8</td>
<td>47.2</td>
<td>52.3</td>
<td>49.9</td>
<td>47.4</td>
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</tr>
<tr>
<td>Jul</td>
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<td>56.3</td>
<td>58.0</td>
<td>56.9</td>
<td>53.2</td>
<td>7.3</td>
<td>6.7</td>
<td>5.9</td>
<td>6.1</td>
<td></td>
</tr>
<tr>
<td>Aug</td>
<td>52.6</td>
<td>53.4</td>
<td>53.1</td>
<td>55.5</td>
<td>50.8</td>
<td>5.8</td>
<td>5.3</td>
<td>5.2</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>Sep</td>
<td>42.9</td>
<td>44.0</td>
<td>45.6</td>
<td>48.2</td>
<td>41.0</td>
<td>4.3</td>
<td>3.9</td>
<td>3.8</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Oct</td>
<td>37.7</td>
<td>36.0</td>
<td>31.0</td>
<td>29.5</td>
<td>30.1</td>
<td>2.8</td>
<td>2.1</td>
<td>1.7</td>
<td>1.6</td>
<td></td>
</tr>
</tbody>
</table>

*Due to lack of historical records of solar radiation, the reference evapotranspiration (ASCE equation) cannot be estimated.

**Acknowledgments**

The www.wawn.net is supported by the Department of Plant Sciences, Wyoming Sugar Company LLC, Washakie County Conservation District, and Heart Mountain Irrigation District.

**Contact Information**

Axel Garcia y Garcia at axel.garcia@uwyo.edu or 307-754-2223.

Key words: automated weather station, normals, Powell Research and Extension Center.

PARP: X:1
Forage and Seed Yield Potential of Tall Fescue Under Irrigated Conditions

M.A. Islam¹ and R. Violett²

¹Department of Plant Sciences; ²Powell Research and Extension Center.

Introduction
Irrigated grass pastures are essential components of western U.S. agriculture, especially on cattle ranches of the intermountain region. However, the yield and quality of these grasslands is often low compared to the national average. Price increases of fertilizer, energy, and fuel make improvement of these natural grasslands more difficult and thus threatens the profitability and sustainability of current production systems. Tall fescue is one of the most productive cool-season grasses in the U.S. It can grow on a wide range of soils, has high drought and winter hardiness, and can be used for pasture, hay, stockpiling, silage, soil conservation, and turf grass. Also, it has prolific seed production ability. Therefore, tall fescue may have potential for improving forage and seed production in northwest Wyoming and perhaps other areas of Wyoming and neighboring states.

Objectives
The objectives of this project are to identify tall fescue cultivars/lines that are suitable for western mountain regions—specifically the Bighorn Basin—and generate information on growth, forage yield, and seed yield that could benefit growers in the Bighorn Basin and other areas of Wyoming and beyond.

Materials and Methods
The study was conducted at the Powell Research and Extension Center (PREC) and at the Stroh farm, Powell, under irrigated conditions from 2009 to 2012. The experimental design was a factorial randomized complete block with four replications organized in a split-plot arrangement. The experiments included a forage yield trial that received three different nitrogen (N) treatments (0, 50, and 100 pounds N per acre) and a seed yield trial that received three N treatments (0, 100, and 150 pounds N per acre). There were three clipping treatments (none, early May, and late May‒early June) for the seed yield trial. (Details of the materials and methods can be found in the WAES 2011 Field Days Bulletin at www.uwyo.edu/uwexpstn/publications/). Forage yield, seed yield, and forage quality were measured, and an economic comparison was made.

Results and Discussion
Tall fescue cultivars/lines responded well to N treatments. The highest forage and seed yields were associated with the highest N treatment (Table 1). Clipping treatments influenced seed yield as well.
The highest seed yields were associated with the highest N and no clipping treatments. All cultivars/lines produced acceptable forage quality. Economic comparisons showed that at least 50 pounds N per acre were needed to make forage production profitable under irrigation (Table 1). Seed production from tall fescue cultivars/lines was more profitable than forage production. At both locations, the maximum expected net returns ($721 per acre at PREC; $640 per acre at Stroh farm) were obtained from 150 pounds N per acre with no clipping treatment (data not shown). Early clipping may be used in years when late freezing injury and/or limited forage availability are expected. Based on three years of data and economic comparison, late harvesting is not recommended.

The economics of forage and seed yield indicate that tall fescue may have potential to add revenue to producers’ enterprises. Further studies warrant determining the maximum N rates for maximum profits.

Acknowledgments

We thank the Wyoming Crop Improvement Association for funding, PREC staff for assistance, and Rick Stroh for land.

Contact Information

Anowar Islam at mislam@uwyo.edu or 307-766-4151.

Key words: tall fescue, forage yield, seed yield

PARP: I:1,2, II:2, VI:10, VII:1

Table 1. Economic comparison of tall fescue lines/cultivars managed for forage production under irrigation.

