

FIELD DAYS BULLETIN



U W A E S 2 0 1 4



2014
Wyoming Agricultural Experiment Station
Field Days Bulletin

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

B.W. Hess¹

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

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 Laramie Research and Extension Center

D. Zalesky¹

¹Director, Laramie Research and Extension Center.

Introduction

The Laramie Research and Extension Center (LREC) provides resources for a wide variety of efforts in research, teaching, and outreach in the College of Agriculture and Natural Resources. Departments and programs within the college that utilize these resources include Animal Science, Plant Sciences, Ecosystem Science and Management, Molecular Biology, Veterinary Sciences, Microbiology, Family and Consumer Sciences, and Agricultural and Applied Economics. Numerous classes use the facilities providing students with hands-on experience.

LREC is unique from other Wyoming research and extension centers because of its close proximity to the main UW campus. In addition to supporting research and extension activities, we also provide support for teaching. This requires staff to balance the resource needs of all three parts of the mission of a land-grant institution. LREC staff work diligently to

meet these needs by providing the highest quality resources possible.

LREC Highlights and Accomplishments

We were pleased to welcome Leslie Montoya to the LREC staff in October 2013 as an office associate, senior. Leslie works with both LREC and the Wyoming Agricultural Experiment Station.

The **LREC greenhouse complex** (Figure 1) will have a new addition to its facility this year with the All-America Selections' (AAS) vegetable Display Garden (see related story about this project). Twenty-one cultivars of 2014 AAS winner vegetables will be grown in raised beds to determine what varieties will grow, thrive, and produce in Laramie.

The **LREC Sheep Unit** continues to be a hub of activity. In addition to conducting two producer-owned ram tests each year, it also provides sheep for teaching and research. In the past year, sheep were provided for a cheatgrass control study at



Figure 1. There are a variety of greenhouses at the LREC greenhouse complex.

the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle. This year, the Sheep Unit will provide sheep for a weed control/grazing project to be conducted at the U.S. Department of Agriculture's High Plains Grasslands Research Station near Cheyenne. Additionally, the GrowSafe system is used heavily for projects related to feed efficiency and fetal programming.

The **LREC Swine Unit** is providing animals and facilities for research evaluating Vitamin D production in swine (see related story about this project). The unit also continues to provide animals and facilities for teaching needs.

In 2013, the **LREC Beef Unit** saw the addition of 12 GrowSafe feeding nodes (Figure 2) and a data-collection system. The new system will provide opportunities to conduct research in beef cattle to evaluate feed efficiency. The majority of the research will focus on the impact of feed efficiency on reproductive traits in females, but it will also examine feedlot and carcass traits.

The **LREC lab animal facility** is fully operational and is currently the home for

mice and rats being utilized in research efforts by Department of Animal Science faculty members and graduate students.

Other animal facilities are housing heifers involved in a research project evaluating the efficacy of a brucellosis vaccine.

The **Cliff and Martha Hansen Livestock Teaching Arena and the Mary Mead Room** are constantly busy with a wide variety of activities (Figure 3). This facility is home to the UW Rodeo Team along with numerous other UW teams and clubs. Several classes use the facility during the school year, and meetings and events are also held in the building.

Acknowledgments

The success of LREC in providing quality resources for research, teaching, and outreach is the result of the tireless efforts of the LREC team. The staff that comprises LREC makes all things possible in serving the faculty and students of UW and the people of Wyoming.

Contact Information

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Figure 2. New GrowSafe units at LREC.



Figure 3. Extension team meeting at the Mary Mead Room, Hansen Livestock Teaching Arena.

Short Format Reports—Laramie R&E Center

1. Rearing and release of an insect biological control agent for Russian knapweed

Investigator: Timothy Collier

Issue: Russian knapweed is an invasive, noxious weed that reduces forage production and is toxic and/or unpalatable to some livestock. An insect biological control agent—the Russian knapweed gall wasp—has recently become available for management of Russian knapweed.

Goal: The goal of this work was to rear and/or release the Russian knapweed gall wasp at sites across Wyoming.

Objectives: Specific objectives include the production of large numbers of Russian knapweed plants for rearing and the production and field release of gall wasps.

Impact: Rearing of the wasp was unsuccessful; however, wasps obtained from another source were released at sites in Albany, Park, and Weston counties. The gall wasp is expected to reduce the height and seed production of Russian knapweed at release sites and provide galls for collection and release at other sites in the future.

Contact: Timothy Collier, tcollier@uwyo.edu or 307-766-2552.

Key Words: gall wasp, Russian knapweed, weed management

PARP: III:5, VI:3

2. Vitamin D synthesis in swine at high altitude and latitude

Investigators: Brenda Alexander and Enette Larson-Meyer

Issue: Animals have evolved to meet their vitamin D requirement through exposure to sunlight; however, recent swine-management practices severely limit sunlight exposure, and the majority of vitamin D in swine is from vitamin D-supplemented feeds.

Goal: The overall goal of this study is to determine the extent and efficiency of vitamin D synthesis in growing pigs and determine how limited sunlight exposure (one hour daily at close to solar noon) influences tissue content and growing swine morbidity.

Objectives: Our objective is to measure vitamin D synthesis in growing pigs exposed to sunlight and determine if pork from these pigs has increased vitamin D content.

Impact: Confinement practices risk insufficient concentrations of vitamin D and may compromise bone health and the immune system. In an era when many consumers are demanding natural products and are adverse to animal practices that are perceived to be abusive, confinement practices, in general, are being scrutinized. This is a favorable time to explore the benefits of limited sunlight exposure in swine operations.

Contact: Brenda Alexander, balex@uwyo.edu or 307-766-6278, or Enette Larson-Meyer, enette@uwyo.edu or 307-766-4378.

Key Words: vitamin D, swine

PARP: V:2,5,7

3. Does forage quality affect how 'good' fats are absorbed when fed as part of a dried molasses lick tub?

Investigators: Daniel Rule and Paul Ludden

Issue: Increasing the concentration of long-chain omega-3 fatty acids ('good' fats, such as those found in fish oil) has been a goal of a significant number of beef cattle producers for modifying the fatty acid profile of the beef and improving fertility in heifers. Optimal by-pass of omega-3 fatty acids through the rumen of cattle may be a function of the rumen environment that would be affected by the quality of forage fed to the cattle.

Goal: The goal is to determine the extent of ruminal bypass of omega-3 fatty acids when supplemented to heifers as the calcium salt of fish oil fatty acids and delivered to the cattle as part of a dried molasses lick tub.

Objectives: The objective is to determine if quality of dietary forage affects intestinal absorption by measuring blood levels of polyunsaturated omega-3 fatty acids in beef heifers fed the fat as the calcium salt of fish oil fatty acids.

Impact: Results will allow development of recommendations for producers regarding amounts of calcium salts of fish oil supplement to feed to increase omega-3 fatty acids in grass-fed beef, which should improve its nutritional quality for human consumers. Results should also allow producers to study effects on reproductive efficiency in beef females maintained on forage-based diets so that greater profitability through increased fertility would be possible.

Contact: Daniel Rule, dcrule@uwyo.edu or 307-766-3404.

Key Words: dietary forage, omega-3 fat supplementation

PARP: V:1,4,5

All-America Selections' Vegetables

K. Panter¹, N. Gompert¹, C. Barry², and A. Smith³

¹Department of Plant Sciences; ²University of Wyoming Landscaping Services; ³UW Landscaping and Grounds.

Introduction

All-America Selections (AAS) is a national, independent, non-profit organization devoted to testing and highlighting the best of the best in vegetables, flowering annuals, and perennials. There are more than 70 AAS Trial Grounds plus almost 200 Display Gardens across the U.S. and Canada. The University of Wyoming is home to a Display Garden (it is the only AAS garden of either type in Wyoming).

The first AAS garden at UW was established in 2012 on the west side of Old Main. It initially encompassed flowering annuals and perennial flowers as well as vegetables. This year, the vegetables are being grown at the Laramie Research and Extension Center (LREC) while the flowering annuals and perennials remain at Old Main.

Objectives

The three purposes of AAS are to 1) test new, unsold cultivars; 2) inform gardeners about AAS winners; and 3) earn gardeners' trust in the AAS winners.

The general goal of the UW AAS project is to highlight new vegetables as part of our agreement with AAS. Specific objectives are to determine varieties and yields of

bean, cucumber, eggplant, peppers, pumpkins, radish, tomatoes, melons, and squash that will grow, thrive, and produce in Laramie. This will help encourage commercial growers and backyard gardeners to try some of these new varieties.

Materials and Methods

Twenty-one cultivars of 2014 AAS winning vegetables are being grown outdoors in raised beds at the LREC greenhouse complex in Laramie. Seeds were sown starting in February with transplant dates dependent upon cultivar. Cultivars being grown are listed in Table 1. AAS also chooses a few winners from previous years to highlight in all of its gardens across the U.S. and Canada (Figure 1).



Figure 1. Pumpkin 'Hijinks' in the 2013 UW AAS Display Garden.

Data collected include days to germination, days to transplant, and fresh weight of harvested vegetables on a per-plant basis.

Results and Discussion

Initial results should be available for the August 28 field day at the LREC greenhouse complex in Laramie.

Acknowledgments

We thank UW Landscaping Services and UW Landscaping and Grounds for their assistance with this project. The raised beds used for vegetables were purchased using LREC discretionary funds.

Contact Information

Karen Panter at kpanter@uwyo.edu or 307-766-5117.

Key words: vegetables, horticulture, gardening

PARP: None applicable

Table 1. All-America Selections' cultivars under test.

Vegetable	Cultivar	AAS year, Comments
Bean	'Mascotte'	2014, dwarf
Cucumber	'Pick a Bushel' F1	2014, early to set fruit
Eggplant	'Gretel' F1	2009, good for containers
Pepper	'Cajun Belle'	2010, fruit turns red
Pepper	'Cayennetta' F1	2012, mildly spicy
Pepper	'Mama Mia Giallo' F1	2014, sweet, yellow/gold fruit
Pepper	'Orange Blaze'	2011, sweet, orange
Pumpkin	'Hijinks' F1	2011, 15-foot vines
Radish	'Rivoli'	2014, bright red, 1.5-inch diameter
Tomato	'Chef's Choice Orange' F1	2014, orange, indeterminate, beefsteak
Tomato	'Fantastico' F1	2014, determinate bush, grape-shaped fruit
Tomato	'Jasper' F1	2013, red cherry type, vining
Tomato	'Lizzano' F1	2011, red cherry, semi-determinate
Tomato	'Mountain Merit' F1	2014, medium to large round red fruit
Tomato	'Terenzo' F1	2011, red cherry, determinate
Melon	'Lambkin' F1	2009, 2- to 4-pound fruit
Melon	'Melemon' F1	2013, 4-pound fruit
Squash	'Honey Bear' F1	2009, acorn type
Watermelon	'Faerie' F1	2012, 4- to 6-pound fruit
Watermelon	'Shiny Boy' F1	2010, 7- to 12-foot vines
Watermelon	'Harvest Moon' F1	2013, 4- to 5-foot vines

Wyoming Fresh Herb Production

C. Seals¹ and K. Panter¹

¹Department of Plant Sciences.

Introduction

Interest in local production of agricultural commodities is increasing in Wyoming. Much of the discussion centers on edible crops, and fresh herbs are part of the mix.

One purpose of this project is to successfully grow fresh oregano, chives, marjoram, and basil for local market. Another purpose is to make the methods used available to Wyoming growers. The project began in April 2013 and will continue through fall 2014.

Objectives

This project has the main goal of adding niche crops for Wyoming growers who use high tunnels and/or greenhouses. The aim is to study specialty crops that can be grown in Wyoming for sale at local venues such as farmers' markets. This could encourage expansion of specialty crop production in Wyoming.

Materials and Methods

Four species of herbs are being grown in the greenhouse and two high tunnels at the Laramie Research and Extension Center (LREC) greenhouse complex. The four herbs are oregano (*Origanum vulgare*), garlic chives (*Allium tuberosum*), sweet marjoram (*Origanum majorana*),

and sweet basil (*Ocimum basilicum*). Two additional species—lavender (*Lavandula* spp.) and rosemary (*Rosmarinus officinalis*)—are being grown as edge rows so all test plants are surrounded by other plants.

The first of our herb crops were transplanted mid-May 2013 into the greenhouse and two high tunnels at LREC. Seeds from these plants were sown in March 2014 and transplanted into the high tunnels and the greenhouse in May.

Data being collected include days to germination, days to transplant, and fresh weight of harvested herbs on a per-plant basis. Fresh herbs are harvested twice a week (just prior to blooming) and weighed immediately. The experimental design is a randomized complete block with four replications (Figure 1). Treatments are the



Figure 1. High tunnel production of herbs, September 2013.

five locations: greenhouse, north and south sides of the east–west oriented tunnel, and east and west sides of the north–south tunnel. Each of the four herb species was randomly assigned a block within each of the five treatments. All data will be analyzed using analysis of variance and mean separations.

Results and Discussion

Comprehensive first-year production results and statistical analysis will be available for the August 28 Laramie field day at the LREC greenhouse complex. First-year greenhouse production was finalized March 15, 2014. Figure 2 shows greenhouse and high tunnel comparisons over the same growing period in 2013. Green-

house herb growth showed lower production weights than that of the high tunnels in 2013. High tunnel orientation and greenhouse-only studies are also being conducted. There were differences in yields among the five locations (Figure 2).

Acknowledgments

Funding for tissue testing is provided by the Wyoming Groundskeepers and Growers Association.

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Key words: herbs, greenhouse, high tunnel

PARP: None applicable

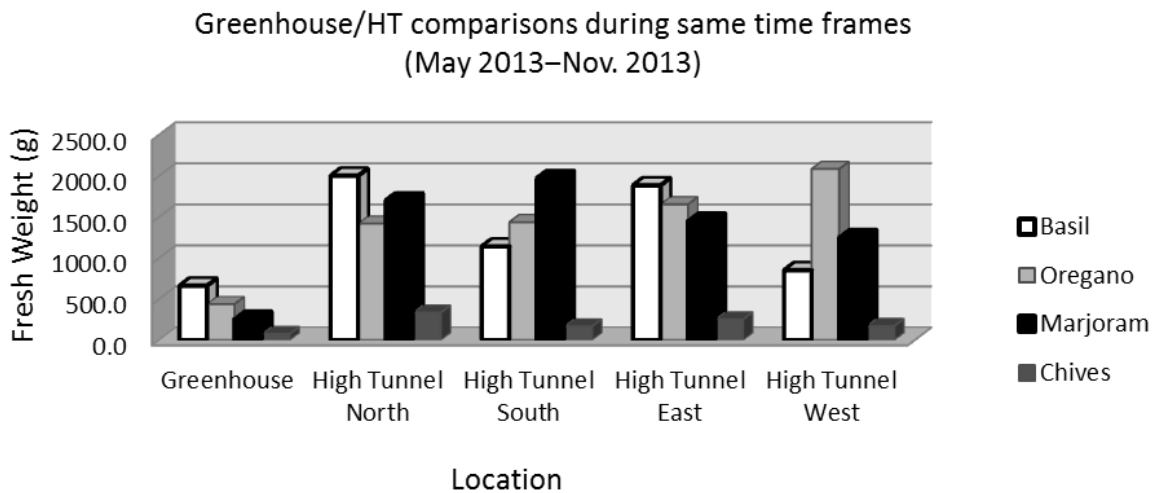


Figure 2. Greenhouse/high tunnel fresh weight comparisons over same time frame, May 2013–November 2013.

Competitive Effect of Forage Kochia and Perennial Grass on Cheatgrass Growth

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Introduction

Forage kochia (*Bassia prostrata*) is a perennial semi-shrub, a plant having a woody basal stem and herbaceous upper shoots. Forage kochia—unlike the weedy annual kochia—is a valuable species for reclaiming degraded lands and to provide forage for livestock and wildlife. It can grow on disturbed harsh soils and weed-infested areas. It can compete with invasive weeds such as cheatgrass (*Bromus tectorum*) and halogeton (*Halogeton glomeratus*). Cheatgrass is an exotic invasive weed across many areas of the United States, including Wyoming. It can 1) cause frequent wildfires, 2) outcompete native plant communities, often becoming the dominant species, 3) degrade wildlife habitat, and 4) reduce desirable forage yield and quality. Cheatgrass germinates in the fall, can resume its growth in early spring before many of the native species such as bluebunch wheatgrass, and competes for water and nutrition. Planting desirable competitive species can improve western rangelands invaded by cheatgrass. Forage kochia and some perennial cool-season grasses may have potential to compete with cheatgrass.

Objectives

The objective of this study was to determine the competitive ability of forage kochia and perennial grass seedlings to suppress the growth of cheatgrass.

Materials and Methods

The experiment was conducted in early 2014 at the Laramie Research and Extension Center (LREC) greenhouse complex. This study consisted of a “target” species (cheatgrass) and four desirable perennial species and cultivars (‘Immigrant’ forage kochia, ‘Snowstorm’ forage kochia, ‘Hycrest’ crested wheatgrass, and ‘Critana’ thickspike wheatgrass). All species were seeded January 11, 2014, and transplanted into pots shortly after germinating (about two weeks). Each perennial species was transplanted in increasing densities (0, 1, 2, 3, 4, and 5 seedlings per pot) with one cheatgrass seedling. The experimental design was completely randomized with six replicates. During the first two weeks of transplanting, dead seedlings were replaced by new seedlings. The tiller number (number of shoots arising from the base of a grass) and the height of cheatgrass plants were collected two weeks after transplanting and prior to

harvesting. The differences between the initial values of plant height and tiller number and the final values of plant height and tiller numbers were the response variables. Cheatgrass plants were harvested March 23, 2014, oven-dried, and weighed to determine aboveground biomass.

