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

B.W. Hess

1Director, 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 field days throughout the summer months. 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 to describe a project that is soon

*The complete Fourth Edition will be available on our website at www.uwyo.edu/uwexpstn, select “Publications” on the left.
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 issue, goal(s), objective(s), and potential impact.

The intent of the WAES Field Days Bulletin is to demonstrate the vast 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 PARP, which will be continually updated as additional priorities are identified. An electronic copy of PARP 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.

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Introduction to the Sheridan Research and Extension Center

B.W. Hess¹

¹Director, Wyoming Agricultural Experiment Station.

Introduction

This has been another year of change for the Sheridan Research and Extension Center (ShREC). The center has experienced tremendous growth resulting from a unique partnership between the University of Wyoming, Northern Wyoming Community College District (NWCCD) in Sheridan, and Whitney Benefits. Originally established in 1915, ShREC had been solely located seven miles east of Sheridan near Wyarno. This site consists of approximately 300 acres of dryland. ShREC began to expand its focus to include horticulture over the past two decades. In addition to winter wheat and forage trials, ShREC near Wyarno had developed an orchard, a vineyard, and a certified organic garden. The horticulture presence at this location today continues to expand.

ShREC now has two active sites within Sheridan County. UW purchased and renovated the Sheridan College (SC) Watt Regional Agriculture Center, and it subleases the Adams Ranch located immediately south of the SC campus. With the Adams Ranch came approximately 400 acres to be utilized for research and educational activities. Because most of the Adams Ranch is under irrigation, the scope of ShREC has expanded even further. The ranch facilitates research and education on agriculture, forage management, horticulture, and viticulture (the science, study, and production of grapes).

Objectives

The objective of this introduction is to highlight a few key events that recently transpired at ShREC and to explain the general program for this year’s field day.

Rededication of the Watt Center

Thanks to a generous appropriation by the Wyoming Legislature, UW was able to purchase and renovate the Watt Agriculture Center. A rededication ceremony was hosted in February to celebrate the newly renovated facility on the SC campus. The ceremony was attended by many who played key roles in UW’s new presence on the SC campus. The ceremony included presentations by UW President Dick McGinity, NWCCD President Paul Young, UW College of Agriculture and Natural Resources Dean Frank Galey, and Whitney Benefits Board President Tom Kinnison.

The Watt Agriculture Center now serves as the official home to ShREC, the UW Outreach School in Sheridan, and the Sheridan County office of UW Extension. Co-locating all of these entities under one roof creates the one-stop-shop
atmosphere because it readily provides access to all UW programs in Sheridan County and surrounding areas.

**ShREC Advisory Group**

An advisory group was re-established for ShREC and consists of UW Extension educators in northeast Wyoming, on- and off-campus faculty and staff members, as well as stakeholders. External members of the advisory group were nominated by Extension educators who work in northeastern Wyoming. External stakeholders were selected based on their expertise and abilities to complement the activities of ShREC.

**ShREC Strategic Plan**

The first meeting of the advisory group was June 26, 2013. Twenty non-UW participants attended and provided excellent input that was included in the first draft of the center’s Strategic Plan. After refining the first draft and including input from members of the UW community, the next rough draft was shared with the advisory group for additional input. The final version is currently under review for approval. In short, the plan lays the foundation for how ShREC will address the three main mission areas of the UW College of Agriculture and Natural Resources: research and development; learning; and engagement and community outreach.

**2014 Field Day**

Members of the ShREC advisory group encouraged us to keep the June 14 field day similar to last year’s event. Thus, faculty and staff developed a program that follows last year’s format and takes place at both ShREC locations (Watt Agriculture Center and Wyarno). The morning includes field tours starting near Wyarno and finishing at the Adams Ranch. Following lunch and tours of the newly renovated laboratories, the afternoon will feature presentations on a variety of topics geared to interests of homeowners and other area residents.

**Acknowledgments**

Thank you to all the contributors to ShREC. Leaders of UW as well as the Wyoming Legislature helped solidify the partnership with NWCCD and Whitney Benefits. Numerous members of the UW community and advisory group donated countless hours during the development of the strategic plan. Special thanks go to Gary Moss, Karen Panter, Bill Taylor, and Valtcho Jeliazkov for their efforts on the strategic plan. Lastly, and most importantly, members of the ShREC team deserve special recognition for all of their hard work. Thanks Dan Smith, Jeremiah Vardiman, Rochelle Koltiska, Sadanand Dhekney, and Valtcho Jeliazkov.

**Contact Information**

Bret Hess at brethess@uwyo.edu or 307-766-3667.
1. Utilization of CBM water for irrigation of biofuel crops

**Investigators:** Shital Poudyal and Valtcho Jeliazkov

**Issue:** In Wyoming, due to the extensive methane extraction from coal seams, there is large production of wastewater, known as coal-bed methane water (CBMW). The disposal of CBMW—if not done properly—is an environmental and economic problem. This research focuses on using such wastewater for irrigation of biofuel and industrial crops (such as switchgrass and mints), which could provide a better alternative for disposal of such water.

**Goal:** The goal is to improve economic, environmental, and agronomic sustainability of energy production in Wyoming and the U.S. through the sustainable utilization of CBMW.

**Objectives:** Specific objectives are to assess the impact of CBMW on several biofuel and industrial crops and on soil physical, chemical, and biological properties.

**Impact:** The study should help identify suitable crops that could be grown by irrigating with CBMW. Additionally, this study could provide information about the long-term effects of CBMW on soil characteristics. Ranchers and farmers having available CBMW could also benefit from the study. Ultimately, utilizing wastewater instead of discharging it into rivers and streams could also translate into environmental benefits, such as less contamination of surface and groundwater.

**Contact:** Shital Poudyal, spoudyal@uwyo.edu, or Valtcho Jeliazkov, vjeliazk@uwyo.edu or 307-737-2415.

**Key Words:** biofuel, coal-bed methane water

**PARP:** I:1, XI:1, XII:1

2. Season-extension vegetable and herb production systems studied

**Investigators:** Santosh Shiwakoti and Valtcho Jeliazkov

**Issue:** Fresh, locally produced vegetables and herbs are less available in many parts of Wyoming compared to other states for a variety of reasons, including a short growing season, adverse climatic conditions, and high altitude. Plastic tunnels of varying height may help producers overcome some of these obstacles.

**Goal:** The goal is to help Wyoming producers establish more sustainable vegetable and herb production systems.

**Objectives:** Specific objectives include comparing three season-extension production systems: high tunnel, low tunnel, and low tunnel within a high tunnel. They will be compared for 1) early spring production of five cool-season vegetables (radishes, lettuce, spinach, carrots, and pak choi); 2) early spring production of five high-value crops (spearmint, oregano, dill, rosemary, and thyme); and 3–4) late fall production of the same crops.

**Impact:** The project should provide important information on which vegetables and herbs could be grown in early spring and late fall under the different systems. Findings may also benefit commercial vegetable and herb growers by providing research information for further extending the growing season.

**Contact:** Santosh Shiwakoti, sshiwako@uwyo.edu, or Valtcho Jeliazkov, vjeliazk@uwyo.edu or 307-737-2415.

**Key Words:** high tunnel, low tunnel, vegetables

**PARP:** I:1,2, IX:4,5
3. Evaluating table and wine grape cultivars in high tunnels for yield and quality improvement

**Investigators:** Sadanand Dhekney, Raju Kandel, Jeremiah Vardiman, and Daniel Smith

**Issue:** Freezing winter temperatures, late spring frosts that damage grapevine flowering, a short growing season, and incidence of pests (e.g., grasshoppers/flea beetles/deer) can severely limit the cultivation of popular bunch grape varieties in Wyoming. The use of high tunnels for grapevine production is an attractive prospective because of the benefits they offer compared to field production. Among potential benefits are frost protection, a longer growing season for late-maturing cultivars, and protection from insect pests and foraging animals.