<table>
<thead>
<tr>
<th></th>
<th>PREC</th>
<th>Stroh farm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N treatment (pounds per acre)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 50 100</td>
<td>0 50 100</td>
</tr>
<tr>
<td>Revenue per acre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forage production (pounds per acre)</td>
<td>1,909, 4,516, 5,881</td>
<td>1,443, 3,537, 5,160</td>
</tr>
<tr>
<td>Revenue* ($)</td>
<td>180, 427, 556</td>
<td>136, 334, 488</td>
</tr>
<tr>
<td>Expenses per acre ($)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land preparation</td>
<td>15, 15, 15</td>
<td>15, 15, 15</td>
</tr>
<tr>
<td>Seed</td>
<td>28, 28, 28</td>
<td>28, 28, 28</td>
</tr>
<tr>
<td>Fertilizer N</td>
<td>0, 32, 64</td>
<td>0, 32, 64</td>
</tr>
<tr>
<td>Fertilizer phosphorus</td>
<td>46, 46, 46</td>
<td>46, 46, 46</td>
</tr>
<tr>
<td>Fertilizer potassium</td>
<td>10, 10, 10</td>
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</tr>
<tr>
<td>Weed control</td>
<td>30, 30, 30</td>
<td>30, 30, 30</td>
</tr>
<tr>
<td>Planting</td>
<td>12, 12, 12</td>
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</tr>
<tr>
<td>Corrugating</td>
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</tr>
<tr>
<td>Seed harvesting</td>
<td>0, 0, 0</td>
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<tr>
<td>Forage harvesting</td>
<td>30, 30, 30</td>
<td>30, 30, 30</td>
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<tr>
<td>Misc. expenses and interest on invested $</td>
<td>80, 80, 80</td>
<td>80, 80, 80</td>
</tr>
<tr>
<td>Total expenses</td>
<td>261, 293, 325</td>
<td>261, 293, 325</td>
</tr>
<tr>
<td>Expected net return* ($ per acre)</td>
<td>-80, 134, 231</td>
<td>-124, 41, 163</td>
</tr>
</tbody>
</table>

*For hay price (revenue), the 2012 average market price for Wyoming was used; even with a modest hay price ($140 per ton), the expected net returns are $87 and $36 per acre from 100 pounds N for PREC and Stroh farm, respectively (data not shown)

#Custom enterprise budgets were prepared to determine the expected net returns.
Effectiveness and Economics of Cultural and Mechanical Weed Control Practices for Managing Herbicide-Resistant Weeds

A.R. Kniss\textsuperscript{1}, J.A. Ritten\textsuperscript{2}, R.G. Wilson\textsuperscript{3}, and P. Jha\textsuperscript{4}

\textsuperscript{1}Department of Plant Sciences; \textsuperscript{2}Department of Agricultural and Applied Economics; \textsuperscript{3}University of Nebraska–Lincoln; \textsuperscript{4}Montana State University.

Introduction

Cultural and mechanical weed management practices are underused in many cropping systems, particularly for managing herbicide-resistant weeds. This may be due, in part, to a lack of knowledge about the impact of non-herbicide management practices on the development of herbicide-resistant weeds. Simulation models are currently the most common approach for comparing the impact of weed control practices on the evolution of herbicide-resistant weeds. Nearly all modelers recognize the importance of validating assumptions and results of predictive models through field research; yet, there is an alarming lack of field studies that quantify the impact of non-herbicide weed management practices on the evolution of herbicide-resistant weed populations.

Objectives

Our objectives are to: 1) determine the impact of crop rotation diversity and tillage on evolution of herbicide resistance within a weed population, and 2) quantify the economic benefits and risks of adopting a diversified weed management program to delay the development of herbicide resistance.

Materials and Methods

Using field sites established in 2014 at the Powell Research and Extension Center (PREC) and the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle, we will quantify the impact of tillage and diverse crop rotations on development of herbicide resistance in kochia (Kochia scoparia), a summer annual weed species with a relatively short soil life.

We will establish a kochia population at each study site that has a known proportion of ALS-herbicide susceptible (S) and resistant (R) individuals. (ALS is short for acetolactate synthase. This enzyme is a protein found in plants, and herbicides that target the ALS enzyme are among the most widely used weed control chemicals.)

We will then monitor the proportion of R:S individuals (as well as total weed density) in response to tillage intensity, crop rotation, and herbicide use. Based on the field results, we will establish biological and economic models that aid in developing herbicide-resistant weed...
management recommendations. By determining the efficacy and economic impacts of non-herbicide practices on development of herbicide resistance, we hope to decrease reliance on herbicides, thereby reducing the evolution and spread of new herbicide-resistant weeds. This could greatly benefit producers in Wyoming and beyond.