Results and Discussion

The results showed that two cultivars of forage kochia and two perennial grasses moderately affected the growth of cheatgrass; however, no cheatgrass mortality due to competition was observed. All four perennial species and cultivars had similar effects on the height of cheatgrass seedlings. Compared to ‘Immigrant’ forage kochia, however, other perennial species and cultivars resulted in a significantly lower tiller number of cheatgrass (data not shown). The interaction between perennial species or cultivars and their density per pot had a significant effect on aboveground biomass of cheatgrass (Figure 1). In general, there is

a decreasing trend of aboveground cheatgrass biomass with increasing densities of perennial species, especially Critana thickspike wheatgrass, Hycrest crested wheatgrass, and Immigrant forage kochia. This indicates that increasing densities of desirable competitive plant species may have potential to decrease growth of cheatgrass seedlings at an early growth stage. However, more research is needed to determine which of the four species and cultivars used in this research would better compete with cheatgrass.

Acknowledgments

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Key words: cheatgrass, competitive effect, forage kochia

PARP: III:5, VI:8, XII:1

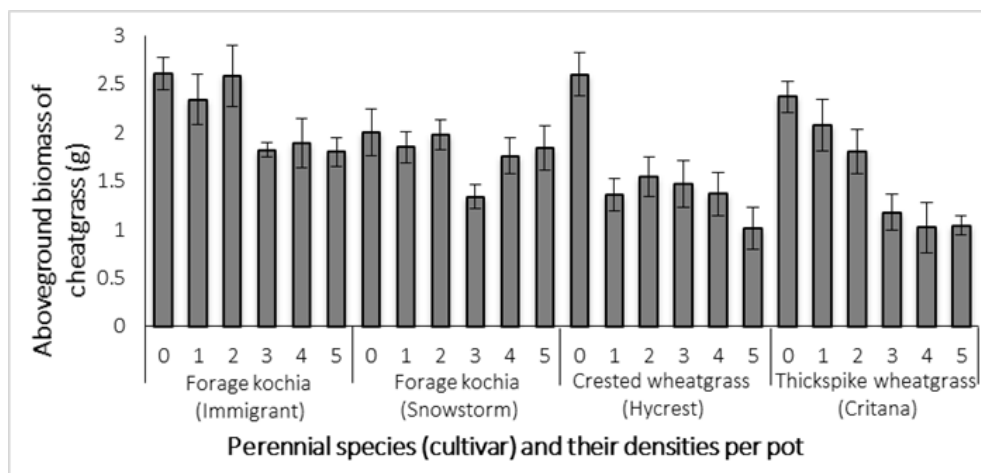


Figure 1. Means of aboveground biomass of cheatgrass (\pm standard errors) as influenced by desirable species (cultivars) and their densities per pot.

Effects of Phosphorus and Potassium Fertilization on Alfalfa Persistence

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Introduction

Livestock production in Wyoming and the United States typically relies on good quality hay. According to Wyoming Agricultural Statistics, 1.3 million tons of alfalfa hay was produced in Wyoming in 2012. Its value (\$2.7 million) far exceeded corn grain, dry beans, barley, and winter wheat. Although alfalfa is an important crop in Wyoming, the bloat potential associated with feeding alfalfa (a legume) to livestock is a major concern to producers. One of the best practices to avert this issue is to mix alfalfa with grass species. As an added benefit, grass-legume mixtures produce a high quantity of, and reduce the need for, commercial nitrogen (N) fertilization associated with sole grass stands. This is because alfalfa is able to convert atmospheric N into forms usable by plants. Establishing grass-legume mixtures, therefore, has the potential of increasing farm profits; however, poor persistence of alfalfa can result when established in mixtures with grasses, which can be discouraging. Further, loss of alfalfa in grass-legume mixtures can increase weed infestations, which reduces forage yield and quality and increases production costs. Carbohydrate content in roots is critical for winter survival and persistence of alfalfa. Low levels of

phosphorus (P) and potassium (K) in the soil are among the major causes of the poor persistence of alfalfa in mixed stands. Grasses are able to absorb much P and K even when these nutrients are available in small amounts in the soil. This is because grasses have a fibrous and extensive root system. Thus, grasses deprive alfalfa of soil P and K when they are inadequate. Fertilizing a soil low in P and K, therefore, has the potential of increasing the longevity of alfalfa in mixed stands.

Objectives

The objectives of the study were to 1) determine the effects of P and K fertilization on alfalfa and meadow bromegrass regrowth after cutting and 2) assess the effects of P and K on forage yield and quality, root mass, and root carbohydrates.

Materials and Methods

The research was conducted at the Laramie Research and Extension Center (LREC) greenhouse complex. There were 27 treatment combinations. These comprised three levels of P (0, 38, and 76 pounds P₂O₅ per acre), and three levels of K (0, 110, and 220 pounds K₂O per acre), applied to sole stands of alfalfa (cultivar 'WL 363 HQ'), sole stands of meadow bromegrass (cultivar 'Fleet'), and stands of

50:50 mixture of alfalfa and meadow bromegrass. Sole stands of meadow bromegrass received a blanket application of 50 pounds N per acre. Urea (46-0-0), triple superphosphate (0-45-0), and muriate of potash (0-0-60) were used as sources of N, P, and K, respectively. Alfalfa and meadow bromegrass were planted at a seeding rate of 13 pounds pure live seed per acre in 0.4-gallon plastic pots. Pots were filled with 2.2 pounds of planting material (two parts Metro-Mix 900 growing mix and one part mortar sand). Data being collected include plant height, number of tillers (meadow bromegrass), number of branches (alfalfa), number of buds on stump at harvest, regrowth dry matter, forage quality, root carbohydrate, and root dry matter.

Results and Discussion

The experiment is ongoing, and data is being collected and analyzed. Preliminary data on plant growth shows that meadow bromegrass in mixtures with alfalfa were ($p < 0.05$) taller (mean 10.0 inches) than the sole stand of meadow bromegrass (mean 8.9 inches). This might increase the yield of meadow bromegrass-alfalfa mixtures over sole meadow bromegrass. Effects of K on plant height have not been observed yet. P application increased the height of alfalfa plants in sole stands relative to alfalfa-meadow bromegrass mixtures except for the 76 pounds P_2O_5 per acre (Table 1). This is because P moves slowly in soils having grasses because their fibrous root system quickly absorbs higher amounts of P relative to legumes. When legumes are grown

Table 1. Effects of P rate and species combination on alfalfa height (inches).

	Rate of P (pounds P_2O_5 per acre)		
	0	38	76
Alfalfa only	3.8a*	4.5a	4.3a
Alfalfa in mixture	2.1b	3.8b	4.3a

*means within column followed by different letters are significantly different ($p < 0.05$)

in mixtures with grasses, the legume is able to absorb adequate amounts of P only when P is abundant as evident at the 76 pounds P_2O_5 per acre. Data on number of tillers, branches, buds on stump at harvest, regrowth dry matter, forage quality, root carbohydrate, and root dry matter will be collected from May through August 2014.

It is expected that P and K will promote growth, yield, and quality and increase root carbohydrate content. An increase in root carbohydrate due to P and K fertilization means persistence of alfalfa can be enhanced by applying P and K. Results may help producers in identifying the best rates of P and K to improve alfalfa persistence.

Acknowledgments

We thank the Sheridan Research and Extension Center's Competitive Graduate Assistantships Program for funding this project and also LREC greenhouse staff.

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Key words: fertilization, persistence, yield

PARP: I:2, II:2

Using Germination Differences to Remove Cheatgrass from Reclamation Seed

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Introduction

Disturbances such as oil and gas extraction and surface mining create an opportunity for infestation of new areas by weeds such as cheatgrass (*Bromus tectorum* L., also known as downy brome). Reclamation is implemented on these sites in an effort to restore native vegetation. Cheatgrass seeds, however, often contaminate native seed mixes used for reclamation. A recent 1.5 million pound Bureau of Land Management seed purchase contained an estimated 230 million weed seeds including approximately 45 million cheatgrass seeds.

Many authors have noted the rapid germination rate of cheatgrass compared to native grass species. Cheatgrass germination rates may be two to five times greater than that of native grass species. More impressive, perhaps, is the ability of cheatgrass seeds to germinate at low temperatures. As much as 25% of cheatgrass germination can occur in 11.4 days at only 37°F while the minimum temperature of germination for some desirable species has been observed to be 39°F.

Encouraging cheatgrass seed to germinate and then withholding moisture may kill cheatgrass seed while leaving desirable seeds unharmed. This would allow selective removal of cheatgrass seed from

desirable seed before it is used in reclamation efforts.

Objectives

The objectives of this study were to 1) compare the effect of a range of temperatures on germination of cheatgrass and desirable seeds, and 2) determine the treatment effect on germinability of desirable seeds.

Materials and Methods

Phase I: 20-Day Germination Treatment:

Seeds from four species (bluebunch wheatgrass, western wheatgrass, blue grama, and three cheatgrass populations) were placed on filter paper in 1-pint containers and inserted randomly into three germination chambers set at 37°F, 43°F, and 54°F. Each germination chamber contained four replicates of 50 seeds from each species. Chambers were kept dark throughout the treatment. After 20 days, containers were removed from the chambers and placed on a lab bench to air-dry for 14 days in an effort to kill germinated cheatgrass seedlings

Phase II: 14-Day Post-Treatment Germination Trial:

After the drying period, containers were reinserted into one of four chambers set at

temperatures reported in the literature to be optimal for germination of each individual species. As a control, four replicates of 50 non-treated seeds for each species were included.

Results and Discussion

Cheatgrass displayed earlier and more rapid germination in all three temperatures. No cheatgrass (0%) survived the 43°F and 54°F treatments, and only 9.2% survived the 37°F treatment (Table 1). Non-treated seeds achieved greater germination than treated seeds among all species except blue grama. The 37°F treatment yielded 85.5% survival of blue grama, and the 43°F treatment yielded 65.5% survival. Non-treated blue grama seeds achieved 86.0% survival, suggesting that the 37°F treatment had no effect on the germinability of blue grama seeds.

At a minimum, results from this experiment confirm the existence of significant germination differences between cheatgrass and desirable species.

These differences can potentially be exploited for purification of reclamation seed. The concept was exemplified by the 85.5% survival of blue grama seeds versus the 9.2% average survival of cheatgrass in the 37°F treatment. Further research is required to understand how to mitigate the negative treatment effects on bluebunch and western wheatgrass.

Acknowledgments

We thank the Department of Plant Sciences and Wyoming Reclamation and Restoration Center for support and funding as well as the Laramie Research and Extension Center for facilitating the experiment.

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Key words: cheatgrass, reclamation, germination

PARP: III:5, XII:1

Table 1. Survival for three native grasses and three cheatgrass populations by temperature.

	Survival (%)			
	Control	37°F	43°F	54°F
blue grama	86.0	85.5	65.5	0.0
bluebunch wheatgrass	49.0	5.5	6.0	0.0
western wheatgrass	29.5	3.0	1.5	0.0
cheatgrass 1	97.0	9.5	0.0	0.0
cheatgrass 2	90.0	9.5	0.0	0.0
cheatgrass 3	90.8	8.5	0.0	0.0

Effects of Defoliation on Dalmatian Toadflax and Four Native Grasses

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Introduction

Dalmatian toadflax is a competitive forb on noxious weed lists in at least 15 North American states and provinces, including Wyoming. It is considered undesirable for livestock or wildlife forage, but can be safely consumed by sheep, goats, deer, and cattle. Studies have shown varied impacts of defoliation on the plant, from negative to no effect. Repeated grazing, however, is predicted to reduce toadflax density over time, particularly if used in conjunction with other control measures.

Targeted grazing is a rangeland management practice used for weed control. To achieve a desired outcome, managers may manipulate defoliation timing, intensity, frequency, and herbivore species for maximum stress on weeds and minimum impact on the native plant community.

Objectives

Our objective was to evaluate effects of defoliation treatments on Dalmatian toadflax and native grass plants.

Materials and Methods

We collected approximately 200 shoot-bearing Dalmatian toadflax roots from the U.S. Department of Agriculture's High Plains Grasslands Research Station (HPGRS) outside Cheyenne. These were

trimmed to uniform size and planted in individual pots at the Laramie Research and Extension Center (LREC) greenhouse complex.

We grew one toadflax plant alone or with one of four native grasses in each pot. We germinated seeds of four perennial native grasses (blue grama, bluebunch wheatgrass, needle and thread, and western wheatgrass) in a growth chamber and transplanted them into pots with toadflax. Pots containing just one grass individual were also included in the study.

We randomly applied five defoliation treatments to toadflax one month after planting: moderate (50% height removed), heavy (75% height removed), stripping (all leaves, flowers, and growth points removed), or check (no defoliation). These were crossed with moderate, heavy, or check defoliation treatments for each grass species. Treatments were arranged in a randomized complete block design. We harvested biomass one month after treatment by removing the above-ground portion of each plant.

We compared percent change in height and stem number at soil surface (measured just prior to treatment and harvest) and oven-dry biomass (total from treatment and harvest) for each plant.

Results and Discussion

We detected no interaction between defoliation treatments. Dalmatian toadflax presence, however, reduced total grass biomass production ($p=0.0166$).

Grass plants receiving moderate or heavy defoliation produced fewer tillers and less total biomass than those receiving none ($p<0.035$). Only heavy defoliation reduced vertical growth ($p=0.0006$; Figure 1).

Total Dalmatian toadflax biomass responded to moderate and heavy defoliation similarly to that of the grasses. Stripped plants produced less total biomass and fewer stems following defoliation than those subjected to other treatments ($p\leq 0.0001$; Figure 2).

Selective feeders (such as sheep or goats) may more successfully decrease Dalmatian toadflax growth than generalist feeders (such as cattle) by removing more critical biomass and relatively reducing grass

defoliation. Reducing Dalmatian toadflax flowering and vegetative spread could be important in a successful targeted grazing program. We initiated a field study in spring 2014 to test our results under field conditions.

Acknowledgments

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Key words: Dalmatian toadflax, defoliation, targeted grazing.

PARP: III:3, V:3, VI:5, XII:1

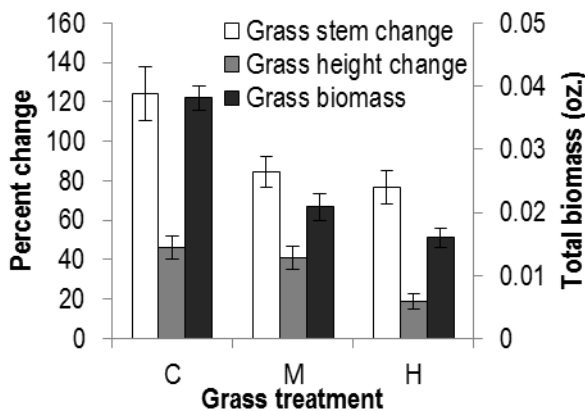


Figure 1. Pooled response of four native grasses to grass defoliation treatments. Treatments were (C) check, (M) moderate, and (H) heavy. Error bars show standard error.

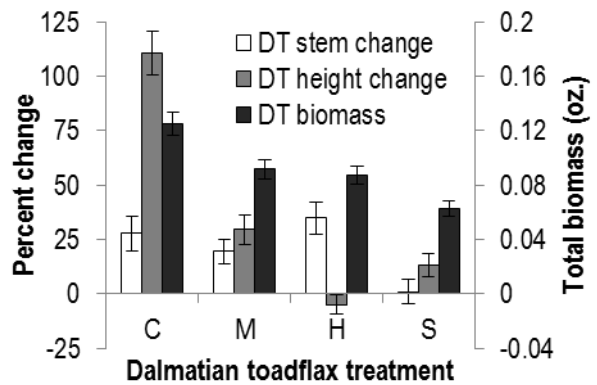


Figure 2. Dalmatian toadflax (DT) response to toadflax defoliation treatments. Treatments were (C) check, (M) moderate, (H) heavy, and (S) stripping. Error bars show standard error.

Local Vegetable Production in Laramie, Wyoming

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Introduction

Local food production and consumption have recently been gaining popularity across the United States, including in Wyoming. In many areas of Wyoming, however, consumer preferences of buying locally grown produce is often hampered by an insufficient amount of knowledge.

Within a local food network, there are several typical ways of obtaining food: supermarkets, farmers' markets, Community Supported Agriculture (CSA), and local food cooperatives. CSA is a form of direct agreement between producer and consumer typically established at the beginning of the growing season. Produce will be received throughout the growing season, but is purchased with a pre-paid flat rate. Payment helps to offset the costs and risks associated with traditional farming methods as customers and farmers share the burden of ecological mishaps, such as drought, hail, or freezing temperatures during the growing season.

The local food movement has been developing quickly in places like Laramie. Its high elevation, short growing season, cool temperatures, and wind are among the factors contributing to the difficulty in growing produce. This research provides preliminary analysis of the local food

system in Laramie. This project represents a case study relevant to the geographic regions of high dependency on outside food resources, where climatic conditions (high altitude and short growing season) prevent a complete reliance on local production and limit consumer choices. The main goal of this research is to evaluate the sustainability of local food production in Laramie by examining economic, social, and environmental factors affecting promotion of local food systems.

Objectives

Our objectives are to 1) assess the amount, diversity, and seasonal availability of locally grown vegetable crops, 2) compare the value and cost of local food production with sale prices at local food-selling venues, and 3) evaluate the distance some produce travels before reaching Laramie stores.