**Goal:** The goal is to evaluate seedless table grape and wine grape cultivars in high tunnels for the production of fresh fruit targeted toward farmers’ markets and high quality wine including ice wine. Ice wine, also called Eiswein, is a dessert wine made from grapes that are kept on the vine until a hard freeze and are typically pressed while still frozen.

**Objectives:** Specific objectives include evaluating 14 table and wine grape cultivars for cold-hardiness, early establishment, bud break, flowering, fruiting, and berry qualities.

**Impact:** Information generated from the project should greatly benefit grape producers; wineries; juice, jam, and jelly processors; and citizens exploring the potential for investing in Wyoming agriculture and/or starting their own ventures, whether private or public.

**Contact:** Sadanand Dhekney, sdhekney@uwyo.edu or 307-673-2754.

**Key Words:** grapes, wine, high tunnel

**PARP:** I:1, X:1

4. Testing the relative contribution of genetic diversity and local adaptation to restoration seeding success

**Investigators:** Kristina Hufford

**Issue:** Local adaptation is an important ecological consideration because many native plant species occupy wide geographic ranges and populations are often adapted to local environments. A genetically diverse seed source, however, may be equally important to provide the raw material for survival at degraded sites and to adapt to changing environmental conditions.

**Goal:** The goal of this study is to test the relative contribution of genetic diversity and adaptation to local climate conditions to restoration seeding success.

**Objectives:** Specific objectives include comparing establishment of single or multiple sources of either cultivated or wild-collected seeds in a field setting.

**Impact:** Restoring native plant communities to meet regulatory requirements can be especially challenging in this region due to limited soil development, harsh climate conditions, and competitive pressures from aggressive introduced weed species such as leafy spurge and cheatgrass. Early results indicate multiple seed sources can assist restoration practitioners with revegetation of rangeland sites by improving establishment of target species. These results will be presented at the June 14 Sheridan Research and Extension Center field day and possibly elsewhere in Wyoming this year.

**Contact:** Kristina Hufford, khufford@uwyo.edu or 307-766-5587.

**Key Words:** adaptation, genetic diversity, restoration

**PARP:** I:2, IX:2–5, X:1,3
5. Evaluation of alfalfa and sainfoin varieties under dryland environment

Investigators: Valtcho Jeliazkov and Henry Sintim

Issue: Alfalfa is one of the main forage crops in Wyoming, supporting the state’s well-developed beef industry. Sainfoin, meanwhile, is an underexplored forage crop in Wyoming. Ranchers and farmers in the Sheridan area and beyond are interested in how varieties of these two crops compare with respect to productivity.

Goal: The goal is to provide information on comparative forage productivity of alfalfa and sainfoin varieties based on a dryland research project established at the Sheridan Research and Extension Center in 2012.

Objectives: The specific objective was to compare the productivity of 17 alfalfa and three sainfoin varieties.

Impact: Results should help ranchers and farmers make informed decisions on variety selection of alfalfa and sainfoin for dryland production. The study will continue through 2016, but preliminary results will be presented at this year’s ShREC field day, June 14. More information about the study is in the 2012 Field Days Bulletin, pages 111–112: http://www.uwyo.edu/uwexpstn/publications/. (Note: The 2012 paper also includes information about an irrigated trial, but that trial has since been discontinued.)

Contact: Valtcho Jeliazkov, shrec@uwyo.edu or 307-737-2415, or Henry Sintim, hsintim@uwyo.edu

Key Words: forage, alfalfa, sainfoin, varieties

PARP: I:1,2, IX:4,5

6. Sainfoin under test for forage productivity and quality

Investigators: Valtcho Jeliazkov and Henry Sintim

Issue: Forages such as alfalfa and grasses are major crops in Wyoming. Recently, there has been interest in sainfoin as an alternative forage for the Sheridan region. Generally, sainfoin provides greater yields than alfalfa from the first cut. In addition, sainfoin is excellent forage for grazing animals mainly because it does not cause bloating in cows.

Goal: The goal is to provide information to Wyoming producers on sainfoin forage productivity in the Sheridan area.

Objectives: Two dryland field trials are being conducted at the Sheridan Research and Extension Center east of Sheridan at Wyarno. The objective of the variety x nitrogen (N) trial is to evaluate productivity and forage quality of four sainfoin varieties (‘Delaney,’ ‘Shoshone,’ ‘Rocky Mountain Remont,’ and ‘Remont’) at four different N rates (0, 36, 71, and 107 pounds N/acre [lb/ac]).

The objective of the fertility trial is to evaluate productivity and forage quality of sainfoin variety ‘Shoshone’ grown under different fertilizer regimes. The fertility treatments include four rates of phosphorus (0, 45, 89, and 134 lb/ac) x three rates of potassium (0, 45, and 134 lb/ac) x two rates of N (0 and 89 lb/ac).

Impact: These projects, which will continue until approximately 2016, should provide yield and forage quality data on four different sainfoin varieties under various fertility regimes under dryland conditions in the Sheridan area.

Contact: Valtcho Jeliazkov, vjeliazk@uwyo.edu or 307-737-2415.

Key Words: forages, sainfoin, fertility, varieties

PARP: I:1,2, IX:4,5
7. Screening grapevine cultivars for adaptability to soil and climatic conditions in Wyoming

**Investigators:** Sadanand Dhekney, Axel Garcia y Garcia, Raju Kandel, Jeremiah Vardiman, and Daniel Smith

**Issue:** Grapevine production in Wyoming evinces strong interest from producers exploring new crops in addition to traditional crops, as well as homeowners with backyard plantings. Diverse soil and climatic conditions throughout the state necessitate multi-location screening of promising grapevine germplasm to identify suitable region-specific cultivars.

**Goal:** The project goal is to evaluate and identify promising grapevine cultivars for diverse soil and climatic zones of Wyoming. This should help commercial grape growers overcome obstacles to initial vineyard establishment, which should result in increased production and early returns. Field trials are being conducted in Sheridan and Powell to determine the effect of diverse soils and climate on grape growth, yield, and quality.

**Objectives:** The objectives are to: 1) identify grapevine cultivars that exhibit rapid growth and establishment in specific soils and locations in Wyoming and 2) study the influence of varying soil conditions and climate on grapevine yield and quality.

**Impact:** Identification of cultivars suitable for specific regions of Wyoming will assist growers and homeowners select the right cultivar, improve production, and more quickly “pay off” the costs of grapevine establishment.

**Contact:** Sadanand Dhekney, sdhekney@uwyo.edu or 307-673-2754.

**Key Words:** grapes, wine, cold-hardy, vineyards

**PARP:** 1:1, X:1

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8. Study examines impacts of deer and antelope on irrigated hay field

**Investigators:** Gary Moss, Bret Hess, and Jeremiah Vardiman

**Issue:** The Adams Ranch south of Sheridan College has a resident population of pronghorn antelope and deer that could impact research studies. “Wildlife-proof” fences have or will be constructed around some small areas. It is not economically feasible or desirable, however, to exclude wildlife from all portions of the ranch including the large irrigated center pivot circles where forage research is to be conducted.

**Goal:** The goal is to determine how wild ungulates (primarily antelope and deer) impact forage production in a pivot-irrigated field dedicated to forage production.