Results and Discussion

The study was established in 2014 at PREC and SAREC. Additional sites are being established at the University of Nebraska—Lincoln’s Panhandle Research and Extension Center near Scottsbluff, Nebraska, and Montana State University’s Southern Agricultural Research Center near Huntley, Montana. The project will run through 2017. No results are yet available.

Acknowledgments

This study is funded by a grant from the U.S. Department of Agriculture’s National Institute of Food and Agriculture.

Contact Information

Andrew Kniss at akniss@uwyo.edu or 307-766-3949.

Key words: kochia, herbicide resistance, crop rotation, tillage

PARP: I:3,7,9, III:1,7, VII:4,7, VIII:2, IX:1
2013 Dry Bean Performance Evaluation

M. Moore\textsuperscript{1}, M. Killen\textsuperscript{2}, J. Sweet\textsuperscript{1}, J. Christman\textsuperscript{2}, and S. Frost\textsuperscript{3}

\textsuperscript{1}Wyoming Seed Certification Service; \textsuperscript{2}Powell Research and Extension Center; \textsuperscript{3}UW Extension

Introduction

The Wyoming Seed Certification Service funds and coordinates the dry bean variety performance evaluation at the Powell Research and Extension Center (PREC). With assistance from PREC staff, a wide range of germplasm is evaluated, which assists producers in selecting varieties.

Objectives

Wyoming’s climate is locally variable, as is varietal yield potential and days to maturity. Yield potential and data on days to maturity are important to producers, as moderate- and long-season bean varieties may not mature in all areas.

Materials and Methods

The experiment was conducted at PREC. Weed control consisted of a preplant-incorporated treatment of 2 pints Sonalan\textsuperscript{\textregistered} and 14 ounces Establish\textsuperscript{TM}. The plots received 65 units of nitrogen (N), 50 units of phosphorous (P), and five units of zinc (Zn). The plot design was a complete randomized block with four replications. The seeding rate was four seeds per foot of row, on 22-inch rows. The three-row by 20-foot plots were planted May 18. Visual estimates were made for the number of days to reach 50\% bloom (50\% of plants with a bloom) and days to maturity (50\% of the plants with one buckskin pod). Subplots of one row by 10 feet were pulled by hand and threshed with a Wintersteiger small plot thresher.

Results and Discussion

Stand establishment was slow due to cool, wet weather, which delayed planting about 10 days. Summer temperatures were reasonable, and a reasonable fall allowed all entries to reach maturity. Yields across entries averaged 3,507 pounds per acre (Table 1), ranging from 2,460 pounds per acre for ‘CELRK’ light red kidney to 4,327 pounds per acre for ‘PT11-9’ pinto bean.

Contact Information

Mike Moore at mdmoore@uwyo.edu, 307-754-9815, or 800-923-0080.

Key words: dry bean, performance evaluation

PARP: VIII
Table 1. Agronomic data, 2013 cooperative dry bean nursery, Powell, Wyoming.

<table>
<thead>
<tr>
<th>Name</th>
<th>Market class</th>
<th>Yield lbs./A</th>
<th>Seeds per pound</th>
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Appendix

Wyoming Production Agriculture Research Priorities (PARP)

GRAND CHALLENGE—
Enhance the competitiveness, profitability, and sustainability of Wyoming agricultural systems.

Goal 1. Improve agricultural productivity considering economic viability and stewardship of natural resources.

Goal 2. Develop new plant and animal production systems, products, and uses to increase economic return to producers.

Producer Recommendations

I. Production Systems Objectives

1) Develop and maintain base line agriculture production systems to evaluate effects of innovations on the natural resource base, sustainability, and profitability.

2) Develop best-agronomic management practices for alternative crops such as sunflower seed production and various forages (perennial and annual legumes, grasses, and legume-grass mixtures) and other oilseed crops.

3) Identify synergistic effects among crops to improve crop rotation systems.

4) Develop methods to deal with residue when establishing new stands in crop rotation systems.

5) Evaluate effects of legumes in dryland wheat production systems.

6) Evaluate incorporating crops and crop aftermath into livestock production systems.

7) Evaluate and compare no-till versus tillage techniques.

8) Identify improved harvesting techniques.

9) Evaluate the use of legumes in rotational cropping systems.

II. Soil Fertility Management Objectives

1) Develop methods to ameliorate poor soil pH for crop production.

2) Investigate effects of fertilizer type, placement, and timing on crop production (sugarbeets, cereal grains, dry beans, and forages).

3) Evaluate the efficacy of managing soil nitrogen applied by pivot irrigation.

4) Determine and categorize nitrogen release times for varied forms of nitrogen.

5) Discover methods to reduce dependence on commercial fertilizers.

6) Develop tillage systems that minimize soil disturbance.

7) Develop cheaper alternatives to commercial fertilizer (e.g., cover crops, legumes).