Materials and Methods

This three-year study quantified the bounty of produce provided by the University of Wyoming ACRES Student Farm. CSA shares were compared to the other food options in Laramie. Vegetables were produced in outside beds and in hoop houses. A price comparison of each vegetable produce box offered weekly during the growing season by ACRES was

Table 1. Average cost of ACRES CSA weekly veggie boxes compared to other options (2011–2013).

	Avg price	\$ difference
ACRES CSA	\$23.85	—
Organic market	\$23.53	-\$0.32
ACRES market	\$22.78	-\$1.07
Local food coop	\$21.41	-\$2.44
Farmers’ market	\$21.14	-\$2.71
Conventional supermarket	\$19.28	-\$4.57

compared to food available at: local famers’ markets (including ACRES-produced food sold at these markets), the local food cooperative, and local supermarkets (both organic and conventionally grown produce that is trucked here). Additionally, members of the ACRES CSA were interviewed regarding their motivation to participate and their satisfaction with the service.

Results and Discussion

ACRES Student Farm provided produce to 24 CSA members over a 12-week period from 2011 through 2013. There were 25 types of crops grown. The CSA vegetable

food boxes were priced competitively with all other options (Table 1).

While ACRES CSA baskets appear to be more expensive, the produce is grown chemical-free and in town. In addition, some produce types that can be grown in Laramie travel more than 5,000 miles to local supermarkets (Table 2).

Promoting the local economy, University of Wyoming students, and availability of fresh, local produce were also important decision-making factors for members.

Acknowledgments

We thank the student volunteers of ACRES Student Farm who collected data and worked hard to produce the food offered in the CSA shares.

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Key words: local food systems, Community Supported Agriculture, food miles

PARP: I:1, VII:4

Table 2. The number of miles food travels from its source to purchase, a common marker of locality in Europe.

Miles to Source	Origin	Crops
100–200	Colorado	romaine lettuce
800–900	Arizona, Minnesota	arugula, carrots, dill, kale, turnips
1,000–1,100	California	artisan lettuce, beets with greens, broccoli, cilantro, collard greens, mustard greens, spinach
1,200–1,500	Mexico	acorn squash, pak choi, radishes, scallions, slicing tomatoes
2,000–2,200	Florida	radishes
5,000–5,400	Holland	green peppers

Effects of Feed Efficiency on Reproductive Performance in Growing Beef Heifers

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Introduction

While feed typically represents the highest operating cost for cow-calf producers, cow longevity and reproductive success are the primary factors affecting economic profitability. Reproductive success is largely dependent on age at which puberty is attained. Monitoring fat composition has proven to be a useful tool in predicting the onset of puberty. Beef heifers receiving a lower plane of nutrition and lacking adequate fat reserves are less likely to reach puberty by their first breeding season. Furthermore, heifers with decreased body condition scores (BCS) leading up to their first breeding season are more likely to be removed from the herd earlier in life.

It has been reported that feed-efficient heifers contain 2–5% decreased fat reserves and will reach puberty 5–6 days later, on average, compared to their inefficient herd mates. Recent findings indicate that heifers selected for low residual feed intake (RFI) values (high feed efficiency) had a 10% lower conception rate compared to high RFI (low feed efficiency) heifers between days 12 and 37 of the breeding season. Therefore, heavy selection based on feed efficiency may result in leaner, later-maturing

replacement heifers that calve later in the calving season. Reproductive performance is largely determined by ovarian characteristics. The number of countable ovarian follicles—or antral follicle count (AFC)—is known to be a good indicator of cow fertility and longevity and is largely dependent on prior nutritional status.

Objectives

The overall objective was to evaluate the effects of RFI on reproductive efficiency. Specific objectives were to evaluate the effects of RFI on body weight (BW), BCS, conception rate, pregnancy rate, and AFC. An additional objective was to compare the results of actual RFI for these heifers to their predicted RFI estimated using the Cornell Value Discovery System (CVDS), an alternative way of assessing feed efficiency.

Materials and Methods

Seventy-five Angus x Hereford heifers were utilized. Following weaning (average age=217 days \pm 2.88 days) all heifer progeny were managed as a common group. Ultrasonic ovarian scans and BCS were conducted prior to artificial insemination to determine AFC. Estrus in all heifers was synchronized and fertility was measured via pregnancy detection.

Following breeding, all heifers had free access to a GrowSafe system where a high-fiber pelleted ration was offered for 42 days to determine individual intake. RFI was calculated as actual dry matter intake (DMI) minus the predicted DMI. The CVDS was used to predict RFI (PRFI) and compared to actual RFI. The 25 most feed-efficient heifers were considered LOW ranking, intermediate 25 heifers were MED, and 25 least efficient heifers were HIGH. (All animal procedures were approved by the University of Wyoming Institutional Animal Care and Use Committee.)

Results and Discussion

Heifers that were predicted to be feed efficient (LOW PRFI) were heavier at weaning with greater average daily gain (ADG) compared to heifers that were not predicted to be feed efficient (HIGH PRFI; Table 1). Weaning weights (WW) and ADG, however, were not affected by actual RFI in the current study. Our actual RFI results correspond with other studies that did not report differences in ADG, WW, or mature BW between high and low RFI animals. Actual RFI and PRFI were not correlated ($r = -0.12$; $p = 0.29$) with each other in the current study.

Variation in the results of the two systems may be due to the fact that the CVDS must base RFI predictions on limited information, mainly growth. The CVDS has been proven a useful tool for accurately predicting pen averages in a feedlot setting; however, it cannot be assumed that

Table 1: Effects of RFI and PRFI on reproductive performance.

	Ranking			p-value
	LOW	MED	HIGH	
RFI				
WW, lb	496	489	487	0.76
ADG, lb/d	2.89	3.04	3.02	0.79
BCS	5.31	5.27	5.17	0.53
AFC	11.3	12.8	12.4	0.39
Conception, %	72.0	58.3	66.7	0.61
Pregnancy, %	96.0	91.7	87.5	0.57
PRFI				
WW, lb	471 ^a	482 ^a	522 ^b	0.01
ADG, lb/d	2.47 ^a	3.11 ^b	3.46 ^c	0.01
BCS	5.01 ^a	5.11 ^a	5.67 ^b	0.01
AFC	11.9	11.8	12.5	0.81
Conception, %	52.0 ^a	64.0 ^{ab}	76.0 ^b	0.08
Pregnancy, %	84.0 ^a	94.0 ^{ab}	100 ^b	0.04

^{abc} Means with different superscripts differ ($p < 0.10$).

accuracy in predicting pen averages will apply for individual heifers due to averaging of under- and over-predicted values. Similar to prior research, actual RFI does not seem to affect early conception or pregnancy in growing heifers. Fertility differences among HIGH and LOW PRFI groups is likely a result of PRFI values being positively correlated to growth traits such as DMI and ADG. There were no differences among AFC for RFI or PRFI rankings.

Acknowledgments

Thanks to all students and staff involved.

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Key words: beef, feed efficiency, reproduction

PARP: V:1

Introduction to the Powell Research and Extension Center

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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, a new faculty member (Assistant Professor Gustavo Sbatella) joined us 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 facili-

tate 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 (ET_o) correspond to totals. (ET_o 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,



Figure 1. Research already going on in the new hoop house at PREC.

(Photo by Austen Samet)

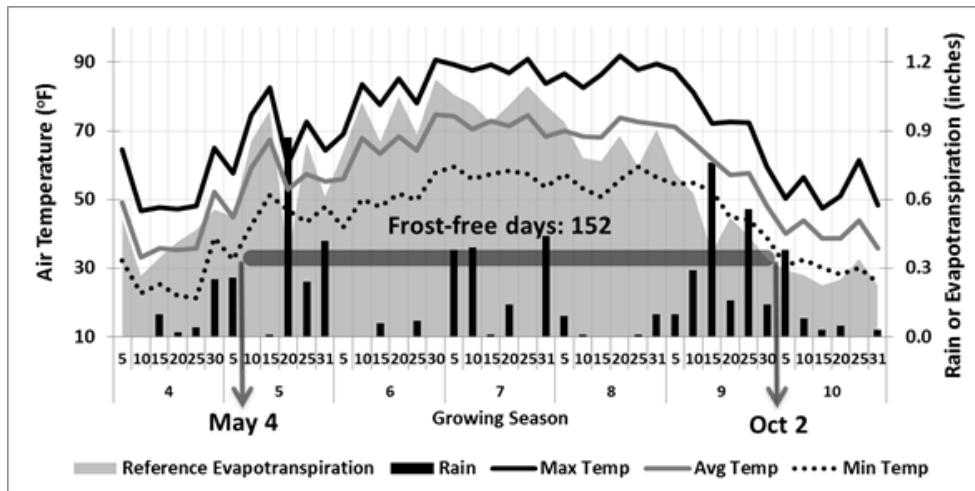


Figure 2. Weather conditions during the 2013 growing season at PREC.

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 temperatures 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

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.



Figure 3. a) Ph.D. students Abdelaziz Nilahyane (left) and Marcelo Abritta (right) discuss their research with Associate Professor Valtcho Jeliakov; b) Master’s student Nana Kusi (left) and U.S. Department of Agriculture researcher Bart Stevens discuss a project.

Short Format Reports—Powell R&E Center

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:2,4, 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, best management practices

PARP: I:1, II:8, IV:2,4, 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: None applicable

Effect of Irrigation and Nitrogen Application on Yield of Corn for Silage

A. Nilahyane¹ and A. Garcia y Garcia^{1,2}

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

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 examining different rates of N fertilizer with irrigation treatments.

Objectives

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

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 \approx 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 (50 lb/A and 60 lb/A)

when the plant was at V5 and V8, respectively. (The V5 stage is when the collar of the fifth leaf is visible, while the collar of the eighth leaf is visible at V8.) 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

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

Irrigation	Yield (lbs/acre)*
100ET	15,452 A
80ET	15,298 A
60ET	11,282 B
50ET	11,159 B
LSD	287

* Means with the same letter are not significantly different at $\alpha=0.05$.

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

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Key words: irrigation, nitrogen, fertilization

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

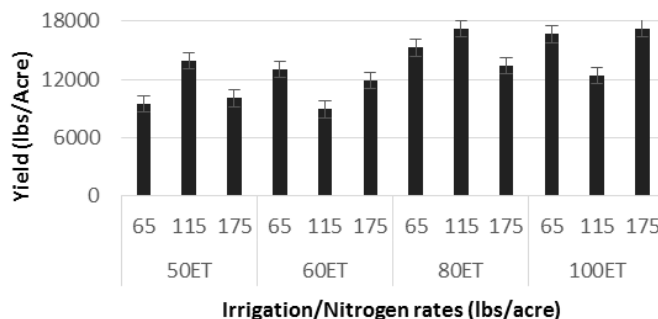


Figure 1. Effect of irrigation and N fertilization on dry matter yield of corn for silage.

2013 Spring Barley Variety Performance Evaluation

A. Pierson¹, J. Christman¹, and M. Moore²

¹Powell Research and Extension Center; ²Wyoming 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 P₂O₅ 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™) and pinoxaden (3.4 pt Axial® 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 Powell R&E Center staff members for their assistance during 2013. Thanks go to Riverland Ag Corp. for providing entries for testing.

Contact Information

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Key words: barley, variety trial

PARP: VIII:1

Table 1. Agronomic performance of spring barley genotypes grown at PREC during 2013.

Variety	Row Type	Grade	Height inches	Heading Date days from Jan 1	Lodging 1-9*	Grain Yield bu/acre	Test Weight lb/bu	Plump	
								6/64 % above screen	5.5/64
Malting									
2B10-4465	2	malting	35.3	176	2.3	109.85	48.16	92.4	96.3
2B09-3425	2	malting	31.3	176	1.3	107.87	47.32	96.0	98.5
2B10-4162	2	malting	32.3	176	2.0	107.79	47.09	92.8	96.6
2Ab07-X031098-31	2	malting	35.3	176	3.0	105.34	44.75	92.4	96.1
2B10-4480	2	malting	36.3	176	3.6	102.84	43.43	88.6	93.8
2ND28065	2	malting	35.3	176	1.3	102.65	47.39	95.3	97.7
2Ab08-X04M278-35	2	malting	34.7	177	3.0	100.97	46.27	93.7	97.2
2ND25276	2	malting	37.3	175	2.7	98.11	48.88	97.6	99.0
2ND27705	2	malting	36.3	176	4.3	92.65	45.91	92.0	98.5
2Ab07-X04M219-46	2	malting	34.3	180	4.3	91.72	41.25	84.7	92.2
2Ab08-X05M010-82	2	malting	34.3	176	4.0	89.24	45.78	89.4	94.5
AC Metcalfe	2	malting	36.3	176	4.3	86.17	46.66	91.8	96.3
2Ab08-X04M282-48	2	malting	33.7	179	4.3	78.76	40.90	74.0	84.9
Harrington	2	malting	36.0	176	4.3	74.54	41.67	85.9	93.1
Feed/Food									
09WA-231.5	6	feed	31.3	176	1.0	122.56	49.50	97.5	99.1
08ID2661	2	feed	33.0	177	1.0	120.37	48.08	95.6	98.6
09WA-203.24	6	feed	33.3	173	1.0	115.95	50.90	98.7	99.4
UT6R2120-14	6	feed	35.7	169	3.0	111.94	46.29	91.8	96.6
UT2170-16	6	feed	36.3	170	3.3	110.30	41.90	71.7	84.0
Steptoe	6	feed	36.3	170	4.0	107.83	45.31	93.2	97.3
MT100126	2	feed	37.7	177	2.7	107.08	48.27	93.8	96.9
MT090180	2	feed	36.0	176	2.0	106.73	49.30	93.6	96.9
Baronesse	2	feed	33.3	176	3.0	102.78	46.47	92.0	95.8
MT090190	2	feed	36.0	176	2.3	102.28	47.25	93.6	97.0
MT100120	2	feed	37.3	176	2.3	100.59	49.01	94.7	97.4
09WA-249.9	6	feed	39.0	176	2.3	100.12	48.38	95.9	98.3
09WA-203.26	6	feed	35.3	174	2.7	99.45	50.31	95.1	97.7
09WA-228.13	6	feed	36.7	173	2.3	96.86	50.09	97.2	98.9
X06G07-T43	6	H,F**	28.7	176	1.0	114.75	46.19	91.7	97.4
X05013-T1	6	H,F**	37.3	170	1.7	104.93	54.17	93.3	97.4
2Ab09-X06F058HL-21	2	H,F**	34.3	178	2.7	89.50	48.77	94.1	97.5
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=hullless

On-Farm Water Management for Optimum Grain Yield in Confection Sunflower

A. Samet^{1,2}, V.R. Joshi¹, and A. Garcia y Garcia^{1,2}

¹Department of Plant Sciences; ²Powell 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



Figure 1. Sunflower at the two stages of growth chosen to begin irrigation.

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 sug-

gest, however, that irrigation water application beginning at the later stages of sunflower growth may not effect the 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.

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Key words: water management, application time, sunflower

PARP: I:2, IV:3,4

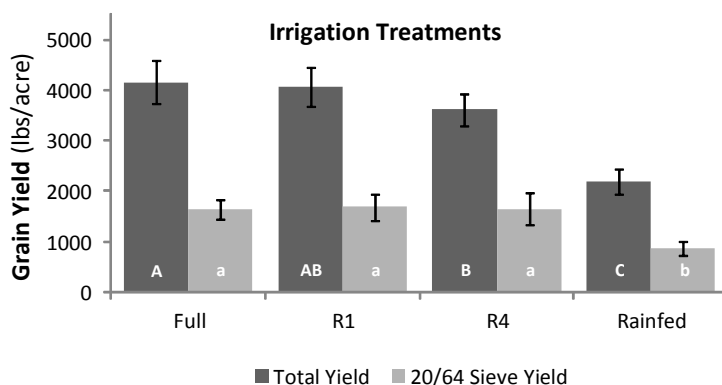


Figure 2: Yield results from October 13, 2010, sunflower grain harvest. Means of total yield with the same uppercase letter are not significantly different ($p < 0.05$). Means of 20/64 yield with the same lower case letter are not significantly different ($p < 0.05$).

Phosphorus Fertilizer Management in Sugarbeets

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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

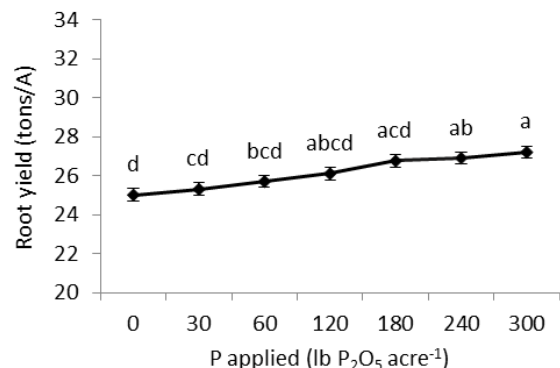


Figure 1: Effect of P₂O₅ rates on root yield.

(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.

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Key words: sugarbeets, phosphorus, sugar yield

PARP: I:2, II:1

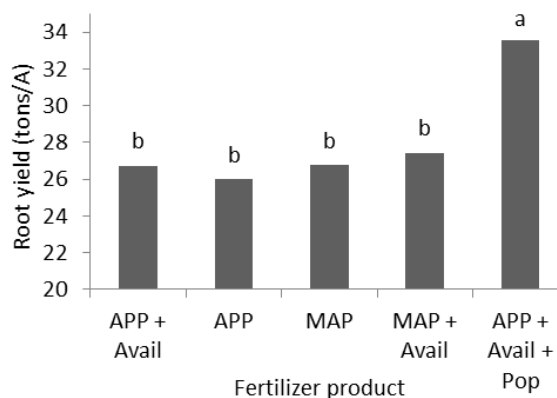


Figure 2: Effect of fertilizer product on root yield.