**Objectives:** Specific objectives are to quantify the effects of grazing by deer and antelope on alfalfa and grass hay production.

**Impact:** Results should enable researchers to quantify how antelope and deer affect alfalfa production in an irrigated field. Determination of these impacts is necessary to develop cost-effective methods to limit wild ungulate grazing of forages in fields under irrigation.

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

**Key Words:** antelope, deer, grazing

**PARP:** VI:9, VII:4
9. Sugarbeet seed enhancement emergence study

Investigators: Tim Koenig and Dan Smith

Issue: Sugarbeet seed is small with a rough outer shell that can be difficult to germinate and grow in cool spring soil conditions. As producers have been forced to reduce costs and move away from the historic practice of overplanting and hand thinning, expectations have risen for seed to germinate faster and more uniformly to improve stand establishment. Growers are now expecting one seed, one beet.

Goal: The goal is to evaluate proprietary seed enhancement treatments developed by ASTEC USA. This could help seed companies better meet expectations of producers.

Objectives: Specific objectives include 1) evaluating emergence rates of 15 proprietary seed enhancement treatments, 2) determining effects the enhancements might have on plant growth and yield throughout the growing season, and 3) comparing results of this trial—which is not in a sugarbeet production area but is close to Sheridan-based ASTEC's seed processing facility—with those of similar trials in sugarbeet production areas.

Impact: Since most producers have converted to plant-to-stand practices rather than overplanting and thinning, improving establishment of sugarbeet stands can have a great impact for not only Wyoming producers, but sugarbeet producers worldwide. (Planting-to-stand is a practice that involves determining an optimum harvestable plant population—like 24,000 plants per acre—and only using enough seeds to meet that goal.)

Contact: Tim Koenig, tim@astecnet.com or 307-674-8970, or Dan Smith, dmsmith@uwyo.edu or 307-673-2856.

Key Words: ASTEC, seed enhancement, sugarbeet emergence

PARP: None applicable

10. Perennial cool-season grasses for hay production and fall grazing under full and limited irrigation

Investigators: Blaine Horn, Anowar Islam, Axel Garcia y Garcia, and Valtcho Jeliazkov

Issue: Perennial cool-season grasses comprise about 25% of all hay-field acreage of Johnson and Sheridan counties with smooth bromegrass (e.g., ‘Manchar’) and, to a lesser extent, meadow bromegrass (e.g., ‘Paddock’) being the prominent species. There are other varieties of these two grasses and other grasses that might be a better fit for an agricultural operation, especially those with limited irrigation, but there is limited to no knowledge on how they would perform in northeast Wyoming.

Goal: The goal is to provide agricultural producers of northeast Wyoming information on the forage production potential and quality of cool-season perennial grasses grown under full and limited irrigation.

Objectives: Specific objectives are to determine 1) late spring/early summer hay yields and fall regrowth yields for grazing of perennial cool-season grasses under full and reduced irrigation, and 2) forage quality of the hay and the regrowth of these grasses.

Impact: The project should address the knowledge gap on perennial cool-season grasses for hay production in northeast Wyoming by identifying yield potential of perennial cool-season grasses under full and limited irrigation. This knowledge would assist agricultural producers in selecting grasses that would better fit their operations and, as a result, could enhance farm income and profitability.

Contact: Blaine Horn, bhorn@uwyo.edu or 307-684-7522.

Key Words: cool-season perennial grasses, hay production, irrigation

PARP: I:2
11. Dry bean disease training nursery

Investigators: Mike Moore

Issue: Seed-borne diseases such as bacterial bean blight can seriously impact dry bean production in areas of the United States. While they do not have an impact on dry bean yields in the Bighorn Basin, a significant portion of the dry bean seed produced in Wyoming is marketed in areas where bacterial bean diseases can devastate a dry bean crop. This nursery provides an important hands-on training for Wyoming Seed Certification Service field inspectors. The nursery is planted in Sheridan so as to not provide inoculum in the seed-producing area of the state.

Goal: The goal is to provide training for those who inspect dry bean fields.

Objectives: The specific objective is to provide in-the-field examples of disease symptoms, which allow inspectors to not only identify the diseases, but to differentiate them from similar plant appearances that are not disease related.

Impact: Wyoming dry bean seed production generates more than $500,000 in additional revenue for bean seed producers. This is above and beyond the market price they would receive if the beans were sold as a cash crop. Seven to 10 inspectors are trained each year via this nursery to protect that production and income opportunity by providing accurate field inspections.

Contact: Mike Moore, mdmoore@uwyo.edu or 307-754-9815.

Key Words: bean, disease, training

PARP: None applicable

12. Establishment of mints as high-value specialty crops for Wyoming

Investigators: Valtcho Jeliazkov and Santosh Shiwalakoti

Issue: The U.S. is a major producer of peppermint and spearmint. Wyoming producers could tap into this lucrative and expanding market. This project will build on previous mint trials conducted at the Sheridan R&E Center in 2011 and 2012.

Goal: The long-term goal is to establish a sustainable mint essential oil production industry in Wyoming.

Objectives: Specific objectives for this two-year study are to: 1) evaluate productivity and oil quality of mint oils produced in Wyoming, 2) study optimal nitrogen (N) fertilization for four mints in Wyoming, and 3) show the new crops and demonstrate growing practices to potential growers, to students at Sheridan College, the University of Wyoming and potentially other schools, and to other interested parties.

Impact: This project could provide information on how N fertilizers and location affect the yields and essential oil composition of four mint species grown under Wyoming conditions. The ultimate beneficiaries will be Wyoming growers who decide to venture into the establishment of essential oil crops. The establishment of mints as new cash crops may also facilitate the creation of a value-added processing industry, using the oils produced locally. This could also create new jobs.

Contact: Valtcho Jeliazkov, vjeliazk@uwyo.edu or 307-737-2415.

Key Words: specialty crops, essential oil

PARP: I:1,2, IX:4,5
13. Communicating science to engage natural resource managers

Investigators: Ann Hild, Jacqueline Shinker, Stephen Bieber, and Kristen Gunther

Issue: Scientists are taught to communicate primarily with other scientists. As a result, they sometimes struggle to articulate their research in non-academic settings. However, transfer of scientific ideas to stakeholders who can provide feedback and apply concepts “on the ground” is a crucial step in developing and testing applications for new concepts emerging from research.

Goal: The goal is to study the effectiveness of different communication strategies in transferring management-relevant scientific concepts to ecosystem stakeholders, including Wyoming agricultural producers.

Objectives: Specific objectives include testing techniques that strengthen or diminish transfer of concepts related to the types of “uncertainty” inherent in ecosystems. Results will be used to provide training workshops at the University of Wyoming for Extension educators, graduate students, and others.

Impact: Results should help scientists and educators more effectively share findings with stakeholders. Enhanced communication should also increase the ability of producers and other stakeholders to share their questions, observations, and needs with researchers. Further, building or strengthening understanding about the types of uncertainty inherent in ecosystems could facilitate adaptive management and assist producers and other stakeholders in setting monitoring and management goals.

Contact: Kristen Gunther, kgunthe1@uwyo.edu or 307-766-3114.

Key Words: adaptive management, uncertainty in ecosystems, science communication

PARP: IX:3–5, X:1, XII:2

14. Physiological and molecular assessment of grapevine response to abiotic stress under greenhouse conditions

Investigators: Sadanand Dhekney

Issue: Global shifts in climate change resulting in fluctuating temperatures, drought, and related effects are of particular concern for sustainable grape cultivation worldwide, including Wyoming. Semi-arid grapevine production regions frequently suffer from drought and are also prone to salinization. Drought and salinity can severely affect grape yield and quality attributes and limit distribution in regions otherwise suitable for grapevine cultivation.