8) Test the ability of compost and manure to enhance soil fertility.

9) Identify plants such as legumes that enhance soil fertility.

Continued on next page
III. Weed Control Objectives

1) Develop control methods for weeds resistant to Roundup® or other herbicides.
2) Develop methods to control weed emergence that can be applied in the fall.
3) Improve procedures to control noxious weeds, especially milkweed and thistle.
4) Evaluate the efficacy of weed-control chemicals applied before planting in dry bean fields.
5) Develop chemical and non-chemical methods to control cheatgrass and other noxious weeds.
6) Coordinate application of Roundup with precision agriculture.
7) Optimize use of herbicides economically and environmentally.

IV. Irrigation Objectives

1) Test and develop surge and drip irrigation techniques for specific crops, especially alfalfa seed, dry beans, and sugar beets.
2) Test the ability and reliability of moisture monitors to indicate timing of irrigation.
3) Conduct irrigation management studies to optimize water use for specific crops (alfalfa seed, dry beans, sugar beets).
4) Develop methods to maximize (optimize) production with less water.
5) Improve irrigated pasture production at high elevations.

V. Livestock Objectives

1) Develop strategies to enhance the efficiency of feed utilization.
2) Evaluate effects of additives or chemicals to feeds to influence forage and/or weed consumption.
3) Train livestock to consume alternative feeds such as brush and weeds.
4) Determine heifer development strategies that optimize reproduction, foraging ability, and cow longevity to maximize profitability.
5) Identify strategic supplementation protocols that optimize animal production traits with costs of production.
6) Develop improved methods to control flies.
7) Determine how to minimize feed costs and maximize profit per unit of production.
8) Develop genetic markers for feed efficiency.
9) Develop practical estrous synchronization methods for commercial producers.
10) Determine cumulative effects of minerals, ionophores, worming, and implants on animal productivity.
11) Provide cost/benefit information on grazing of irrigated pastures.

VI. Grazing Management Objectives

1) Develop improved forage-based livestock production systems.
2) Demonstrate and evaluate benefits of strip grazing corn stalks.

Continued on next page
3) Increase the carrying capacity of range and pastureland.

4) Evaluate effects of multi-species grazing on forage utilization and range health and productivity.

5) Develop alternative grazing strategies to enhance rangeland health.

6) Evaluate management intensive and rotational grazing strategies in dry environments.

7) Identify optimum grazing height for alfalfa aftermath and effects of grazing on stand longevity.

8) Develop forage species that are drought resistant.

9) Investigate ways to optimize wildlife-livestock interactions.

10) Provide new information on meadow management and irrigated pasture grazing in higher elevations.

VII. Production Economics Objectives

1) Determine the cost-effectiveness of fertilizer alternatives.

2) Determine the economics of alternative grazing systems.

3) Determine the cost-effectiveness of vaccines, mineral supplements, and pour-ons in livestock production systems.

4) Develop practical methods to assign economic values to ecological management procedures.

5) Identify obstacles and evaluate options and opportunities for marketing Wyoming-produced meat to consumers.

6) Determine impacts of alternative management strategies on whole-ranch/farm economics.

7) Provide information on costs per unit of production.

VIII. Crop and Animal Genetics and Biotechnology Objectives

1) Improve marker-assisted selection procedures to identify plants and animals with desired production traits.

2) Develop and evaluate genetically modified organisms that enhance desired production traits.

3) Identify optimum cow size for Wyoming environments.

4) Increase longevity and production persistence of forage legumes.

IX. Rural Prosperity, Consumer and Industry Outreach, Policy, Markets, and Trade Objectives

1) Analyze economic impacts of farming/ranching management decisions. Consider input costs, budgets, and market risks by region and crop.

2) Conduct applied research studies with producers and develop demonstration trials with cooperators to facilitate adoption of new or changing technologies.

3) Increase dissemination of research results (Wyoming Livestock Roundup, and other media outlets including radio programs).

4) Work with commodity groups to enhance adoption of new technologies.

5) Conduct hands-on classes at R&E Centers or with cooperators for young/new producers.

Continued on next page
X. Responding to Climate Variability

Objectives

1) Consider regionally unique environmental conditions when designing research studies.

2) Conduct integrated agricultural systems research that links environment and conservation to production and profitability.

3) Develop drought-resistant plants that fit the extreme environmental conditions of Wyoming.

XI. Sustainable Energy

1) Conduct research on bioenergy/biofuels and biobased products that are suitable to Wyoming’s environment.

XII. Landscape-Scale Conservation and Management

1) Develop improved methods to reclaim disturbed lands.

2) Evaluate water, soil, and environmental quality using appropriate organisms as indicator species.

If you have comments or suggestions on the PARP, please contact the Wyoming Agricultural Experiment Station at aes@uwyo.edu.