Yield of Confection Sunflower as Affected by Planting Date and Irrigation

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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 suggest that planting 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

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Key words: irrigation management, planting date, confection sunflower

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

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

Planting date	Yield (lb/A) [‡]	
	Total	Yield 20/64 [*]
May 30	5,071a	3,998a
May 20	4,502b	3,450b
June 10	3,845c	2,919c [§]
May 10	3,758c	2,781c [§]
June 20	3,696c	2,714c
May 1	2,848d	2,046d
June 29	2,745d	1,922d

[‡] Within columns, means with the same letter (a–d) are not significantly different at $p \leq 0.05$.

^{*} 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	Yield (lb/A) [‡]	
	Total	Yield 20/64
June 10	5,386a	4,516a
June 4	5,172a	4,475a
May 23	4,663ab	4,177a
May 9	4,021bc	3,782ab
May 3	3,390c	3,157b

[‡] Within columns, means with the same letter (a–d) are not significantly different at $p \leq 0.05$.

Planting Date Effect on Corn Yield and Water Productivity in the Bighorn Basin

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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

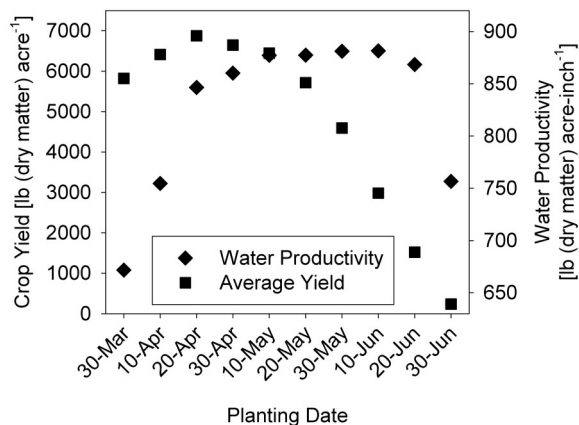


Figure 1. Average simulated corn yield and water productivity for climate data between 1980–2009.

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

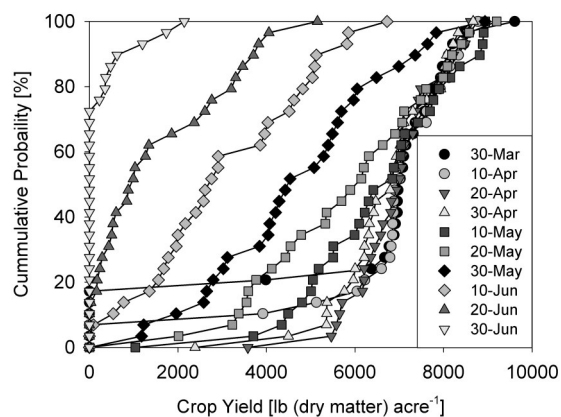


Figure 2. Yield-probability curves for the simulated planting dates.

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

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Key words: corn, planting dates, modeling

PARP: I:1, X:1,2

References

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Inter-Annual Weather Variation at Powell R&E Center

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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_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_o (Figure 1).

Results and Discussion

The four years of environmental monitoring provided valuable information for agriculture-related research and

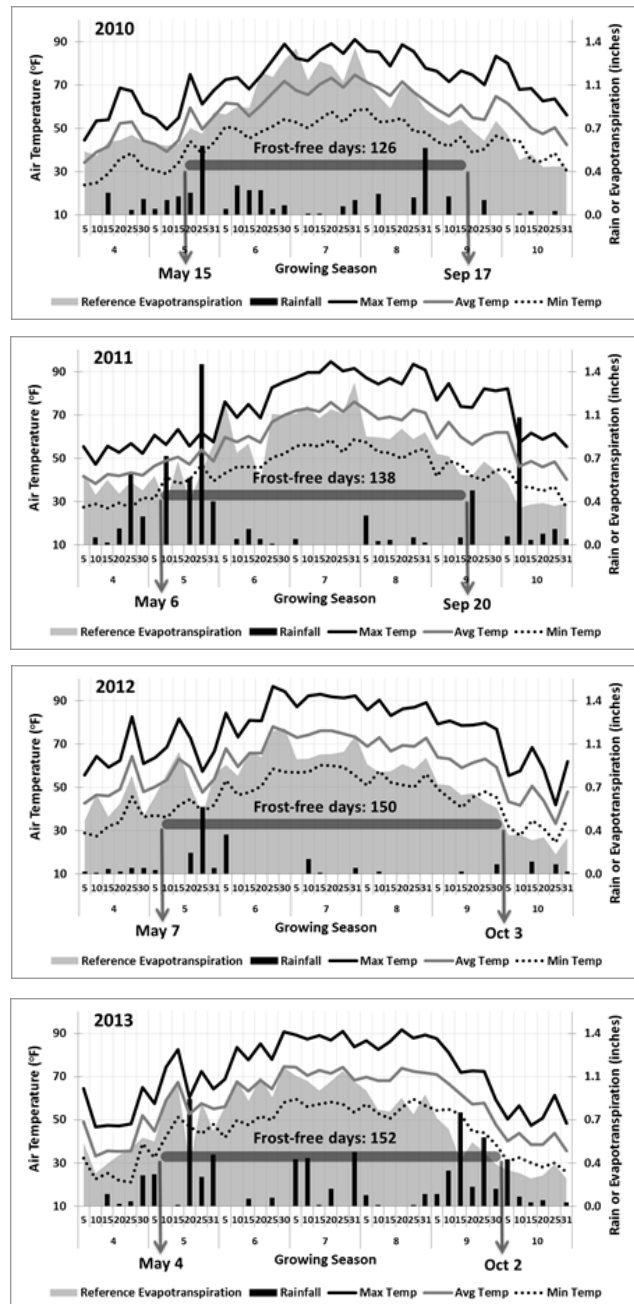
decision-making among producers. During the four-year period, the growing season (number of frost-free days) was as short as 126 days in 2010 and as long as 152 days in 2013. During the 2012 growing season, rainfall was less than 2 inches, while in 2011 and 2013 more than 6.5 inches were recorded. The 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.

Figure 1. Summary of weather conditions from 2010 to 2013 at PREC.



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Key words: weather, evapotranspiration, temperature

PARP: I:2, II:2, VI:8

Short- and Long-Term Weather Variation at the Powell R&E Center

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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_o), an indication of plants' water needs, peaks in July, with the next highest totals in June and August. Both solar radiation and ET_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).

Month	2010	2011	2012	2013	Normal	2010	2011	2012	2013	Normal*
	Average Monthly Maximum Temperature (°F)					Total Monthly Rainfall (inches)				
Apr	57.5	53.3	64.2	53.2	58.4	0.4	1.0	0.2	0.4	0.5
May	60.7	59.2	68.4	68.5	67.1	1.1	3.1	0.8	1.8	1.3
Jun	76.5	76.0	84.9	80.7	75.2	0.8	0.2	0.3	0.1	1.3
Jul	85.9	90.5	91.3	87.8	84.6	0.2	0.1	0.2	1.4	0.8
Aug	83.4	87.9	87.0	87.5	84.6	0.9	0.4	0.0	0.2	0.5
Sep	75.4	78.6	78.9	74.2	72.6	0.3	0.5	0.1	2.0	0.7
Oct	66.1	62.5	57.4	52.4	59.1	0.1	1.4	0.2	0.6	0.6
Month	Average Monthly Temperature (°F)					Average Monthly Solar Radiation (MJ m ⁻² d ⁻¹)				
	Apr	44.1	41.7	49.4	40.2	44.4	21.9	17.8	21.0	19.4
May	48.7	49.3	54.6	56.1	53.9	23.4	18.7	23.4	22.1	
Jun	62.9	61.9	68.8	65.8	61.3	26.5	26.0	27.8	27.8	
Jul	70.2	73.4	74.5	71.9	68.9	27.2	28.4	24.5	26.2	
Aug	67.5	70.1	70.0	70.8	67.7	22.2	23.1	22.6	21.6	
Sep	58.2	60.8	61.6	60.4	56.8	19.2	19.3	18.8	15.1	
Oct	51.0	48.2	43.6	40.0	44.6	12.0	12.5	10.6	10.6	
Month	Average Monthly Minimum Temperature (°F)					Average Monthly Ref Evapotranspiration (inches)				
	Apr	30.7	28.7	34.1	27.1	30.4	3.4	2.9	3.4	2.6
May	36.8	39.6	40.1	44.2	40.7	3.9	3.3	4.4	4.2	
Jun	49.8	47.2	52.3	49.9	47.4	6.1	5.3	5.9	5.7	
Jul	54.4	56.3	58.0	56.9	53.2	7.3	6.7	5.9	6.1	
Aug	52.6	53.4	53.1	55.5	50.8	5.8	5.3	5.2	5.0	
Sep	42.9	44.0	45.6	48.2	41.0	4.3	3.9	3.8	3.0	
Oct	37.7	36.0	31.0	29.5	30.1	2.8	2.1	1.7	1.6	

*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.

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Key words: automated weather station, normals

PARP: X:1

Forage and Seed Yield Potential of Tall Fescue Under Irrigated Conditions

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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

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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.

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

*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

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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.

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Key words: kochia, herbicide resistance, crop rotation

PARP: I:3,7,9, III:1,7, VII:4,7, VIII:2, IX:1

2013 Dry Bean Performance Evaluation

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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[®] and 14 ounces Establish[™]. 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

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Key words: dry bean, performance evaluation

PARP: VIII

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

Name	Market class	Yield lbs./A	Seeds per pound	50% Bloom days after planting	Pod Maturity days after planting
Eclipse	Black	3750	2134	59	98
Zorro	Black	3493	2158	58	97
T-39	Black	3115	2272	60	101
Majesty	DRK	3219	632	56	97
Coyne	GN	3698	1291	55	90
GN9-4	GN	3299	1277	56	96
OAC Inferno	LRK	3352	743	55	94
CELRK	LRK	2460	751	54	89
Rexeter	Navy	3521	2320	56	102
Rosetta	Pink	3161	1400	57	95
UCD 9634	Pink	3150	1299	55	92
PT11-9	Pinto	4327	1285	55	97
Windbreaker	Pinto	4226	1175	57	96
Lariat	Pinto	4052	1085	56	99
ISB 19	Pinto	4015	1177	56	96
Maverick	Pinto	3830	1201	57	99
Medicine Hat	Pinto	3826	1110	56	95
ISB 21	Pinto	3603	1102	54	92
ISB 20	Pinto	3518	1107	53	91
PT9-6	Pinto	3423	1265	57	97
Othello	Pinto	3239	1191	53	86
ISB 18	Pinto	3215	1146	56	92
SVS-0863	Yellow	3370	1094	59	99
Canario 707	Yellow	3314	891	56	97
Mean		3507	1296	56	95
CV		15	4	4	4
LSD		751	80	3	6

Introduction to the James C. Hageman Sustainable Agriculture Research and Extension Center

J. Freeburn¹

¹Director, James C. Hageman Sustainable Agriculture Research and Extension Center.

Introduction

The James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle began with the purchase of the first property in 2002. SAREC is a facility where integrated, systems-oriented research takes place. It has nearly 400 acres of irrigated cropland, more than 1,000 acres of rain-fed cropland, and more than 2,000 acres of native range and improved pasture along with a feedlot capable of handling both cattle and sheep.

SAREC staff is dedicated to conducting research that benefits the agricultural community in southeast Wyoming and beyond. Approximately 75 projects are completed each year. These range from long-term projects funded from National Institute of Food and Agriculture grants to small projects completed at the suggestion of SAREC focus group leaders.

In 2014, SAREC employees are establishing permanent vegetative cover on about 150 acres of dryland crop ground. This will be accomplished by planting spring triticale and then adding grass and other plant mixtures prescribed by the Wyoming Reclamation and Restoration Center. These lands will be used to enhance

grazing capacity and research on livestock projects at SAREC.

Background Information

Weather at SAREC has been highly varied the past few years (Table 1). Precipitation in 2009, 2010, and 2011 was above normal each year (13.84" is the 30-year average), while 2012 was the driest year in recorded history in this area of southeast Wyoming (5.41"). Dryland crop yields and range production were very low in 2012, but rebounded in 2013. Due to a wet fall, annual precipitation in 2013 ended slightly above normal (15.33"). Temperatures for the 2013–14 winter were below normal, but crops (Figure 1) and livestock came through in good condition.

Facility Improvements and Activities

SAREC has matured as a research center in recent years, but a new windshield-wiper pivot (one that can reverse direction) is being added in 2014. An old shop that

Table 1. SAREC precipitation, 2008–2014.

Month	2008 Precip	2009 Precip	2010 Precip	2011 Precip	2012 Precip	2013 Precip	2014 Precip	30-Year Avg Precipitation
January	0.10	0.46	Trace	0.18	0.1	0.20	0.23	0.31
February	0.18	0.15	0.92	0.18	0.21	0.60	0.82	0.40
March	0.25	0.66	1.04	0.99	0.00	T		0.70
April	0.42	2.57	3.38	2.37	0.30	2.05		1.68
May	1.91	0.91	2.62	4.57	1.19	1.86		2.54
June	2.43	3.27	4.31	1.97	1.24	1.65		2.09
July	1.40	0.86	1.01	1.08	0.82	0.59		1.78
August	2.44	3.45	0.85	1.11	0.00	1.59		1.19
September	1.04	0.65	0.00	0.13	0.37	2.45		1.27
October	0.55	1.64	0.95	1.84	0.93	3.67		0.95
November	0.34	0.12	0.55	0.43	0.11	0.4		0.57
December	0.04	0.37	0.59	0.25	0.14	0.27		0.36
Total	11.1	15.11	16.22	15.1	5.41	15.33	1.05	13.84

collapsed in a wet spring snowstorm in April 2013 is being reconstructed. A newly acquired stripper header will also be used to harvest small grains in 2014 in an effort to retain stubble and reduce wind erosion.

Numerous groups from southeast Wyoming—and some from around the globe—visit SAREC each year for educational programs and tours. The past year was no exception, and groups ranging from local schools to international tours were hosted.

Rogers Research Site

The Rogers Research Site (Figure 2) at Fletcher Park, near Laramie Peak, is also part of the SAREC mission. A wildfire in July 2012 swept through the entire property. More than 98% of the trees perished, and a reservoir became heavily silted. The incident, however, provides a unique research opportunity, and the Wyoming Agricultural Experiment Station

(WAES) is supporting a new research project there led by University of Wyoming Professor Emeritus Stephen Williams. The project encompasses nearly 50 acres of burned forest lands and will examine the effects of various timber-harvest and revegetation strategies to determine long-term consequences of post-fire management. Fences and water developments are also being rebuilt or rehabilitated.

Acknowledgments

The dedication and effort of the SAREC team cannot be overstated. The employees at SAREC make research possible, and we are indebted to them for the work they do to serve the agricultural community. Our work is funded in part by the WAES.

Contact Information

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Figure 1. 2013 SAREC corn harvest.



Figure 2. Rogers Research Site near Laramie Peak.

Short Format Reports—SAREC

1. Assessment of alfalfa pest management challenges in Wyoming

Investigators: Randa Jabbour and Shiri Noy

Issue: Alfalfa hay—the highest-value crop in Wyoming—is susceptible to a suite of insect pests. Considerable economic and environmental costs of chemical pest management highlight a critical need to develop more effective and efficient control strategies.

Goal: We will define farmer priorities statewide using a combination of focus groups and surveys. Focus groups will be composed of alfalfa growers from six counties, encompassing both hay and seed producers.

Objectives: Specific objectives are to define farmer priorities and decision-making strategies regarding alfalfa pest management and incorporate this information into the University of Wyoming agroecology curriculum and UW Extension materials for statewide distribution.

Impact: Results should assist growers in managing insect pests in alfalfa more efficiently and effectively. Incorporation of farmer priorities into the UW agroecology curriculum should better prepare agriculture students for decision-making using a regionally relevant example.

Contact: Randa Jabbour, rjabbour@uwyo.edu or 307-766-3439.

Key Words: alfalfa pests, decision-making, focus groups

PARP: X:2

2. Use of perennial and annual flowers to attract beneficial insects to alfalfa

Investigator: Randa Jabbour

Issue: Alfalfa weevil and aphids are major pests of alfalfa hay in Wyoming. Beneficial insects that can kill and consume these pests also require alternate resources such as flower nectar to survive. These beneficial insects may increase their pest control activities in response to increased flower resources.

Goal: We will test whether planting strips of flowers in alfalfa fields improves biological control of alfalfa insect pests.

Objectives: Specific objectives are to compare the effect of annual and perennial flowering strips on biological control of insect pests of alfalfa hay in a study at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle.

Impact: Results should assist growers in deciding whether there is pest management value in incorporating flowering strips into alfalfa hay operations. The flower species used in the study have already been recommended by the Natural Resources Conservation Service for the purpose of pollinator conservation, so this study will evaluate whether these flowering species are capable of providing multiple functions to growers. More information about pollinator conservation and flowering species is at www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/pollinate/

Contact: Randa Jabbour, rjabbour@uwyo.edu or 307-766-3439.

Key Words: alfalfa, biological pest control, flowering strips

PARP: I:1–2, X:2

3. Evaluating guar bean production in SE Wyoming for yield and production practices

Investigator: Brian Lee

Issue: Interest in guar bean production has increased recently due to increases in demand. The crop is not typically produced in southeast Wyoming, but could be of great value to local producers. Guar is a fairly drought tolerant annual legume that works well in crop rotations. Demand is rising, in part, due to the use of guar gum in hydraulic fracturing, a technique used to release oil and gas from certain formations.