Goal: The goal of the project is to increase our understanding of grapevine response to drought and salt stress and improve performance of elite cultivars and rootstocks under changing environmental conditions.

Objectives: Specific objectives include exposing grapevine cultivars to various levels of drought and salt stress under greenhouse conditions to identify drought-tolerant cultivars and related genes involved in conferring cold, drought and salinity tolerance.

Impact: Information generated from the project could be utilized for improving grapevine tolerance to cold, drought, and salinity stress using genetic engineering technology. This, in turn, could help with the development of elite cultivars and rootstocks suitable for cultivation in Wyoming.

Contact: Sadanand Dhekney, sdhekney@uwyo.edu or 307-673-2754.

Key Words: grapes, cold, salt, drought

PARP: 1:1, X:1
15. Understanding the market for Wyoming unadulterated honey

**Investigators:** Linda Thunstrom, Mariah Ehmke, Chian Jones Ritten, and Cole Ehmke

**Issue:** The honey market is changing rapidly, in part due to the recent phenomenon called colony collapse disorder, in which worker bees suddenly disappear from a beehive. Because of this, the honey market increasingly relies on foreign honey, often higher in pesticides and antibiotics. This honey, in turn, may pose risks to consumer health and cause consumers ethical concerns.

**Goal:** The goal is to study consumers’ willingness to pay for non-blended, locally produced Wyoming honey.

**Objectives:** Specific objectives include estimating the premium consumers are willing to pay for safe and locally produced honey, compared to honey of unknown origin, and to what extent the premium is determined by health or ethical concerns.

**Impact:** Results should provide Wyoming honey producers with information on factors that impact demand and may increase their market shares, as well as how to target their product marketing, which, ultimately, may help boost the Wyoming honey market.

**Contact:** Linda Thunstrom, lthunstr@uwyo.edu or 307-766-2319.

**Key Words:** honey, demand, locally produced

**PARP:** VII
Developing Weed Management Strategies to Improve Reclamation of Drastically Disturbed Lands

B. Fowers¹, B.A. Mealor¹,², and A.R. Kniss¹

¹Department of Plant Sciences; ²UW Extension.

Introduction

Direct disturbance of plant communities by natural resources extraction projects is a primary negative impact to wildlife habitat, biological diversity, and forage production for domestic livestock. Successful reclamation of disturbed areas is a critical step in mitigating such negative impacts, but establishment of desirable plant communities on disturbed areas, particularly in Wyoming’s more arid and semiarid environments, is typically difficult.

Non-native and undesirable weed species often readily invade areas with bare soils. Widespread growth of weeds was the second most prevalent event of non-compliance on coal-bed methane (CBM) reclamation sites in northeast Wyoming’s Powder River Basin. To address this issue, this research seeks to determine the effectiveness of herbicides and season of application on weed control.

Objectives

This research addresses the following: How do various herbicide treatments (chemical, rate, and application timing) affect reclamation?

Materials and Methods

Three field trials were established at the Sheridan Research and Extension Center (ShREC) and Laramie Research and Extension Center, and also near Ucross in northeast Wyoming, where much CBM activity has occurred in recent years. At each site, 10 different seeding treatments were planted in fall 2011 and spring 2012 composed of species used in reclamation and based on site potential. Six pre-emergent herbicide treatments were applied in fall 2011 at the time of fall seeding, and eight post-emergent treatments were applied in spring 2012 (Table 1). Weed control, desirable species establishment and growth, and percent vegetative cover were recorded.

Results and Discussion

Seeding response is discussed in a separate paper that appears in this bulletin. At ShREC, control of annual grasses was not strong for most herbicides and was best with imazapic and rimsulfuron, the two grass-specific herbicides (Figure 1). Herbicide effectiveness varied by seeding season. Control of annual forbs varied by chemical (Figure 2). Herbicides with good control of
annual forbs were aminopyralid and those with aminocyclopyrachlor. Application season had little influence on activity of herbicides. Data collection will continue through the 2014 growing season.

Acknowledgments

This project was supported by a University of Wyoming School of Energy Resources competitive grant, DuPont, Bureau of Land Management, Apache Foundation, and Department of Plant Sciences. Thanks to Rachel Mealor and UW students for field assistance.

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Key words: reclamation, herbicide, weed science

PARP: III:2, III:5, XII:1

<table>
<thead>
<tr>
<th>Table 1. Herbicides and rates.</th>
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<tbody>
<tr>
<td>Chemical Name</td>
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<tr>
<td>Aminocyclopyrachlor plus chlorsulfuron</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Aminocyclopyrachlor plus chlorsulfuron</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Aminocyclopyrachlor</td>
</tr>
<tr>
<td>Aminopyralid</td>
</tr>
<tr>
<td>Chlorsulfuron</td>
</tr>
<tr>
<td>Imazapic&lt;sup&gt;1,2&lt;/sup&gt;</td>
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<td>Rimsulfuron&lt;sup&gt;1,2&lt;/sup&gt;</td>
</tr>
<tr>
<td>2,4-D Amine&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Saflufenacil&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> indicates the four chemicals only applied in spring; 
<sup>2</sup> indicates chemicals substituted at the ShREC site in place of 2,4-D and saflufenacil; ai stands for active ingredient.

Figure 1. ShREC undesirable annual grass cover by seeding season 2013

Figure 2. ShREC undesirable annual forb cover by seeding season 2013

Figure 1. ShREC undesirable annual grass cover. Rate is H (high) and L (low), season of herbicide application is F (fall) and S (spring); refer to Table 1 for herbicide abbreviations.

Figure 2. ShREC undesirable annual forb cover. Rate is H (high) and L (low), season of herbicide application is F (fall) and S (spring); refer to Table 1 for herbicide abbreviations.
Developing Strategies to Improve Reclamation Seeding of Drastically Disturbed Lands

B. Fowers\textsuperscript{1}, B.A. Mealor\textsuperscript{1,2}, and A.R. Kniss\textsuperscript{1}

\textsuperscript{1}Department of Plant Sciences; \textsuperscript{2}UW Extension.

Introduction
Direct disturbance of plant communities by natural resource extraction projects is a primary negative impact to wildlife habitat, biological diversity, and forage production for domestic livestock. Successful reclamation of disturbed areas is a critical step in mitigating negative impacts, but establishment of desirable plant communities on disturbed areas, particularly in Wyoming’s more arid and semiarid environments, is typically difficult.

Non-native and undesirable weed species often readily invade areas with bare soils. Widespread growth of weeds was the second most prevalent event of non-compliance on coal-bed methane (CBM) reclamation sites in northeast Wyoming’s Powder River Basin. Although policy encourages weed control, some reclamationists avoid controlling annual weeds like kochia or Russian thistle because they perceive that weeds act as nurse plants for newly seeded desirable species. This research seeks to determine methods to increase success of reclamation projects.

Objectives
This research addresses the following questions: 1) Which desirable species are able to successfully establish in reclamation settings? 2) Does season of seeding or herbicide application improve or diminish the establishment of desirable plant species?