Goal: The goal is to evaluate guar bean production and to increase interest in this alternative crop through demonstration plots at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle.

Objectives: Specific objectives include evaluation of production practices for optimal growth and yield and performing a cost-benefit analysis.

Impact: Results should 1) assist area farmers in deciding whether to grow guar bean as a viable alternative crop and 2) help farmers achieve optimum growth and yield.

Contact: Brian Lee, blee@uwyo.edu or 307-837-2000.

Key Words: guar bean, alternative crops, legumes

PARP: 1:2, IX:1, X:3

4. SAREC wind turbine update

Investigators: Brian Lee and John Ritten

Issue: Installing a wind turbine offers “green” benefits, in part, because the energy it produces is renewable. But can small turbines save landowners money?

Goal: The goal of this study is to examine the feasibility of installing a small wind generator in areas of Wyoming such as Goshen County.

Objectives: Specific objectives are to study the cost-effectiveness of a Skystream 3.7 wind generator over its anticipated lifespan of 20 years.

Impact: A Skystream 3.7 was installed in 2010 at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle at a total project cost of \$12,727. Data produced over 20 years should help landowners make an educated decision about whether to install a small-scale wind turbine on their property. Preliminary results can be found at:

- 1) www.uwyo.edu/uwexpstn/centers/sarec/
- 2) www.facebook.com/UWSAREC
- 3) Or on pages 97–98 in the 2013 *Field Days Bulletin* at www.uwyo.edu/uwexpstn/publications/

Contact: Brian Lee at blee@uwyo.edu or 307-837-2000.

Key Words: sustainable energy, wind production

PARP: XI:1

5. Winter forage crops as a supplement to cornstalk grazing in integrated crop/livestock systems in southeast Wyoming

Investigators: Jenna Meeks, Andrew Kniss, and Brian Mealor

Issue: Winter feed is typically one of the most costly aspects of beef cattle production so producers commonly graze cornstalks, a relatively low-cost, low-quality feed source. Protein and mineral supplementation is typically required to improve animal feed intake and performance.

Goal: Our goal is to increase forage quality and quantity in post-harvest corn fields to reduce the need for supplemental winter feed in integrated crop/livestock farming operations.

Objectives: Objectives are to determine the optimal 1) species of forage (e.g., grasses, legumes, and brassicas) for establishment within a corn crop and 2) seeding time to increase winter forage crop production while minimizing negative effects on corn yield.

Impact: Results should aid producers in decreasing feed costs by reducing the need for traditional feed supplements if high quality forage species could be established in the field prior to grazing cornstalks.

Contact: Jenna Meeks, jmeeks8@uwyo.edu or 307-837-2000.

Key Words: cattle grazing, forage, cornstalk

PARP: I:2,4,6, II:5, VII:2,6

6. Evaluating heifer diet selectivity, performance, and economics of two growing rations

Investigator: Steve Paisley, Beth Burritt, and Larry Howe

Issue: Many ranching operations lack the equipment to grind, mix, and deliver mixed-ration diets when developing replacement heifers. Therefore, other low-input ration delivery methods need to be evaluated.

Goal: The goal is to evaluate the feasibility of allowing yearling beef heifers to select their own growing diets by supplying individual component feeds.

Objectives: A specific objective is to compare animal performance, diet selection, feed efficiency, and overall economics of traditional total mixed rations (TMRs) vs. providing individual ration ingredients and allowing heifers to select their own diet.

Impact: Feed costs and overall heifer development costs may be impacted depending on heifer performance, overall health, and feed conversion.

Contact: Steve Paisley, spaisley@uwyo.edu or 307-760-1561.

Key Words: efficiency, diet selection, beef cattle

PARP: I:1, V:1,7

7. Evaluating registered yearling Hereford and Angus bulls for feed efficiency and RFI

Investigators: Steve Paisley, Robert Baumgartner, and Larry Howe

Issue: Because of rising feed and operating costs, there is an increasing industry demand for improved feed efficiency.

Goal: The goal is to better understand genetics and select bulls for improved efficiency.

Objectives: Specific objectives are to evaluate locally produced registered Angus and Hereford yearling bulls for performance, feed intake, feed efficiency, and residual feed intake (RFI) on a predominantly forage-based growing ration.

Impact: Efficiency is a moderate to highly heritable trait. Results from efficiency testing should assist seedstock producers in better understanding efficient bloodlines and improving the overall efficiency of seedstock genetics offered to commercial beef producers in Wyoming and beyond.

Contact: Steve Paisley, spaisley@uwyo.edu or 307-760-1561.

Key Words: efficiency, RFI, beef cattle

PARP: I:1, V:1,7,8

8. Economic impacts of climate change and drought on Wyoming ranchers

Investigators: Tucker Hamilton, John Ritten, Christopher Bastian, Scott Lake, Dallas Mount, Steve Paisley, Dannele Peck, Justin Derner, and Justin Reeves

Issue: Increases in climate variability can have major economic consequences for Wyoming livestock producers. Cow/calf producers especially are vulnerable to any changes in annual forage availability as altering herd size is both costly and time consuming.

Goal: The goal is to help producers understand and prepare for the economic implications associated with increases in climate variability.

Objectives: Specific objectives include evaluation of alternative stocking and risk management strategies to help producers endure increased periods of drought.

Impact: Results should assist producers in understanding the implications of, and preparing for, increased climate variability. An economic analysis of alternative strategies to respond to increased climate variability should help producers better withstand increased periods of drought.

Contact: John Ritten, jritten@uwyo.edu or 307-766-3373.

Key Words: livestock production, climate variability, drought

PARP: V:7, VI:1, VII:2,6, X:1

9. Efficacy of a one-time in-furrow fungicide treatment for season-long Rhizoctonia control as influenced by sugarbeet replant date

Investigator: William Stump

Issue: Because of unforeseen frost and hail events, growers sometimes are faced with having to replant sugarbeet crops typically into warmer soil temperatures, which are more favorable to Rhizoctonia disease development. Because of shrinking profit margins under this scenario, growers may need to limit pest-management inputs to a single fungicide application.

Goal: The goal is to determine if a single in-furrow fungicide application at replant is sufficient to protect the sugarbeet crop until harvest from Rhizoctonia impacts.

Objectives: Specific objectives will be to compare the efficacy of various in-furrow fungicide treatments at three different replant dates in terms of Rhizoctonia disease incidence and severity and final yield and sugar content.

Impact: Results should assist growers in selecting the most effective fungicide treatments for season-long control.

Contact: William Stump, wstump@uwyo.edu or 307-766-2062.

Key Words: Rhizoctonia, sugarbeet, fungicide efficacy

PARP: None applicable

Establishing Forage Kochia in Diverse Environments in Wyoming

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¹Department of Plant Sciences.

Introduction

Restoration of deteriorated areas caused by overgrazing, intensive cultivation, fire, and energy/mineral extraction is a challenging task. Planting of desirable introduced plant species may be an effective way to reclaim and restore areas that are degraded, burned, disturbed, and dominated by invasive weeds where establishment of native species would be unsuccessful. Introduced perennial species such as forage kochia (*Bassia prostrata*) have demonstrated their ability to compete with invasive weeds such as cheatgrass (*Bromus tectorum*) and halogeton (*Halogeton glomeratus*).

Forage kochia is a long-lived, semi-evergreen half-shrub that is native to the arid and semiarid regions of central Eurasia. (Half-shrub is a perennial with a woody base and herbaceous upper stems.) It is highly palatable and provides excellent forage for livestock and many wildlife species. Forage kochia is an extremely drought and salt tolerant species that can persist on disturbed harsh soils where other plant species are not suitable; however, it loses seed viability quickly during storage and has low germination. Therefore, successful stand establishment is challenging and hinges on many factors

such as seed viability and quality, companion species, planting time, planting method, weather condition, and management practices.

Objectives

Objectives of this field experiment are to: 1) determine the potential of forage kochia to reclaim and revegetate degraded areas, 2) evaluate the suitability and establishment of different grass mixtures with forage kochia, and 3) develop management strategies of forage kochia for Wyoming conditions.

Materials and Methods

The study is being conducted at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Species being tested are 'Immigrant' forage kochia, four native perennial grasses (thickspike wheatgrass, bluebunch wheatgrass, basin wildrye, and western wheatgrass), and two introduced perennial grasses ('Hycrest' crested wheatgrass and tall fescue). The experimental design is a split-plot randomized complete block with four replications under two field conditions. Each replication has three planting times (winter dormant on top of snow, winter dormant on soil, and summer). Each



Figure 1. Broadcasting seeds on top of snow during winter dormant planting in March, 2014.

planting time has eight seeding mixture treatments: 1) forage kochia, 2) four native grasses, 3) forage kochia with four native grasses, 4) forage kochia with crested wheatgrass, 5) forage kochia with tall fescue, 6) forage kochia with two introduced grasses, 7) forage kochia with four native grasses and two introduced grasses, and 8) one untreated control. Winter dormant on top of snow planting (Figure 1) and winter dormant drill seeding were completed on March 3 and April 8, 2014, respectively. The third planting will be conducted in summer 2014.

In addition, 'Immigrant' forage kochia was planted on a producer's field (degraded pasture in Shirley Basin, Wyoming) on January 23, 2014.

Results and Discussion

Data will be collected during summer and fall 2014. Data collection will include

emergence, plant coverage, plant canopy height, forage yield, forage quality, and weed coverage. Data generated from this study should help us to successfully establish forage kochia in degraded lands either as a sole species or as a mixture with other grass species. It is anticipated that completing this study will help to develop not only establishment tools of forage kochia, but also management strategies. This information should be helpful for not only academics and researchers, but also agricultural producers, the managers of land (both private and public) and industry personnel who want to improve degraded range and pasture lands. Our findings should identify directions for future research to enhance management strategies for reclaiming a wide range of degraded western rangelands.

Acknowledgments

The project is funded by the University of Wyoming Energy Graduate Assistantship Initiative. We thank SAREC staff and forage lab members for assistance.

Contact Information

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Key words: forage kochia, reclamation, invasive weeds

PARP: I:1,2, VI:8, X:2,3, XII:1

Feedlot Performance and Profitability of Cattle Fed Either a Mixed Ration or Allowed to Select Their Diet

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¹Utah State University, Logan, Utah; ²Department of Animal Science.

Introduction

Total mixed rations (TMRs) are often fed to finish cattle prior to slaughter. TMRs are nutritionally balanced for the needs of the “average” animal, but up to half the animals in a group may differ in nutritional needs compared with the “average”. Thus, feeding TMRs may negatively affect productivity of some individuals.

Ruminants fed a choice of feeds can select a diet to meet their unique nutritional needs. Giving ruminants a choice of feeds may increase gains, improve feed efficiency, and reduce stress compared to feeding TMRs.

Offering animals feed choices may also enable producers to finish their own cattle without the cost of a nutritionist or mixing feed. If feed prices are low relative to cattle prices, finishing their animals may improve profits.

Objectives

Our objective was to determine how offering cattle a choice of feeds or a TMR containing those feeds would affect production and cost of gain for cattle.

Materials and Methods

We purchased 36 yearling heifers from the Torrington Livestock Auction. Heifers were

trucked to the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) on May 21, 2013, and were fed a growing ration for 30 days.

Heifers were then fed using two methods. One group (mixed) was fed a mixed ration containing 60% whole corn, 25% haylage, and 15% alfalfa pellets. The other group was fed the same ingredients used in the mixed ration, but feeds were placed in separate feeders and animals were allowed to select their own diet (choice). The nutritional analyses of feeds used in the trial are in Table 1. The feeding trial had two treatments with two replications and nine heifers per replication.

Table 1. Nutritional analyses of feed ingredients used in the trial.

Nutrient in Feed	Corn	Pellets	Haylage
Dry matter, %	83.8	92.1	30.9
Crude protein, %	8.1	17.7	18.7
Total digestible nutrients, %	83.2	60.1	59.5

The GrowSafe system used to feed heifers automatically records feed intake each time an animal eats. Intake was recorded from July 15 to September 26, 2013.

Heifers were weighed three times during the trial. The cost of feeds on a dry matter basis (DMB) was \$0.13/lb for corn, \$0.24/lb for alfalfa pellets, and \$0.16/lb for

Table 2. Productivity of heifers offered a choice of feed ingredients or a mixed ration.

Production Variable	Choice	Mixed
Average daily intake (lb/d)	21.7	21.4
Body weight (lb)	1,186	1,188
Average daily gain (lb/d)	2.6	2.6
Feed efficiency	8.4	8.5
Cost per pound of gain (\$/lb)	\$1.35	\$1.32

haylage. Thus, roughages were more expensive than corn.

After September 26, 2013, heifers were removed from the GrowSafe, housed in two pens, and fed using the same method (mixed or choice) as in the feeding trial. On December 19, they were weighed and sold for slaughter.

Results and Discussion

No differences were detected between treatments for feed intake, body weight, average daily gain, feed efficiency, or cost of gain (Table 2). Table 3 shows the variation in intake of heifers given a choice of feeds. Average feed intake on a DMB for choice group was 69% corn, 26.9% alfalfa pellets, and 4.1% haylage. Feed intake on a DMB for the mixed diet was 70% corn, 19.2% alfalfa pellets, and 10.8% haylage. Intake of corn was similar between the two treatments. Heifers in the choice group preferred alfalfa pellets to haylage probably because pellets have higher rates of intake than haylage. Quality and yield grades were similar between treatments (data not shown).

Table 3. Variation in heifer intake of different feeds offered in two different pens.

Pen1	Alfalfa		
	Pellets (%)	Corn (%)	Haylage (%)
465	39.7	56.5	3.7
538	32.1	65.7	2.2
544	26.3	71.9	1.8
547	26.4	66.0	7.6
548	26.2	71.0	2.8
552	31.2	64.8	4.0
553	30.8	67.4	1.8
555	40.7	56.9	2.4
560	33.6	61.8	4.6
Pen 2			
469	22.2	72.5	5.2
540	26.8	67.8	5.4
542	20.7	77.7	1.6
546	20.4	74.6	5.0
551	26.4	70.2	3.5
554	23.1	71.0	5.9
556	13.8	81.0	5.2
559	18.9	76.6	4.5
561	24.5	69.1	6.4

Heifers offered choice or a mixed ration had similar performance and cost of gain. Even though heifers had free access to corn, they did not suffer from bloat or acidosis. Offering cattle a choice of feeds is a viable method to finish cattle.

Acknowledgments

We thank the SAREC crew for care and feeding of trial heifers. The study was supported by a grant from Western Sustainable Agriculture Research and Education.

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Key words: cattle, feedlot, choice

PARP: I:1, V:1,5,7, VI:1, VII:6, IX:1

Grass-Legume Mixtures for Improved Forage Yield, Forage Quality, and Soil Properties

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¹Department of Plant Sciences.

Introduction

Forage harvested as hay contributes greatly to Wyoming's agricultural economy. According to Wyoming Agricultural Statistics, its value in 2012 was \$378 million (63% of the total value of crops). Despite this contribution, the productivity of forage harvested as hay in Wyoming is lower (2.0 tons/acre) than the national average (2.5 tons/ac). Factors that may contribute to this lower yield include dry and cool climate, shorter growing season, use of lower-yielding cultivars, monoculture production systems, and less than ideal management practices.

Nitrogen (N) is among the most important nutrients for forage production systems. Although chemical fertilizer application is a common practice to increase forage productivity, it 1) increases production costs, 2) degrades soil properties by increasing soil acidity and decreasing soil organic matter, and 3) can pollute groundwater and aquatic environments if not carefully applied and managed. Natural fertilizers such as legumes fix atmospheric free N and could be a good alternative to increase yield and quality of forage, reduce production costs, and improve soil properties. Information is

lacking, however, for the optimum seeding ratio of a grass-legume mixture for improving forage yield, quality, and soil properties in Wyoming.

Objectives

The goal of this study is to improve long-term profitability and sustainability of forage production systems. Specific objectives were to evaluate the performance of different combinations of grass-legume mixtures and study effects of such mixtures on soil carbon (C) and N status.

Materials and Methods

The experiment was established in fall 2011 at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. The study consisted of 16 treatments with different seeding ratios of two grasses (meadow bromegrass and orchardgrass) and one legume (alfalfa). The treatments were replicated three times. Plots with monoculture grasses and two grasses in mixtures received either no N or 134 pounds N per acre as urea (Table 1). Plots were harvested in June, July, August, and October 2012 and 2013. Soil samples from each plot were collected and analyzed for total N and mineralizable C in July 2013.

Results and Discussion

The 50-50 mixture of alfalfa and meadow bromegrass produced the highest dry matter (DM, 6.0 tons/ac with 24% crude protein) yield in 2012. The same treatment also produced the highest DM (5.2 tons/ac with 25.6% crude protein) yield in 2013. (For more information, see the 2013 *Field Days Bulletin*, pages 25–26, at www.uwyo.edu/uwexpstn/publications .

There were variations among the treatments for total soil N and mineralizable C in the study soils (Table 1). The total soil N and mineralizable C were greatest in plots with monoculture alfalfa. The lowest total soil N was in plots having a 50-50 mixture of meadow bromegrass and orchardgrass without N. The lowest mineralizable C was in plots of monoculture meadow bromegrass without N. In general, grass-legume mixture plots had higher total soil N content than monoculture grass plots with or without N. Similar results were also observed for mineralizable C. Mineralizable C is an active fraction of soil organic C, which breaks down relatively quickly, and is an active source of nutrition for soil microbes. The increased mineralizable C in soil improves mineralization of nutrients and their availability to plants. The higher total soil N and mineralizable C in plots with higher proportions of legumes indicates that optimum grass-legume mixtures can improve soil properties and increase forage yield and quality. This is significant because producers may be able to reduce production costs by mitigating N use.