Materials and Methods
Three field trials were established at the Sheridan Research and Extension Center (ShREC), Laramie Research and Extension Center, and near Ucross in northeast Wyoming, where much CBM activity has occurred in recent years. At each site, 10 different seeding treatments were planted in fall 2011 and spring 2012. Seedings included single-species grass plantings and mixes of forbs and shrubs. The eight single species included: ‘Arriba’ western wheatgrass at 12 pounds per acre of “pure live seed” (PLS), ‘Sherman’ big bluegrass at 4 PLS lb/ac, ‘Trailhead’ basin wildrye at 12 PLS, ‘Anatone’ bluebunch wheatgrass at 14 PLS, ‘Sodar’ streambank wheatgrass at 12 PLS, alkali sacaton at 2 PLS, ‘Hycrest’ crested wheatgrass at 9 PLS, and ‘Bozoisky’ Russian wildrye at 12 PLS. Forb and shrub species were selected as appropriate for each location and included Wyoming big sagebrush, fourwing saltbush, purple prairie clover, scarlet globemallow, and others. Six pre-
emergent herbicide treatments were applied in fall 2011, and eight post-emergent treatments were applied in spring 2012. Weed control, desirable species establishment and growth, and percent vegetative cover were recorded.

**Results and Discussion**

Minimal emergence of seeded species due to low precipitation was observed at the Laramie and Ucross sites. At ShREC, spring seedings exhibited higher establishment (Figure 1). Annual grass density prohibited direct seeding in the spring, so light disking was performed providing some weed control, which led to increased establishment in spring plots. (Note: weed control is discussed in a separate paper in this bulletin.) Grass species with the best emergence included crested wheatgrass, Russian wildrye, and the native wheatgrasses (Figure 1). Establishment and survival varied by herbicide (Figure 2). Data collection will continue through the 2014 growing season.

**Acknowledgments**

This project was supported by a University of Wyoming School of Energy Resources competitive grant, DuPont, Bureau of Land Management, Apache Foundation, and Department of Plant Sciences. Thanks to Rachel Mealor and UW students for field assistance.

**Contact Information**

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**Key words:** reclamation, weeds, desirable grasses and forbs, seeding

**PARP:** III:2; III:5; XII:1
Introduction

Rainfall in the Great Plains (GP) is often scarce, and its distribution is variable; thus, efficient management and use of available moisture is required for dryland agriculture to be productive. As a result, wheat-fallow rotation has been a common production system throughout the GP because this system is simple, and the fallow period may conserve soil moisture. The wheat-fallow rotation, however, is often not very economical. Average rainfall within the two-year period of the rotation is more than a single wheat crop can typically use. Continuous cropping, on the other hand, increases moisture usage and helps to insulate the soil surface against direct solar energy. This makes it possible to crop more than once every two years.

Replacing the fallow period with an alternative crop in the wheat-fallow rotation could broaden herbicide options and break up the pest and disease cycle. Diversity of the species used in the cropping system may improve soil quality, as different plants use and replenish different soil nutrients. The crop adopted to replace the fallow period must have an agronomic benefit to the cropping system and also provide economic benefits to the farmer.

Camelina offers potential as a possible substitute for the fallow period in the semiarid and arid regions of the GP, including eastern Wyoming, and it also has potential in the Bighorn and Wind River basins of northwest Wyoming. It is a short-season (85–100 days) and drought-tolerant crop. In general, camelina is compatible with existing farm equipment, and, when cultivated on low-fertile lands, it is usually able to do well. Besides the agronomic benefits, the potential for wide application and use of camelina help make it a good choice. Among the uses are low-cost feedstocks for biofuel and animal nutrition. Additionally, the fatty acids contained in camelina can be used in a variety of skin products.

Objectives

The goal of the study was to evaluate water use of camelina and its impact on winter wheat productivity when the fallow period in the wheat-fallow rotation is replaced with camelina.

Materials and Methods

This is an ongoing project at the Sheridan Research and Extension Center (ShREC). ‘Yellowstone’ winter wheat and ‘Blaine Creek’ spring camelina were seeded at 60
pounds/acre (lb/ac) and five lb/ac, respectively. Due to limited seed availability, winter camelina was not seeded in the first year of the study. Data was collected on plant emergence, seed yield, plant materials left on the field after harvest (residue biomass), and percent yield loss from shattering (breaking of the seed pod) during harvesting. A 3 ft x 3 ft area from each plot was harvested immediately as the plot matured. After the first harvest, a 5 ft x 20 ft area was harvested from each plot when plants had all matured. Yield differences between both harvests were expressed as a percent of yield loss.

A neutron probe was used to measure soil moisture in 8-inch depth increments to 40-inch total soil depth.

Results and Discussion

Effects of the cropping systems can only be assessed after the second year of the growing season, so treatment comparison was not made. Preliminary results, however, show that camelina has good promise as a well-adapted crop for dryland cultivation in areas of Wyoming and perhaps beyond (Table 1). Average seed yield was 943 lb/ac for camelina and 3,680 lb/ac (61.3 bushels/ac) for wheat. Percent yield loss due to shattering of camelina was 35.4% and for wheat 18.7%. To curtail this constraint, swathing (pre-harvesting a crop before maturity) of camelina should be considered; however, optimum time to swath needs to be studied since early swathing could potentially reduce oil yield and quality of the crop. The average days to flowering and maturity of camelina were 44 and 80 days, respectively. This is shorter than what is commonly reported in literature, most probably due to late seeding (May 13, 2013). Average residue biomass of wheat and camelina were 7,461 and 3,556 lb/ac, respectively.

In general, moisture depletion of camelina was primarily within the 16-inch soil depth, whereas that of wheat was within 24–40 inches (not shown). Data collected in subsequent years may allow us to make a conclusion about the impact of replacing the fallow period with camelina.

Table 1. Average growth and yield of camelina and wheat for the first growing season.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Plant height (inches)</th>
<th>Seed yield (lb/ac)</th>
<th>Residue biomass (lb/ac)</th>
<th>Yield loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>39.3</td>
<td>3,680</td>
<td>7,461</td>
<td>18.7</td>
</tr>
<tr>
<td>Camelina</td>
<td>30.1</td>
<td>943</td>
<td>3,556</td>
<td>35.4</td>
</tr>
</tbody>
</table>

Acknowledgments

Special thanks go to the ShREC field crews for their assistance. The study was supported by the U.S. Department of Agriculture’s National Institute of Food and Agriculture.

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Key words: camelina, wheat, fallow

PARP: I:1, I:2, XI:1
Seeding Date and Cultivar Affects Growth and Yield of Camelina

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\textsuperscript{1}Department of Plant Sciences; \textsuperscript{2}Sheridan Research and Extension Center, \textsuperscript{3}Kansas State University; \textsuperscript{4}Powell Research and Extension Center; \textsuperscript{5}Department of Agricultural and Applied Economics.

Introduction

Camelina (\textit{Camelina sativa} L.) is a low-cost feedstock with potential in Wyoming. Production costs of camelina can be low when compared to other oilseeds, thus the need to optimize its production.

Seeding date is a useful management tool that can be adopted to minimize adverse effects of moisture stress and high temperatures during critical stages of crop establishment. Early seeding allows crops to establish before most spring weeds emerge, which helps crops better compete with weeds. Low temperature in the early spring, however, can impede crop growth. Camelina is frost tolerant so it may be able to survive early spring seeding. In addition, its short growing season (85–100 days) can compensate for slight delays in seeding, and it may be able to complete its life cycle before the usual summer drought periods. Due to genetic variability, different species vary in their interactions with environmental factors and their absorption and use of moisture and nutrients; thus, production may also vary.

Objectives

The aim of this study is to evaluate the effects of using different cultivars and different spring-seeding dates on the performance of camelina.