Table 1. Effects of different combinations of grass-legume mixtures on total soil N and mineralizable C at SAREC in 2013.

Treatments (ALF-MB-OG*)	Total soil N (%)	Mineralizable C (ppm**)
100-0-0	0.13	20.06
0-100-0	0.07	5.54
0-0-100	0.08	6.00
0-50-50	0.06	7.39
75-25-0	0.12	18.51
75-0-25	0.12	16.93
75-12.5-12.5	0.12	15.62
50-50-0	0.08	14.53
50-0-50	0.11	14.70
50-25-25	0.09	13.27
25-75-0	0.08	12.84
25-0-75	0.08	11.91
25-37.5-37.5	0.08	11.07
0-100-0+N [#]	0.07	9.62
0-0-100+N	0.09	8.54
0-50-50+N	0.07	8.10
LSD (0.05)	0.03	1.59

*ALF=Alfalfa; MB=Meadow bromegrass; OG=Orchardgrass; #N=Nitrogen applied at the rate of 134 lb/ac as urea; **ppm=parts per million.

Acknowledgments

We thank SAREC crews and forage lab members for assistance.

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Key words: grass-legume mixture, dry matter yield, soil nitrogen

PARP: I:2, II:5, VII:1

Evaluation of Organic and Conventional Soil Fertility Management in High Tunnels

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¹Department of Plant Sciences; ²James C. Hageman Sustainable Agriculture Research and Extension Center.

Introduction

There is increasing interest in the use of high tunnels for season extension and production of locally grown, potentially high-value vegetables in Wyoming. Nutrient requirements for vegetables produced under high tunnels tend to be greater due to relatively higher yields compared to field-grown vegetables. Sustainable nutrient management is critical in high tunnel production systems. The goal of the project is to develop sustainable nutrient-management strategies for optimal vegetable production by comparing agronomic and economic benefits of organic and inorganic soil fertility management under high tunnels.

Objectives

Specific objectives of the study are to: 1) determine the effectiveness of cattle manure compost and selected certified organic nutrient sources in comparison to inorganic fertilizers (conventional) on growth, yield, and quality of selected vegetables; 2) assess the impact of the organic nutrient sources on soil quality indicators such as soil carbon (C), nitrogen (N), phosphorus (P), and potassium (K); and 3) compare the economic viability of

selected organic materials to inorganic fertilizer based on their effect on vegetable yield and soil nutrient availability.

Materials and Methods

The experiment is being conducted in a high tunnel at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Eighteen raised seedbeds were installed with local soil mixtures as growth media. A drip irrigation system with timer was also installed to each seedbed to supply water as needed. Temperatures are being recorded regularly with an installed thermometer in the high tunnel. Initial soil tests showed high and variable N concentrations in the soil mixture, so no fertilizer treatment was applied in the initial study with the aim to utilize the most nutrients, especially N, in the soil. Two vegetable species (bell pepper and tomato) and two varieties from each were used in the study. Varieties include 'California Wonder' and 'Keystone Giant' peppers and 'Betterboy' and 'Bushmaster' tomatoes. Two plants per variety were transplanted into the seedbeds May 9, 2013. Vegetative growth, number of fruits, and fruit quality as shape and size were

monitored throughout the growing season. Fruit harvesting started in July, 2013, with 2–6 harvests per month, and continued until October, 2013. Tomato and pepper seedlings were transplanted into the high tunnel in late April/early May, 2014. Prior to planting, seedbeds were tilled and peat moss was incorporated into the soils to improve soil structure (Figure 1).

Results and Discussion

Preliminary analysis showed that there was no effect of seedbed, plant, variety, and species × variety interaction on total fruit yield per plant. As expected, however, there was highly significant effect of species on total fruit yields. Average fruit yield for pepper was 4.6 pounds per plant (4.1 for California Wonder and 5.2 for Keystone Giant) while the average fruit yield for tomato was 21 pounds per plant (22.0 for Betterboy and 20.4 for Bush-master). Fruit yield per plant, especially for tomato, was very high, and it is expected that the growth and fruit yield will be more influenced when all organic and inorganic fertilizer treatments are imposed in the ongoing and next growing season.

To utilize the nutrients and N in the raised seedbeds during winter and spring, spinach and radish were planted in the fall (2013). Radish did not survive the winter, but spinach did and grew well into spring 2014. As early season crop cultivation, radish, spinach, and carrots were planted on March 20, 2014.



Figure 1. Tilling seedbeds for incorporating peat moss in the high tunnel at SAREC.

An economic comparison will be performed to determine the viability of selected organic materials to inorganic fertilizer based on their effect on vegetable yield and soil nutrient availability. Results from this comparison could be very valuable to growers (both commercial and non-commercial) for improving yields and vegetable quality in a high tunnel organic vegetable production system. It could also aid educators and others with demonstration projects and continued research.

Acknowledgments

We thank the Wyoming Department of Agriculture Specialty Crop Block Grant Program for funding, and SAREC staff for assistance.

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Key words: high tunnel, specialty crop, organic nutrient

PARP: I:2, II:8, VII:1

Controlling Glyphosate-Resistant Kochia in Roundup Ready® Corn with Herbicides that Allow Rotation to Sugarbeet

A.R. Kniss¹ and R.G. Wilson²

¹Department of Plant Sciences; ²University of Nebraska–Lincoln.

Introduction

Although not yet found in Wyoming, glyphosate-resistant (GR) kochia has become widespread in western Kansas and has recently been confirmed in Nebraska, Colorado, and Montana. Multiple tactics will need to be used to manage GR kochia once it shows up in sugarbeet rotations. It is critical that we focus on kochia management in all crops in the rotation, not just in sugarbeet. Ironically, though, use of a crop rotation will also limit the available herbicide options. For example, many corn herbicides provide excellent control of kochia (a summer annual weed), but will not allow rotation to sugarbeet the following year. It is important that we determine which herbicide programs in corn will provide the best control of GR kochia and will also allow planting of Roundup Ready® sugarbeet the following year.

Objectives

Our objective was to evaluate corn herbicides for kochia control that allow rotation to sugarbeet or dry bean the following year.

Materials and Methods

Field studies were conducted near Lingle, Wyoming, and Scottsbluff, Nebraska, in

2012 and 2013. Corn was planted in 30-inch rows (Lingle) and 22-inch rows (Scottsbluff) between May 7 and May 13 both years. Herbicide treatments were applied at 16.8 gallons (Lingle) and 20 gallons (Scottsbluff) of total volume per acre at 30 psi with TeeJet® 11002 nozzles. Plots were 10 feet wide by 30 feet long at Lingle, and 11 feet wide by 45 feet long at Scottsbluff. The experiment was a randomized complete block with four replicates at each location. Kochia control was evaluated approximately 14 days after post-emergence (POST) herbicide application at all sites.

Results and Discussion

Preemergence (PRE) herbicides followed by Roundup® POST provided at least 87% kochia control in 2012 and more than 97% in 2013. At the time of POST herbicide application, Sharpen® plus Prowl® H2O PRE provided greater control of kochia compared to Verdict® PRE (99 and 60% control, respectively) in 2012, but both treatments provided at least 97% control in 2013. Prowl H2O, however, requires at least 12 months between application and sugarbeet planting. Therefore, it will not be an option unless corn is planted early and sugarbeet planted late.

Status® provided the greatest and most consistent kochia control of any POST treatment, averaging 95% across locations and years (Figure 1). Laudis® plus Buctril® was the only other treatment to provide greater than 90% kochia control when averaged over locations and years. All other POST treatments provided variable kochia control.

Based on these results, a PRE treatment of Verdict followed by Status plus Roundup POST would provide excellent season-long kochia control in corn and be an excellent treatment to proactively manage glyphosate-resistant kochia. This treatment will contain three separate herbicide modes of action that are

effective on kochia (saflufenacil, PPO; dicamba, auxin; glyphosate, EPSPS). The cost of this treatment would be roughly \$45/acre and will allow rotation to sugarbeet the following year.

Acknowledgments

The study was funded by the Western Sugar Cooperative-Grower Joint Research Committee.

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Key words: kochia, sugarbeet, herbicide resistance

PARP: I:3, III:1,7, X:1

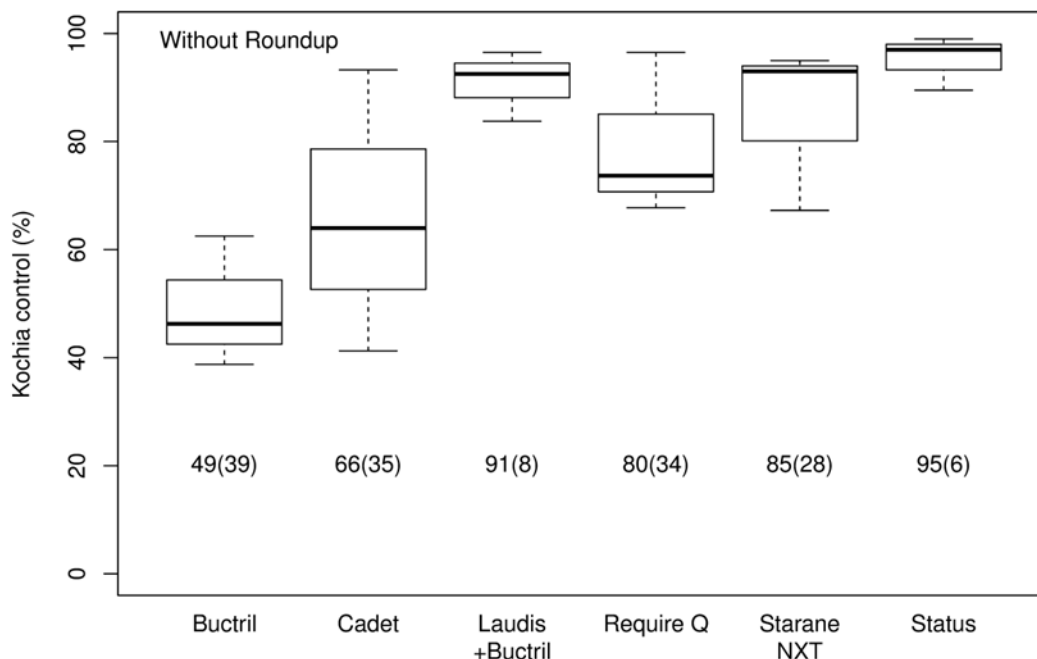


Figure 1. Kochia control from postemergence herbicide programs averaged over four environments.

Controlling Glyphosate-Resistant Kochia in Roundup Ready® Sugarbeet

A.R. Kniss¹ and R.G. Wilson²

¹Department of Plant Sciences; ²University of Nebraska–Lincoln.

Introduction

One of the primary benefits of Roundup Ready® sugarbeet is virtually no crop injury from glyphosate applications. This was a drastic and highly beneficial change compared to conventional herbicide programs. If we cannot control kochia with glyphosate, however, we will need to return to using conventional herbicides, and, consequently, there will once again be the potential for crop injury.

Objectives

Our objectives were to evaluate Nortron® SC, UpBeet®, and Betamix® for kochia control in Roundup Ready sugarbeet.

Materials and Methods

A field study was conducted near Lingle in 2013. Sugarbeet was planted in 30-inch rows into a loam soil. Plots were 10 feet wide by 30 feet long. Experimental design was a randomized complete block with four replicates. Betamix was included in all treatments as a POST herbicide, either as a standalone application (treatments 2 through 5) or as a tank-mixture with the other POST herbicides (treatments 6 through 19).

Results and Discussion

Crop injury was minor in all treatments (data not shown). The best kochia control was obtained with a combination of Nortron SC preemergence (PRE) followed by UpBeet plus Betamix postemergence (POST) (Table 1). POST treatments were applied at the two true-leaf (TL) or four TL sugarbeet stage. A significant response to Nortron rate was observed, but increasing the rate above 24 ounces/acre had less of an effect compared to rates less than 24 oz/A. Based on this result, we recommend using Nortron at no less than 24 oz/A for kochia control. Nortron POST did not provide a significant increase in kochia control.

Acknowledgments

The study was funded by the Western Sugar Cooperative Grower Joint Research Committee.

Contact Information

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Key words: kochia, sugarbeet, herbicide resistance, glyphosate, crop rotation

PARP: I:3, III:1,7, X:1

Table 1. Kochia density and control from Nortron SC, Betamix, and Upbeet in Roundup Ready sugarbeet, Lingle, Wyoming, 2013.

Treatment ^{1,2,3}	Rate	Timing	Kochia density, plants per 100-ft row	Kochia control, %
1 Untreated Check			376	--
2 Nortron SC	40 fl oz/a	PRE	114	70
3 Nortron SC	32 fl oz/a	PRE	162	57
4 Nortron SC	24 fl oz/a	PRE	168	55
5 Nortron SC	16 fl oz/a	PRE	257	32
6 UpBeet	1 oz/a	2TL	18	95
7 Nortron SC UpBeet	40 fl oz/a 1 oz/a	PRE 2TL	10	97
8 Nortron SC UpBeet	32 fl oz/a 1 oz/a	PRE 2TL	73	81
9 Nortron SC UpBeet	24 fl oz/a 1 oz/a	PRE 2TL	20	95
10 Nortron SC UpBeet	16 fl oz/a 1 oz/a	PRE 2TL	21	94
11 Nortron SC Nortron SC	40 fl oz/a 5 fl oz/a	PRE 2TL	49	87
12 Nortron SC Nortron SC	32 fl oz/a 5 fl oz/a	PRE 2TL	95	75
13 Nortron SC Nortron SC	24 fl oz/a 5 fl oz/a	PRE 2TL	117	69
14 Nortron SC Nortron SC	16 fl oz/a 5 fl oz/a	PRE 2TL	125	67
15 Nortron SC Nortron SC	24 fl oz/a 24 fl oz/a	PRE 4TL	106	72
16 Nortron SC Nortron SC	24 fl oz/a 20 fl oz/a	PRE 4TL	72	81
17 Nortron SC Nortron SC	24 fl oz/a 16 fl oz/a	PRE 4TL	127	66
18 Nortron SC Nortron SC	24 fl oz/a 12 fl oz/a	PRE 4TL	134	64
19 Nortron SC Nortron SC	24 fl oz/a 8 fl oz/a	PRE 4TL	140	63
<i>LSD (0.05)</i>			76	

¹ all UpBeet treatments included nonionic surfactant at 0.25%; ² all POST applications of UpBeet or Nortron contained MON 56159, a blank Roundup PowerMax formulation; ³ all treatments included a POST application of Betamix at 32.5 fluid ounces per acre.

Effect of Kochia Control in Corn on Kochia Density in Sugarbeet the Following Year

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Introduction

Previous research has indicated that excellent weed management in one crop can reduce the number of germinating weeds the following year by as much as 50%. Kochia, a weedy annual tumbleweed, has a relatively short-lived seed (only two to three years); therefore, if kochia can be successfully controlled in other crops in the rotation (most notably corn), the remaining kochia population should decline and be more manageable in the sugarbeet crop. If kochia is not controlled in previous crops, however, the prolific seed production may result in a dramatic number of seedlings the following year.

Objectives

This study is being carried out in Wyoming and Nebraska to determine the impact of kochia control in corn on kochia seedling density the following year.

Materials and Methods

In 2012, herbicide treatments were applied in corn that allowed rotation to sugarbeet. Kochia density was evaluated in

the corn crop after all treatments had been applied. Kochia plants that survived herbicide treatments were allowed to produce seed. In 2013, sugarbeet was planted in the same location. Kochia density in the sugarbeet crop was then evaluated to determine the effect of kochia control in corn on kochia density in sugarbeet the following year.

Results and Discussion

Kochia control in the 2012 corn crop was strongly correlated with kochia density in the 2013 sugarbeet crop ($p < 0.001$; correlation coefficient = 0.48). On average, each kochia plant that survived treatment in 2012 resulted in a more than 100-fold increase in the number of seedlings the following year (Figure 1). Kochia can produce many thousands of seeds per plant if uncontrolled, and this result emphasizes the impact that good kochia control in corn can have on weed control the following year. Preventing kochia seed production should be a top priority in all crops.

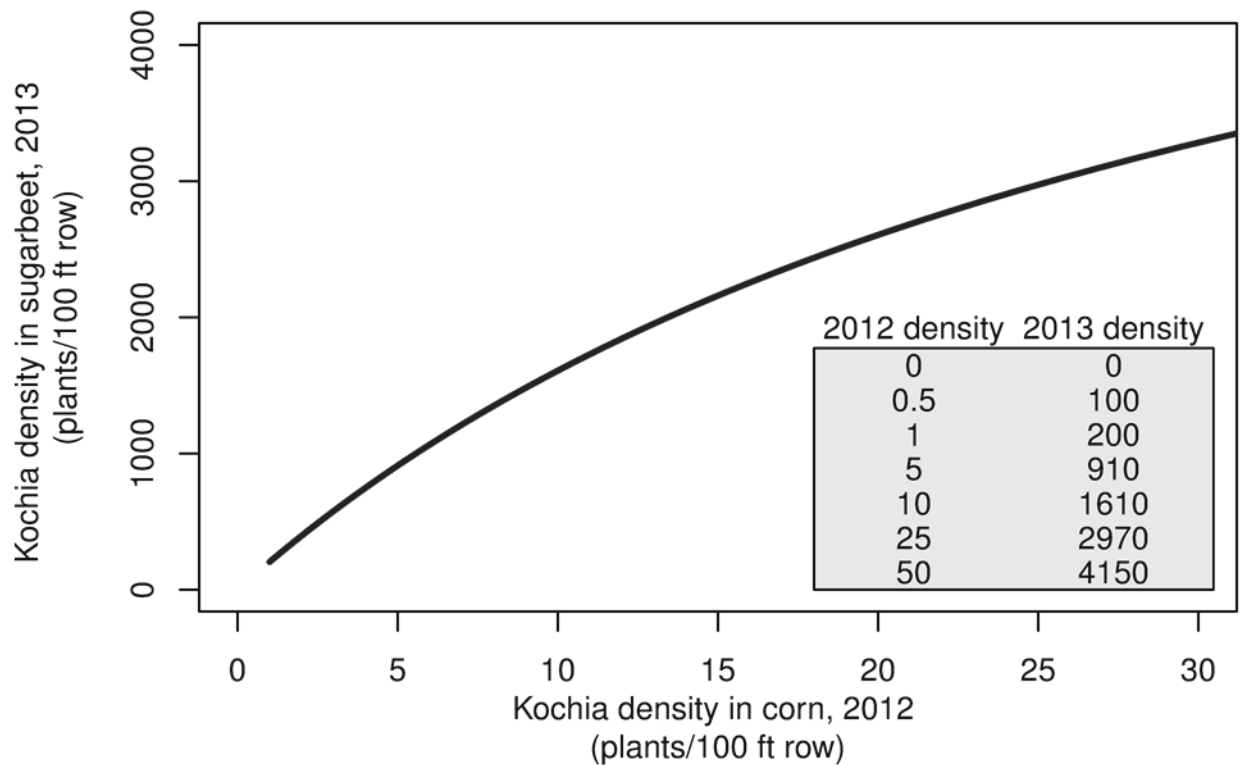


Figure 1. Effect of kochia density in corn (2012) on kochia seedling density in sugarbeet the following year (2013).

Acknowledgments

The study was funded by the Western Sugar Cooperative Grower Joint Research Committee.

Key words: kochia, sugarbeet, corn

PARP: I:3, III:1,7, X:1

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2013 Irrigated Corn Variety Trial: Goshen County

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Introduction

Variety performance evaluations conducted by the Wyoming Agricultural Experiment Station (WAES) are a continuous and ongoing program. In cooperation with the University of Nebraska and private seed companies, WAES evaluates numerous varieties/lines of corn each year.

Objectives

Testing of corn varieties is conducted to help growers select varieties adapted to the region.

Materials and Methods

The experiment was at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. The experimental design of this trial was four replications in a randomized complete block. Measurements taken included: plant height, population, grain yield, test weight, and moisture content.

Fertilizer was applied at a rate of 185 pounds of nitrogen (N) per acre, 50 pounds phosphorus (P), and 20 pounds sulfur (S) before planting. On May 14, 2013, eight corn varieties were seeded in

plots two rows by 30 feet using a HEGE precision plot planter set at a row spacing of 30 inches. The seeding depth was 1.5 inches, and the seeding rate was 30,000 seeds per acre. Weeds were controlled with Option[®] + Status[®]. Plots were harvested November 20 using an ALMACO plot combine.

Results and Discussion

Results are presented in Table 1. The highest yielding entry was NuTech/G2 Genetics 5H-202™ at 188 bushels/acre.

Results for this trial and many others are available on University of Wyoming Department of Plant Sciences' Crop Variety Trials Directory website at: www.uwyo.edu/plantsciences/uwplant/trials.html

Acknowledgments

Appreciation is extended to the SAREC staff for great plot care.

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Key words: corn, variety trial

PARP: VIII

Table 1. Goshen County (SAREC), Wyo., Irrigated Corn Variety Test – 2013.

Brand	Hybrid	Yield (bu/acre, 15.5%)	Harvest Moisture (%)	Bushel Weight (lb/bu)	Stand plts/acre	EPV* (\$)
NuTech/G2 Genetics	5H-202™	188	17	58	26900	1166
NuTech/G2 Genetics	5H-903™	180	17	51	26390	1109
NuTech/G2 Genetics	5H-502™	151	17	56	25220	934
NuTech/G2 Genetics	5H-805™	150	16	55	23330	932
NuTech/G2 Genetics	5H-905™	153	19	49	25000	930
NuTech/G2 Genetics	5H-806™	144	20	50	26970	872
Average		161	18	53	25640	990
LSD (0.05)		16	2	2	1000	109

*The EPV, or estimated processed value, is an index developed at Iowa State University for measuring the utilization value of grain. The EPV per bushel is the total value of products originating from a bushel of grain.

2013 Winter Wheat Variety Trial Nursery: Laramie County Irrigated

*J. Nachtman*¹

¹James C. Hageman Sustainable Agriculture Research and Extension Center.

Introduction

Variety performance evaluations conducted by the Wyoming Agricultural Experiment Station (WAES) are a continuous and ongoing program. WAES evaluates many varieties/lines of winter wheat each year in cooperation with the Crop Research Foundation of Wyoming, University of Nebraska, Colorado State University (CSU), and private seed companies.

Objectives

Testing of winter wheat varieties is conducted to help growers select varieties adapted to the winter wheat growing regions of Wyoming.

Materials and Methods

The experiment was located on the Theron Anderson farm in extreme southeast Wyoming near Albin. The experimental design consisted of five replications in a randomized complete block. Measurements taken included: heading date, plant height, grain yield, test weight, and moisture. Fertilizer was applied at 190 pounds nitrogen, 45 pounds phosphorus, and 24 pounds sulfur per acre. On September 24, 2012, 46 winter wheat

varieties were seeded in plots 5 by 25 feet using a hoe drill with a row spacing of 14 inches. The seeding depth was 1.5 inches, and the seeding rate was 90 pounds per acre. Herbicides were applied by the cooperators. Plots were harvested August 5, 2013, using an ALMACO plot combine.

Results and Discussion

Results are presented in Table 1. The field where the trial was located was adjusted for 35% hail damage. The highest yielding entry was Cowboy hard red winter wheat at 105 bushels/acre. Cowboy was co-released by CSU and the University of Wyoming in 2011. Results for this trial and many others are available on the web at: www.uwyo.edu/plantsciences/uwplant/trials.html

Acknowledgments

Appreciation is extended to Theron Anderson, who allowed us to place trials on his land.

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Key words: winter wheat, variety trial

PARP: VIII

Table 1. Laramie County, Wyo., Irrigated Winter Wheat Variety Test – 2013.

Variety	Grain Yield (bu/acre)	Protein (%)	Bushel Wt (lb/bu)	Plant Height (in)	Heading date (June)
Cowboy	105	13.7	58.6	25	12
Antero (CO07W245) (W)	104	13.8	58.9	25	8
Settler CL	103	14.1	59.8	26	10
Armour	101	14.5	57.8	23	7
SY Wolf	101	14.3	59.4	25	11
T158	101	14.1	60.8	25	7
CO08W218 (W)	100	13.8	58.8	25	9
WB-Cedar	100	14.4	58.6	22	6
CO05W111 (W)	98	14.2	58.7	26	12
CO07W722 (W)	98	14.1	58.4	24	9
CO08263	97	14.1	58.8	24	8
CO08346	97	14.5	60.0	25	11
BL11002	96	14.7	58.3	26	8
Byrd	96	14.0	59.0	24	8
NH09655	95	14.6	58.6	25	9
Winterhawk	95	14.1	59.7	25	9
NI08708	94	14.3	57.5	25	9
LCH08-80	92	14.7	60.0	25	10
SY Gold	91	14.9	59.0	24	9
Brawl CL Plus	90	14.7	59.8	24	7
CO050173	90	14.4	58.6	26	9
Denali	90	14.3	59.2	25	11
NE06430	89	14.6	57.9	25	7
NE07531	89	14.8	60.4	25	9
Bearpaw (SS)	88	15.4	57.5	23	12
T163*	88	14.6	58.2	24	5
Judee (SS)	87	15.2	55.9	24	13
NE09521	86	14.4	58.8	26	8
NI07703	86	14.9	55.6	25	9
Robidoux	86	14.5	58.3	25	10
Anton (W)	85	14.8	57.8	23	12
NW07505 (W)	85	14.8	58.7	25	10
Wesley	85	15.1	57.7	24	7
NW03666 (W)	83	14.4	59.4	26	8
Camelot	82	14.6	58.7	27	7
Post Rock	81	15.4	59.0	23	8
NI06736	80	15.2	57.8	25	7
MTS0808 (SS)	79	15.7	57.1	24	13
NE08499	79	14.5	58.4	25	8
NE09517	79	14.2	59.8	26	10
NW09627 (W)	79	14.0	56.8	23	7
NE06545	78	14.8	55.8	24	6
NE06607	78	15.0	57.1	25	7
Mattern	77	15.9	57.3	26	10
NE05548	77	15.4	56.8	26	10
MTS0832 (SS)	75	15.5	56.5	25	15
Average	89	14.6	58.4	25	9
LSD 0.05%	7	---	1.1	1	1

(W) Hard White Winter Wheat; (SS) Solid stem for sawfly resistance;

*T163 was 15% lodged.

Soil Quality and the Benefits of Crop Rotation, Reduced Tillage, and Manure Application in Crop and Forage Systems

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Introduction

Soil organic matter (SOM) stores carbon (C), drives soil-nutrient and water-supplying capacity, and binds soil particles to resist erosion and facilitate water infiltration. During a century of farming, soils in the West lost as much as 70% of SOM accumulated under previous centuries of native grassland. As a result, soil productivity decreased and needs for inputs of water and fertilizer increased. Since then, realization of the value of SOM off-farm (for conserving water quality and slowing global warming) and on-farm (for supporting productivity and minimizing inputs) have led to development of production strategies that replenish SOM. Two strategies include conserving SOM by reducing tillage and adding it by applying composted manure and/or other organic amendments. Crop rotation also builds SOM by supplying diverse crop residues, especially if legume crops are included, such as alfalfa or clover.

Objectives

The objective was to evaluate changes in soil quality under conventional, reduced-tillage, and organic crop and forage production systems.

Materials and Methods

Starting in 2009, we conducted a four-year experiment on irrigated fields at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. The studies were on 12 one-acre cash-crop plots and 12 two-acre forage production plots. For the cash-crop, we managed four plots as a conventional rotation of dry beans–corn–sugarbeet–corn, four plots as reduced-tillage under the same rotation, and four plots as an organically managed alfalfa–alfalfa–corn–dry beans rotation. Tillage was similar among the conventional and organic plots, and fertility management was similar among the conventional and reduced-till plots. Tillage on the conventional and organic plots included moldboard plow, disk, and harrow for seedbed preparation and cultivation as needed for weed control. The reduced-till plots were tilled once with a Landstar machine (Kuhn Krause Inc., Hutchinson, Kansas). Conventional and reduced-till plots were fertilized with commercial fertilizers based on soil-test recommendations, while the organically managed plots were fertilized with composted and fresh cattle manure at about five tons per acre. For the forage

plots, we followed the same approaches with three years of grass-alfalfa followed by a year of corn. The grass-alfalfa stand was plowed out in the conventional and organic plots, and sprayed out, followed by no-till planting, in the reduced-tillage plots. To assess soil quality, we measured SOM components that respond rapidly to management changes, including soil microbes by phospholipid fatty acid analysis, soluble organic C and N, and easily decomposed SOM. Groups of soil microbes, including bacteria, fungi, and others, have distinct phospholipid fatty acids that allow quantification of each group.

Results and Discussion

Converting from monocropped corn (grown year after year) to rotations had the largest positive impact on soil quality. Reduced tillage, manure, and alfalfa in rotations added to positive effects. At the end of the four-year study, the total number of soil microbes increased in all three systems, with the largest increase in the organic system (Figure 1). The most striking increases were among fungal species that break down crop residues, with five- to eight-fold increases in that group. Mycorrhizal fungi also increased in all three systems by factors of two to four. Mycorrhizal fungi form symbiotic relationships with crops that improve uptake of water and nutrients. Both types of fungi form networks of hyphae, which help hold soil particles together and improve soil porosity and water infiltration. Their presence indicates more

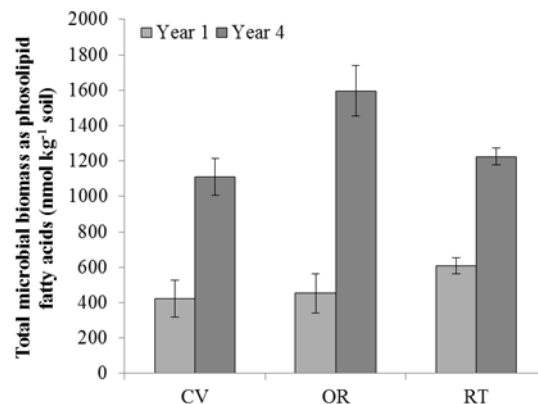


Figure 1. Soil microbial biomass. CV=conventional till; OR=organic; RT=reduced-tillage

stable SOM. The number of different types of microbes increased 50–70% over the four years.

Key findings include:

- Crop rotation improved soil quality in all production approaches;
- No-tilling corn into the three-year-old alfalfa-grass stand maintained soil quality accrued under forage;
- Organic and reduced-tillage (utilizing compost and minimizing soil disturbance) can improve soil and profit even if not implemented as strict organic or no-till practices.

Acknowledgments

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Key words: rotation, reduced-till, organic

PARP: I:3,6,9, II:5,6,8

One-Time Summer Tillage Does Not Negate Long-Term Benefits of No-Till

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Introduction

While most dryland winter wheat producers who practice no-till are committed to keeping steel out of the ground, there are several reasons why occasional tillage may prove beneficial. These include dispersing low-mobility nutrients (i.e., phosphorous that can accumulate near the soil surface), reducing soil compaction, and, most importantly, controlling weeds. It is known that tilling long-term undisturbed systems negatively impacts soil structural attributes and soil organic matter (SOM) quantities and characteristics. Little is known, however, about the impact of one-time or occasional tillage during a dry summer on soil properties improved during periods of no-till.

Even a single tillage operation can increase soil aeration and accelerate carbon (C) and nitrogen (N) mineralization and loss. This can result in immediate bursts of carbon dioxide (CO₂) and nitrous oxide (N₂O). Increases in soil aeration can also increase methane (CH₄) assimilation. These three gas species are very sensitive indicators of soil disturbance and SOM loss. Moreover, CO₂, CH₄, and N₂O are drivers of global atmospheric warming, and agricultural

practices that require frequent disturbance are contributors of these greenhouse gases (GHGs). In general, agriculture contributes 84% of total anthropogenic N₂O, 52% of CH₄, and 25% of CO₂ emissions (Duxbury, 1994; Smith et al., 2008).

Objectives

Our objectives were to evaluate the effects of one-time summer tillage of a fallow in the long-term no-till on GHG emissions and compare the response to frequently tilled soils.

Materials and Methods

The study was conducted at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Treatments included conventional till (>60 years), no-till (11 years), chemical free (11 years), and first time tilled no-till (TNT). Herbicides were applied as needed in no-till; a combination of herbicides and four tillage passes per year were used in conventional; and tillage only with six passes per year were used in chemical free. No fertilizers were applied to any of the treatments for 11 years. Air and soil samples were collected before and immediately after a one-time pass with a

tandem disk that loosened soil to a depth of 4 inches in the conventional, TNT, and chemical-free plots, and, concurrently, without tillage in the no-till. Carbon dioxide, CH₄, N₂O fluxes, soil dissolved organic C (DOC), and mineral N were determined for 0, 1, 5, 25, and 50 hours after tillage.

Results and Discussion

CO₂ emissions from TNT soils were 30 to 40% lower than from the frequently tilled (chemical-free and conventional) soils. TNT soils also had lower dissolved organic C and mineral N concentrations. Moreover, CO₂ emissions, DOC, and inorganic N concentrations from TNT soils were comparable to no-till soils (Figure 1). This suggests that a single summer tillage operation did not negatively affect SOM stored in the previously long-term no-till. The same tillage operation caused TNT soils to remove 32% more CH₄ from the atmosphere than the untilled soils. Tillage did not affect the magnitude of N₂O emissions in any of the treatments, suggesting that if performed during a dry summer, this operation did not contribute to atmospheric N₂O.

In summary, soils under long-term no-till management were resilient to a single summer tillage operation, while frequently tilled soils lost SOM as CO₂, soil DOC, and mineral N, all three of which can be vulnerable to loss. Occasional summer till of fallow can be used by no-till farmers for weed control or other management-related purposes, but we don't know how

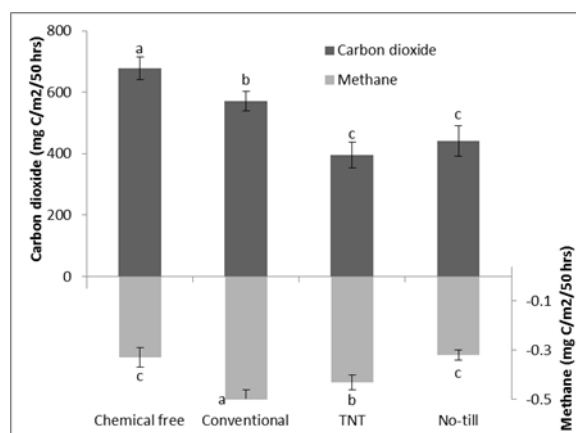


Figure1. Carbon lost through soil microbial CO₂ respiration and gained through microbial CH₄ assimilation following a single tillage event. Different letters indicate significant differences among tillage treatments ($p < 0.01$).

often tillage can be done before the SOM accrued under no-till management starts to unravel and be lost.