Materials and Methods

This is an ongoing project at the Sheridan Research and Extension Center (ShREC). Three spring-seeding dates (May 2, May 9, and May 16, 2013) and five cultivars are being studied. Included are two winter varieties (‘BX WG1’ and ‘Bison’) and three spring varieties (‘Blaine Creek,’ ‘Pronghorn,’ and ‘Shoshone’). Camelina was seeded at five pounds per acre. Data collected included number of days to flowering, flowering period, and days to maturity. We also collected initial growth data on plant emergence, plant height at maturity, and the percent of plants naturally thinned out by maturity as a result of crop competition.

To compute the crop harvest index (estimated as seed yield divided by total above-ground biomass), total above-ground biomass (whole plant) samples from each plot were harvested, weighed, and threshed to determine the seed weight. Yields from all plots were converted to 8% moisture content. Oil content and fatty acid profiles will be analyzed using the gas chromatography method.
Results and Discussion

Preliminary results showed that cultivar and the three seeding dates had no influence on the crop harvest index. Earlier seeding dates resulted in higher plant height (not shown) and yield (Figure 1). There was no effect by seeding date on plant emergence, but the cultivar affected plant emergence. Blaine Creek and Pronghorn cultivars did not differ in plant emergence, but their emergence was higher than the emergence of Shoshone. Consequently, the percent of plants thinned out at maturity was higher in Pronghorn than Shoshone (not shown). Seed yield of Blaine Creek and Pronghorn, which did not differ, were greater than the yield of Shoshone (Figure 2). Plants from the cultivars in this study had similar height. In general, days to flowering, flowering period, and days to maturity were shorter for the third seeding than the first seeding date, with the second seeding date being intermediate.

The two winter cultivars did not yield seed due to late seeding and lack of sufficient time for vernalization (acquired ability of plants to flower by exposure to prolonged cold periods). Results from similar studies that are ongoing near Hays, Kansas, showed that only the winter cultivars from the first seeding date (April 4, 2013) were able to produce seed yield. These findings suggest that different winter cultivars may require different cold periods.

Preliminary results from this study indicate that cultivar and seeding dates may have a significant effect on yield and growth of camelina. The earlier the spring seeding dates (of the three dates we tested), the better the plant growth and seed yields.

Acknowledgments

We acknowledge ShREC field crews for their assistance and Charlie Rife (a private breeder) for supplying seeds. The study was supported by the U.S. Department of Agriculture’s National Institute of Food and Agriculture.

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Key words: camelina, seeding date, cultivar

PARP: I:2, XI:1
Effects of Nitrogen and Sulfur Application on Camelina


1Department of Plant Sciences; 2Sheridan Research and Extension Center, 3Kansas State University; 4Powell Research and Extension Center; 5Department of Agricultural and Applied Economics.

Introduction

Intensive farming over the years has resulted in the depletion of essential soil nutrients. As a result, supplementing soils with the right types and rates of fertilizer is essential to attaining optimum crop yield and quality once other factors—such as moisture and temperature—are favorable. Camelina is an oilseed reported to require low amounts of plant nutrients. Its cultivation is very flexible as camelina is characterized by wide ecological adaptation.

Nitrogen (N) and sulfur (S) are very important macronutrients in the growth and development of most oilseeds. These soil nutrients can affect yield and quality parameters such as oil content, fatty acid composition, and protein content. Nutrient levels below optimum rates can affect potential crop yield and quality, while over-application can have adverse economic and environmental consequences. In addition, specific crops require different rates of fertilizer application under different environmental conditions. In view of this, optimized nutrient rates in other places might not be applicable to the specific conditions of Wyoming.

Objectives

The objectives of this study were to determine rates of N and S that will be most effective for camelina feedstock production in Wyoming at an economically sustainable cost.

Materials and Methods

The study was established in 2013 at the Sheridan Research and Extension Center (ShREC). Four levels of N rates (0, 25, 50, and 100 pounds/acre [lb/ac]) and two levels of S (0 and 22.5 lb/ac) were broadcast-incorporated in four replications. ‘Blaine Creek’ camelina was seeded at 5 lb/ac. Data collected include plant emergence, days to flowering, flowering period, stem lodging, days to maturity, and plant height at maturity. (Lodging is when stems bend over to near ground-level, at times even breaking.) We harvested the plots on two different occasions because the time to maturity was uneven. First, total above-ground biomass from a 3 ft x 3 ft area was harvested from each plot, immediately as they matured, and the respective seed weight was determined. This was used to calculate the crop harvest index (estimated as seed yield divided by total...
above-ground biomass). Secondly, a 5 ft x 20 ft area was harvested from each plot when all the plots matured. Yield differences between both harvests were expressed as a percent of yield loss. The yield loss was primarily due to shattering (breaking of the seed pod) and losses during harvesting.

**Results and Discussion**

The results showed N and S had no effect on days to flowering, flowering period, and days to maturity. Camelina did not respond to S application for the growth and yield parameters considered; however, we expect to see the effect of S on oil content and composition of camelina. On the other hand, camelina responded to N application. Harvest index for 100 and 50 lb/ac N was greater than 25 and 0 lb/ac N, while 0 and 25 lb/ac N were not different.

Plant height increased with increasing N fertilizer application (Figure 1). There was no yield difference between 100 and 50 lb/ac N. Yield of 100 and 50 lb/ac N was greater than 25 and 0 lb/ac N, while 0 and 25 lb/ac N were not different.

Average initial N level in the soil before seeding was 10.0 lb/ac, and after harvest 9.2. Since there was no yield difference between 50 and 100 lb/ac, an application of 50 lb/ac N was considered the most economical for camelina production.

Preliminary results suggest that camelina does not require high rates of N. Swathing (pre-harvesting a crop before maturity) could be a means by which percent of yield loss of camelina can be reduced. To make a reliable recommendation, this study is being repeated in 2014.

**Acknowledgments**

We acknowledge ShREC field crews for their assistance. The study was supported by the U.S. Department of Agriculture’s National Institute of Food and Agriculture.

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**Key words:** camelina, sulfur, nitrogen

**PARP:** I:2, XI:1
The Effects of Seeding Date, Cultivar, and Nitrogen on the Performance of Camelina

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¹Department of Plant Sciences; ²Sheridan Research and Extension Center, ³Kansas State University; ⁴Powell Research and Extension Center; ⁵Department of Agricultural and Applied Economics.

Introduction

Reliance on fossil fuels has raised concerns about how habitable the environment will be for future generations. Combustion of fossil fuels contributes to a rise in atmospheric greenhouse gases such as carbon dioxide, nitrous oxide, and methane, which help contribute to climate change. Additionally, fossil fuel reserves are being depleted, one of the factors leading to higher prices. This makes reliance on fossil fuels unattractive. A good alternative may be the use of biofuels, which can lead to reductions in greenhouse gas emissions compared to fossil fuels and are also biodegradable.

Studies show that camelina is a potential low-cost feedstock for biofuel under dryland cultivation in the Great Plains (including eastern Wyoming) and some areas of the West (including the Bighorn and Wind River basins of northwest Wyoming) (Figure 1). Agronomic benefits of camelina, such as shallow root system and short growing season (85–100 days) make it possible to be incorporated into a rotational cropping system with wheat. Biofuel has successfully been derived from camelina seeds (Figure 2). According to Shonnard et al. (2010), when camelina jet fuel was flight tested, it met all requirements for engine performance. In addition, there is very little greenhouse gas emission of camelina fuels into the environment. Pinzi et al. (2009) indicated that cold weather can be a problem to engine performance of most biofuels, but fuels derived from camelina are able to better withstand cold weather.

The potential to make use of camelina as a bioenergy crop has raised the need for information on management practices such as seeding dates, nutrient requirements, and cultivars that are optimum for specific locations.

Figure 1. Camelina field in Sheridan at flowering stage.
Objectives

Objectives for this study were to: 1) assess the effect of spring and fall seeding dates on winter and spring varieties of camelina, and 2) determine optimum nitrogen (N) rates for each cultivar.

Materials and Methods

This study was established in fall 2013 at the Sheridan Research and Extension Center (ShREC). Two fall-seeding dates and one spring-seeding (earliest possible date in spring) are being studied. Four cultivars comprising of three winter varieties (‘BX WG1,’ ‘Bison,’ and ‘Joelle’) and one spring variety (‘Blaine Creek’) were seeded at 5 pounds/acre (lb/ac). N rates will be 0, 40, 80, and 120 lb/ac. Data will be collected on plant stand at emergence and maturity, days to flowering, flowering period, days to maturity, plant height at maturity, seed yield, and oil content of seeds.

Results and Discussion

Results from this study should provide producers with useful information on management practices such as seeding dates, nutrient requirements, and cultivars optimum for eastern and northwest Wyoming. Yield benefits of cultivating winter or spring varieties of camelina and their respective nutrient requirements will be assessed. Camelina offers potential as a low-cost feedstock for biofuel and, hopefully, results from this study will be encouraging and would help motivate prospective producers to adopt its cultivation.

Acknowledgments

Our appreciation goes to ShREC field crews for their assistance and Charlie Rife (a private breeder) for supplying seeds. The study was supported by the U.S. Department of Agriculture’s National Institute of Food and Agriculture.

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Key words: camelina, seeding date, nitrogen

PARP: I:2, XI:1

References


Irrigated Grass-Legume Mixtures

A.T. Adjesiwr, M.A. Islam, V. Jeliazkov, A. Garcia y Garcia, J. Ritten

Introduction

Forages are very important in Wyoming and the mainstay of livestock production. Alfalfa is an important forage crop in the U.S., including Wyoming, and can produce quality and persistent forage when grown as sole stands. Alfalfa’s bloating characteristic and poor tolerance to acidic soils, however, can make other legumes such as bird’s-foot trefoil and sainfoin viable alternatives. Sainfoin and bird’s-foot trefoil are perennial legumes producing high quality forage and are adapted to a wide range of conditions. These two species do not cause bloat, but may persist poorly, especially under irrigated conditions. Cool-season grasses are also very important in Wyoming. Meadow bromegrass, for example, has high tiller density, typically produces good yields, and is generally well adapted to grazing and is responsive to nitrogen (N) fertilization. (Tiller density is the number of side shoots that grass plants produce in a given area.) The increasing cost of N fertilizers presents a challenge to producers, but grass-legume mixtures offer potential for eliminating or drastically reducing the need for N fertilization. This is because legumes can fix N into the soil. Grass-legume mixtures can produce higher yield, increase the quality of forage, and reduce the bloat potential of legumes such as alfalfa. Despite the numerous advantages of grass-legume mixtures, difficulty in management can discourage many producers from establishing such mixtures. Due to limited rainfall in Wyoming, irrigated agriculture is the backbone of hay production; however, the availability of water for agricultural use is threatened due to competition for water. Thus, it is important to find crops or management practices that use available water efficiently.

Objectives

The major objective is to assess the effects of different ratios of grass-legume mixtures on forage yield, quality, and persistence. Additional objectives are to determine cost effectiveness of establishing sole grass (fertilized with N), sole legume, and grass-legume mixtures and how efficient these practices are at utilizing irrigation water.

Materials and Methods

The field study was initiated at the Adams Ranch of the Sheridan Research and Extension Center (ShREC) in September 2013. There was a single stand each of alfalfa, cultivar ‘WL 363 HQ’; sainfoin, cultivar ‘Shoshone’; and bird’s-foot trefoil, cultivar

1Department of Plant Sciences, 2Department of Agricultural and Applied Economics.
‘Norcen’. Also, there were three sole stands of meadow bromegrass, cultivar ‘Fleet,’ receiving three levels of N (0, 50, and 100 pounds per acre), and five ratios of grass-legume mixtures. The ratios include 100:0 (1:0), 50:50 (1:1), 70:30 (2:1), 50:25:25 (2:1:1); and 50:16.7:16.7:16.7 (3:1:1:1). Treatments were arranged in a randomized complete block with four replications. Nitrogen application is in two splits: the first was in April while the second will be September or October 2014. Data being collected include plant height, percentage of weeds, water-use and nutrient-use efficiency, cost and revenue ratio, and forage yield and quality.

Results and Discussion
A visual estimate showed that both grass and legume stands emerged fairly well (Table 1). Starting in late spring/summer, collection of data on forage yield and quality began. It is anticipated that the results will help recommend the best grass-legume mixture ratios that will be profitable to Wyoming producers. Identifying optimum mixture ratios that suppress weeds and use available soil water efficiently could be a major step toward sustainable forage production in the state.

Acknowledgments
The project is funded by the ShREC Competitive Graduate Assistantships Program. We acknowledge help from ShREC’s staff.

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Key words: forage, yield, quality

<p>| Table 1. Visual estimation of emergence as a percentage of proportion sown on October 1, 2013. |</p>
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Treatment ratio</th>
<th>Alfalfa</th>
<th>Sainfoin</th>
<th>BFT</th>
<th>MB</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>*Alf100</td>
<td>91.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>91.2</td>
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<tr>
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<td>48.8</td>
<td>40.0</td>
<td>88.8</td>
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<tr>
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*Alf = Alfalfa, **MB = meadow bromegrass, *S = sainfoin, BFT = bird’s-foot trefoil
Effects of Coal-Bed Methane Water on Spearmint

V.D. Jeliazkov\textsuperscript{1}, C.L. Cantrell\textsuperscript{2}, T. Astatkie\textsuperscript{3}, E. Jeliazkova\textsuperscript{1}, V. Schlegel\textsuperscript{4}, and D. Lowe\textsuperscript{5}

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Introduction

Coal-bed methane (CBM) is naturally occurring, produced from coal-deposit seams. U.S. production of CBM in 2011 was estimated at 1,763 billion cubic feet, with Wyoming producing about a third of this amount (U.S. Energy Information Administration). The production of CBM is associated with co-produced water, also known as CBM water (CBMW), which has variable quality. Water is often found below, with, or above CBM and is pumped to the surface along with the CBM (this is necessary to release the gas from coal seams). CBMW is considered a waste product and traditionally has been pumped to evaporative ponds, reinjected back into the ground, or discharged to surface waters. CBMW has been used for irrigation of forages and rangelands; however, the long-term effect of this low-quality water on crops, crop products, and the environment is not fully understood. We have chosen ‘Native’ spearmint (\textit{Mentha spicata} L.) as a model plant to study the effect of CBMW on plants and on plant secondary metabolites, namely the essential oil.

Objectives

The objectives of this controlled-environment container study were to evaluate the effect of CBMW on spearmint herbage and essential oil yields, and on oil chemical profile and its antioxidant activity.

Materials and Methods

This experiment was conducted at the Sheridan Research and Extension Center. Two spearmint transplants (virus-free certified material) were transplanted into containers filled with commercial growth medium. The containers were subjected daily to the following treatments: tap (drinking) water only, 25\% CBMW plus 75\% tap water, half CBMW and half tap water, 75\% CBMW plus 25\% tap, and 100\% CBMW. All CBMW treatments were in three replicates (a container with two plants was considered a replication). The CBMW used in this study had a high pH of 8.3, a very high sodium adsorption ratio of 33, and more than 500 parts per million of sodium (this water would not be acceptable for drinking).
Spearmint plants from all containers were harvested at flowering. Essential oil was extracted from fresh herbage samples (17.6 ounces each) in steam distillation units for one hour. The resulting oil was separated from water, weighed, and computed as a percentage. Qualitative and quantitative analysis of the spearmint essential oil from all treatments was performed using gas chromatograph. Spearmint essential oil from 0%, 50%, and 100% CBMW treatments was evaluated for antioxidant activity by the ORAC_{oil} (oxygen radical absorbance capacity in bulk oil) method.

**Results**

CBMW treatments did not affect the antioxidant capacity of spearmint oil, the oil yield, or the concentrations of carvone, the major constituent of spearmint oil. (Carvone is a natural product used in the food and flavoring industries.) CBMW at 100%, however, increased the total phenol and the total flavonoid concentrations in spearmint relative to the control or to the CBM water at 50%, most probably due to physiological stress. (Phenols and flavonoids are natural products found in many plants as plant pigments). CBMW application at 25% increased fresh herbage yields, whereas CBMW application at 75% and 100% reduced yields.

At harvest, growth medium pH in the 0% and 25% CBMW treatments was within normal range. Due to the high pH of the CBMW, the growth medium pH increased in the 50% and was even higher in the 75% and 100%. Soluble Na and the sodium adsorption ratio also increased progressively with the increase of the CBMW treatments. Overall, the concentrations of S and Na in the growth medium increased drastically in the CBMW treatments relative to the control (0% CBMW).

This study demonstrated that addition of CBMW at 25% may increase fresh herbage yields of spearmints relative to using tap water. The observed effect could be due to the higher concentration of some plant nutrients in the CBMW relative to tap water. Also, the results suggest that ‘Native’ spearmint could be watered with CBMW at 50% without reduction of fresh herbage yields. CBMW at 75% or higher, however, will reduce yields.

This and additional data were compiled into a manuscript published in the 2013 issue of the *Journal of Environmental Quality*. Go to https://www.soils.org/publications/jeq/abstracts/42/6/1815

**Acknowledgments**

This research was funded by University of Wyoming start-up funds awarded to Valtcho Jeliazkov.

**Contact Information**

Valtcho Jeliazkov at shrec@uwyo.edu or 307-737-2415.

**Key words**: coal-bed methane discharge water, crop response, essential oil

**PARP**: I:1, X:2, XII:2
University of Wyoming Grape Growers Partnership
May Help Improve Sustainable Grape Production in Wyoming

S.A. Dhekney¹, R. Kandel¹, and A. Garcia y Garcia²³

¹Sheridan Research and Extension Center; ²Department of Plant Sciences; ³Powell Research and Extension Center.

Introduction

Interest in grape production in Wyoming has been steadily rising for the past 10 years since the first vineyard was established in 2001 (Table Mountain Vineyards and Winery in southeast Wyoming). Grape growers are scattered throughout the state from Huntley/Torrington (southeast) to Parkman (north-central) to Powell/Worland/Riverton (northwest). Grape growers and vintners statewide are currently evaluating grapevine cultivars, management practices, and quality of fruit produced in Wyoming.

Grape production and quality is governed by several factors including cultivar, soil, climate, and management practices adopted during the growing season. Low winter temperatures, late spring frosts, and a short growing season have a profound influence on cultivars that can be grown successfully in Wyoming. Management practices also play a critical role in whether grapevines survive the winter.

Viticulture research was first initiated at the Sheridan Research and Extension Center (ShREC) in 1987 to study the possibility of grapevine cultivation in the state for table, wine, and juice. This research recently expanded to study the influence of cold/drought/salinity stress factors on grapevine cold-hardiness and optimize canopy management practices to help vineyards survive the winter.

Objectives

The goal of the project is to work with state grape growers for identifying suitable grapevine cultivars and developing canopy management practices for successful grape production in Wyoming.

Materials and Methods

Research vineyards have been established at ShREC and the Powell Research and Extension Center to evaluate cold-hardy grapevine cultivars suitable for production in Wyoming (Figure 1). Grape growers in Basin, Huntley, Powell, Riverton, Sheridan, Wheatland, and Worland have been contacted to obtain information on production practices. Information on specific soil types, cultivars grown, trellis and pruning systems, irrigation, and fertilization is being compiled (Figure 2). Dormant bud samples are being collected from various sites to estimate freeze-induced damage among different cultivars.
Assessing winter injury will help us provide recommendations of the time and amount of pruning to be carried out for maximizing productivity. Other activities involving grape growers include conducting grape workshops and talks to provide information on purchasing certified, disease-free grape cultivars, grapevine propagation techniques, and canopy management systems suitable for grape production in Wyoming.

Results and Discussion

Preliminary data on grapevine winter injury revealed that freeze-induced cold damage in dormant buds of grapevine cultivars ranged from 15–70% (Figure 3, A/B). This can be attributed to several factors including high soil pH that limits nutrient availability, insufficient irrigation water, inadequate canopy management practices, and temperature fluctuations late in the season that result in poor winter acclimation. In collaboration with grape growers statewide, we will continue to seek information and develop practices for expanding and sustaining grape cultivation in Wyoming.

Acknowledgments

Financial assistance from the University of Wyoming College of Agriculture and Natural Resources is acknowledged. The project is also supported by the Wyoming Department of Agriculture and U.S. Department of Agriculture Specialty Crop Block Grant programs.

Figure 1. Research vineyard at the Sheridan Research and Extension Center.

Figure 2. UW graduate student Raju Kandel examines grapevine leaves for nutrient deficiencies in a Wyoming vineyard.

Figure 3. Microscopic examination of a budwood sample collected from a vineyard in Wheatland reveals (A) freeze-induced damage compared to (B) control sample.

Contact Information

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Key words: grape

PARP: 1:1, X:1
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 sugarbeets.

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, sugarbeets).

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, 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 WY Agricultural Experiment Station at aes@uwyo.edu.
FIELD DAY
Saturday, June 14, 2014
8:30 am - 5:00 pm

ACTIVITIES INCLUDE:
- Tours at Wyarno and UW Watt Agriculture Center

TOPICS INCLUDE:
- Horticulture, forage production, and lawn and garden

LOCATIONS:
Sheridan R&E Center at Wyarno
663 Wyarno Rd.
(7 miles east from Sheridan Information Center on 5th St.)

Sheridan R&E Center at the UW Watt Agriculture Center
3401 Coffeen Ave.

AGENDA
8:30 am
REGISTRATION at Wyarno location

9:00 – 10:30 am
WELCOME, INTRODUCTIONS AND TOUR of field trials at R&E Center near Wyarno.

10:30 – 11:00 am
REGISTRATION at UW Watt Agriculture Center

11:00 – 12:00 pm
TOUR field trials and vineyards located near Sheridan College

12:00 pm
LUNCH – provided
(Please RSVP for lunch by June 9th)

12:45 – 1:00 pm
Sheridan College Ag Program and the partnership with UW – Ami Erickson

1:00 – 1:50 pm
TOUR labs

2:00 – 2:30 pm
Weed control in home lawns – Scott Hininger

2:30 – 3:00 pm
Native plants for the home landscape – Karen Panter

3:00 – 3:30 pm
The Wyoming Honey Project – Chian Jones-Ritten

3:30 – 3:45 pm
Break

3:45 – 4:15 pm
The Wyoming Grape Project – Sadanand Dhekney

4:15 – 4:45 pm
Berry production – Connie Fisk

4:45 – 5:00 pm
Wrap-up