Acknowledgments

We thank the SAREC field crew and the U.S. Department of Agriculture's National Institute of Food and Agriculture for support.

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Key words: no-till, winter wheat, soil

PARP: I:7, II:6, X

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Evaluating Multi-Species Targeted Grazing for Cheatgrass Control

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Introduction

Cheatgrass is an exotic winter annual grass present throughout much of North America and prevalent in many areas of Wyoming. It causes many problems, from displacing native plant communities to increasing fire frequency and reducing wildlife habitat and livestock forage. Herbicides are the most common method of cheatgrass control, but studies suggest that targeted grazing may be a viable option, too. One advantage to ranchers using targeted grazing is that they can use their own livestock rather than incurring the expense of herbicides. What sets this study apart from previous known studies of grazing effects on invasive species is the use of animals rather than simulated grazing, such as mowing, and the comparison to standard herbicide application.

Objectives

The objectives of this study are to 1) determine the effectiveness of targeted grazing as a method for controlling cheatgrass, 2) determine the effects of livestock species (cattle/sheep) and grazing timing on cheatgrass populations, and 3) compare results to those of commonly used herbicide treatments.

Materials and Methods

This project began in spring 2013 at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle and is still in progress. The study is set up as a randomized complete block design with three replicates of 12 treatments, including nine grazing treatments, two herbicide treatments, and a check (Table 1).

Table 1. Grazing treatments by species and season of grazing. Numbers represent the number of different animals in a grazing cell for that treatment.

Treatments	Spring	Fall	Spring & Fall
Cattle	4	4	4
Sheep	20	20	20
Mixed (Cattle/Sheep)	2/10	2/10	2/10

Herbicide treatments include Matrix[®] at 3 ounces/acre and Plateau[®] at 6 oz/ac applied post-emergent in the fall. A permanent electric fence was installed around the perimeter of two rows of 18 plots with an alley in the center for efficient livestock handling. Plots are 30x60 feet (~4% of an acre) and are separated using portable electric fence.

Grazing treatments were conducted at a stocking density of ~100 animal units/acre with a goal of 90% utilization based on visual estimation.

Results and Discussion

Current data are only representative of spring 2013 grazing treatments and fall 2013 herbicide applications. No effect was found in cheatgrass cover among treatments (Figure 1). This was expected after only one grazing event, which is why intensive sampling was not conducted in the first year. Although not reflected in the statistical analysis, both herbicides appeared to have reduced cheatgrass based on visual observations alone. Herbicide effects are expected to become evident in spring 2014 data collection.

Cheatgrass cover increased over the season in all plots as expected (Figure 2). No differences were seen among treatments, but it does appear that sheep grazing may have hindered growth (Figure 2).

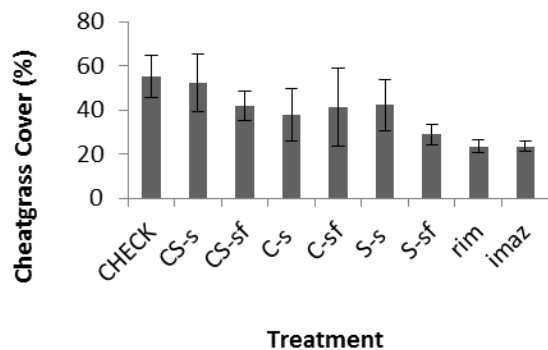


Figure 1. October 2013 cheatgrass cover by grazing and herbicide treatments ($p=0.164$). Error bars represent standard error. Treatments: C=cattle, S=sheep, s=spring, f=fall, rim=rimsulfuron (Matrix®), imaz=imazapic (Plateau®).

Future data collection will include cover and biomass of cheatgrass and natives and seed production of cheatgrass. As of now, targeted grazing does not seem to be a viable method of control (at least in the short term), but it is possible it will prove effective in the long term.

Acknowledgments

The project is funded by the Wyoming Reclamation and Restoration Center, the Wyoming Agricultural Experiment Station Competitive Grants Program, and the Department of Plant Sciences. Thanks to SAREC staff, Rachel Mealor, Beth Fowers, Travis Decker, Shayla Burnett, Will Rose, Julia Workman, and Jenna Meeks.

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Key words: targeted grazing, cheatgrass control, herbicide

PARP: III:5, VI:4

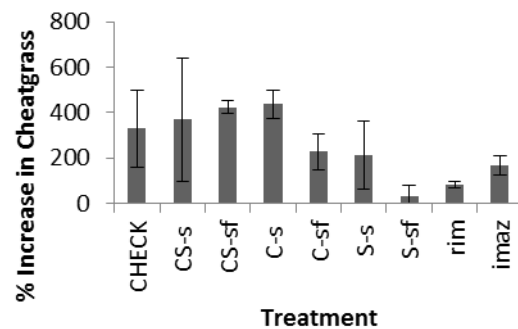


Figure 2. Percent increase in cheatgrass cover from spring 2013 to fall 2013 ($p=0.067$). Error bars represent standard error. Treatment abbreviations same as Figure 1.

Evaluation of Two Yearling Grazing Systems Before Feedlot Entry

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Introduction

High grain prices combined with greater profitability in the stocker cattle business may lead to fewer calves and a greater number of yearlings placed on feed in the future. Research at NDSU's Dickinson Research Extension Center has shown that early weaned calves backgrounded on grazing unharvested corn have a competitive economic advantage.

Objectives

The objective of this project was to compare conventional feedlot finishing to two extensive grazing systems based on either perennial grasses or a combination of perennial and annual forages before feedlot entry.

Materials and Methods

After weaning in November of each year (2011 and 2012), medium- to large-frame steers (5 to 7 frame score; n=141) were wintered for modest gain of less than one pound per day grazing corn aftermath plus medium-quality hay. In early May, the steers were assigned randomly to one of three treatments based on birth date and weight: 1) control (feedlot direct) (FLT), 2) crested wheatgrass followed by native range (PST), or 3) perennial grass pasture followed by annual forage (ANN).

Grazing costs of perennial pastures were determined using a constant cost/lb of body weight (\$0.0009). Annual pasture grazing costs were based on actual current cash crop budgets. The FLT control steers were shipped directly to the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle and fed to final endpoint based on ultrasound backfat of 0.45 inches. Steers assigned to the PST and ANN forage grazing treatments also were fed to final harvest at the SAREC feedlot at the end of the long-term extended grazing period. Current southeast Wyoming market feed costs plus \$.35/head/day yardage were used to determine feedlot costs.

Results and Discussion

Growth rates for the PST and ANN steers were 1.71 and 2.21 pounds/day, respectively, for the average 182-day grazing season. This resulted in a total grazing season gain of 309 and 405 lbs/steer for the PST and ANN treatments, respectively. Total grazing cost for the ANN treatment was higher; however, grazing cost per pound of gain for PST and ANN systems was similar (\$0.5571 vs. \$0.5924 for PST and ANN, respectively). Feedlot performance for either of the extended grazing systems (PST and ANN) was superior to the

FLT control steers. Once the grazing system steers entered the feedlot, their average daily gains (ADG) were significantly greater than those in the FLT control. When the system's two-year average income, expense, and net return were summarized, the ANN extended grazing system was the only system with a positive net return of \$9.09, whereas the PST system lost \$30.10 per steer, which is attributed to slower growth due to declining forage quality. The conventional feedlot control system lost \$298.05 per steer. Results indicate that extended grazing systems can reduce cost of production among steers held for retained ownership. The ANN extended grazing system

that included grazing annual forages during late summer and early fall prior to feedlot entry was a profitable system without using risk management tools—an underlying objective in the study.

Acknowledgments

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Key words: yearling cattle, grazing, feedlot

PARP: I:2,6, V:7,11, VI:1, IX:1

Table 1. Effect of extended grazing system on yearling steer pasture performance.

	PST	ANN	FLT	Std. Error	P-Value
Number of Steers	48	47	46		
Grazing Performance					
Days grazed	181	183			
Start wt., lb.	814	826		5.59	0.058
End wt., lb.	1122 ^a	1231 ^b		8.39	<0.0001
ADG, lb.	1.71 ^a	2.21 ^b		0.03	<0.0001
Cost/head, \$	157.19 ^a	238.36 ^b		0.81	<0.0001
Cost/lb. gain, \$	0.5571	0.5924		0.015	0.14
Feedlot Performance					
Feedlot days on feed	91	66	142		
Slaughter age, mths	22.1 ^a	21.4 ^b	18.1 ^c	0.043	<0.0001
Feedlot start wt., lb.	1073 ^a	1189 ^b	808 ^c	15.1	<0.0001
Feedlot end wt., lb.	1488 ^a	1479 ^a	1350 ^b	18.1	0.0002
Feedlot ADG, lb.	4.59 ^a	4.41 ^a	3.81 ^b	0.15	0.006
Feed: gain, lb.	6.23 ^a	6.15 ^a	6.91 ^b	0.24	0.018
Feed cost/head, \$	381.18 ^a	276.12 ^b	578.30 ^c	7.62	<0.0001
Feed cost/lb. gain, \$	0.9283 ^a	0.9550 ^a	1.08 ^b	0.035	0.005
Carcass					
Hot carcass weight	855 ^a	851 ^a	775 ^b	9.30	<0.0001
Marbling score	516.0	530.0	501.0		0.58
Yield grade	2.93 ^a	2.82 ^a	2.41 ^b		0.042
Percent choice or greater, %	82.1	86.5	65.6		0.312
Systems Economics					
Gross income, \$	1,718.41	1,738.93	1,497.41		
Expenses, \$	1,748.51	1,729.84	1,795.46		
Net return, \$	-30.10	+9.09	-298.05		

^{a-c} Means within a row with different superscripts differ ($p < 0.05$).

In-furrow Fungicide Programs to Manage Potato Diseases

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¹Department of Plant Sciences.

Introduction

Potatoes are beset by a wide range of disease organisms, and no single management program is suitable for all potato pathogens. Despite this, producers are always searching for pesticide programs that can manage more than one disease organism. Benefits of this include reduced pesticide loads in the environment, reduced trips across the field, and lower costs. Additionally, banding of fungicides in-furrow at planting allows growers to more effectively concentrate the fungicide directly over the seed and future root zone thereby improving against soil-borne diseases. The problem is that many in-furrow applied fungicides are not efficacious for later developing diseases.

Objectives

Objectives were to compare the relative effectiveness of in-furrow vs. a broadcast fungicide program for soil-borne diseases and foliar early blight management.

Materials and Methods

Plots were located at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Plots were planted on May 22, 2013, in a randomized complete block design with four replicates. Fungicide was applied in-

furrow at planting in a 7-inch band or as a broadcast foliar application made on July 18 with sequential applications on August 1, 12, and 26 (Table 1). The experiment relied on natural inoculation for the soil-borne diseases. Foliar early blight (*Alternaria solani*) was undoubtedly from bordering inoculated early blight plots. Early blight disease severity was measured by calculating the average number of lesions per leaflet. Six leaves were randomly selected from each treatment plot representing the canopy profile and lesions counted on up to six leaflets per leaf. Leaves were collected on August 22 and 26 and on September 5 and 10. Disease severity data were used to calculate an area under the disease progress curve (AUDPC) rating for each treatment. The AUDPC value is a measure of season-long disease severity for each treatment (higher values equate to greater disease). On September 5, five stems (representing five plants) were pulled from each plot. Stems were rated for severity of *Rhizoctonia* stem canker (*Rhizoctonia solani*) as the % surface area of stem below-ground affected with canker and for incidence of black dot (*Colletotrichum coccodes*). Additionally, plots were visually rated using the Horsfall-Barratt scale to estimate the percentage of stem necrosis

on September 19. All data were analyzed via ANOVA (ANalysis Of VAriance).

Results and Discussion

Early blight foliar disease development was initially slow, but advanced noticeably by early September. The foliar fungicide program and in-furrow fungicide treatments reduced overall early blight disease development, as measured by AUDPC, 88 to 98% compared to the non-treated check ($p \leq 0.05$). Neither the foliar nor in-furrow fungicide treatments had any effect on soil-borne diseases as measured by black dot incidence and Rhizoctonia stem canker severity on September 5. On September 19, however, all fungicide treatments reduced stem necrosis compared to the non-treated check ($p \leq 0.05$). Although neither fungicide application type was effective on both foliar and soil-borne diseases, the in-furrow fungicide treatment (SP102296) was not expected to be

as effective on early blight as the foliar fungicide program. While this chemistry is promising and warrants further work, this product represents one mode of action; resistance management would require some type of foliar fungicide program with multiple sites of action to help manage resistance development.

Acknowledgments

We thank SAREC field crews for their assistance in plot establishment and harvest. Special thanks to Western Potatoes, Alliance, Nebraska, for providing seed potatoes. The study was supported by various sponsored programs.

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Key words: potato, Rhizoctonia, fungicide

PARP: None applicable

Table 1. Effects of in-furrow fungicide vs. foliar application method for potato disease suppression.

Treatment, rate, and application method (product/A) ^z	E. blight		% below-ground stem affected with Rhizoctonia stem canker ^y	% stem necrosis
	AUDPC	Sep 5	Sep 5	Sep 19
Non-treated check	55.2 a ^x	2.0 a	42.0 a	76.5 a
Quadris® (6.2 fl oz broadcast 18 Jul)				
Revus Top® (7 fl oz broadcast 1 Aug)				
Bravo Weather Stik® (24 fl oz broadcast Aug 12)				
Endura® (2.5 oz [dry]/A broadcast Aug 26)	6.6 b	3.3 a	33.0 a	50.0 b
SP102296 (19 fl oz/A concentrated in-furrow)	3.8 b	3.3 a	42.0 a	40.5 b
SP102296 + Serenade Soil® (19 fl oz + 2 qt/A concentrated in-furrow)	1.1 b	3.3 a	48.0 a	46.0 b
SP102296 + Serenade Soil (19 fl oz + 4 qt/A concentrated in-furrow)	0.9 b	3.7 a	52.0 a	46.0 b

^zIn-furrow applications were made May 22 in a 7-inch in-furrow band in 1.21 gal/1,000 row ft. Plot was planted with variety Snowden. Broadcast applications were made in a total volume of 43 GPA at 30 psi boom pressure.

^yStem necrosis and stem canker affects were estimated using the Horsfall-Barratt scale and converted to percentage using the appropriate conversion table. Necrosis resulted from the combined effects of early blight, black dot disease, and senescence.

^xTreatment means followed by different letters differ significantly (Fisher's protected LSD, $p \leq 0.05$).

Soil Amendments and Microbial Recovery Following High-Intensity Forest Fire at the Rogers Research Site

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Introduction

The University of Wyoming's Rogers Research Site (RRS)—in the Laramie Mountains southeast of Laramie Peak—burned July 1, 2012. Since then, efforts have been started to detail impacts of the fire (Williams et al., 2013), among them regeneration of vegetation including ponderosa pine (the main tree at RRS) and recovery of soil fertility. High-severity forest fires, such as the one at RRS, lead to measurable impact on the surface soil chemical and microbial community characteristics. Destruction of important beneficial and nutrient-cycling organisms can impact vegetative succession and long-term sustainability of products derived from forested ecosystems (e.g., wood, water, and recreation).

Objectives

Objectives were to enhance the soil microbial community recovery in the post-fire ponderosa pine forest through the addition of various microbial, organic, and inorganic amendments to the soil. We hypothesized that these amendments would stimulate microbial community growth in a significant way and that the impact of this stimulation would be

measurable over the course of our study, which is expected to last through 2019. A central feature of this study was using compost tea to regenerate the biological activity of disturbed soils. There is considerable interest in compost tea, but very few studies have compared its effectiveness to untreated controls. (Compost tea is made by steeping compost in water. This process increases beneficial organisms and nutrients in the water.)

Materials and Methods

This study was located at the RRS where slope and soil depth were uniform across the area. All ponderosa pine on the site burned during the 2012 fire. Four soil treatments were compared to untreated controls in a randomized, complete block design where each treatment was replicated seven times. Treatments were compost (a mixture of sheep manure and vermicompost), two compost teas (made by steeping the compost in water for different lengths of time), and nitrogen (N) fertilizer (ammonium nitrate). Ten-foot by 10-foot plots were the experimental units. For rates and amendment analysis, see Wilkin, 2014. Soils were sampled immediately before treatment (November

14, 2012) and after treatment (November 25, 2012). Soils were sampled again in spring and summer 2013 (May 14 and August 14). Ammonium and nitrate N content were determined on all soils from all plots and dates. All plots were analyzed for microbial communities using a phospholipid fatty acid (PLFA) analysis. Particular PLFA profiles are specific to known groups of soil microorganisms. PLFA profiles for total abundance of the microbial community, bacteria, arbuscular mycorrhizal fungi, total fungi, and protozoa were determined. (Arbuscular mycorrhizal fungi help vascular plants capture important nutrients from the soil, including N, phosphorus, sulfur, and micronutrients.)

Results and Discussion

Highly variable microbial community responses and strong seasonal trends were observed among PLFA profiles of the soil treatments. Inorganic fertilizer, compost, and compost tea treatments showed sample date-dependent spikes of microbial activity, but study-wide trends were not observed. The RRS was greatly impacted by the fire, and likely this ecosystem will take decades to return to a pre-fire condition. The release of organic-bound nutrients and the charring of woody biomass may increase soil bacteria populations in the short term, as will N and other nutrients typically found in ash. The addition of compost and its aerated teas may have stimulated ammonification

and fungal activity and narrowed fungi to bacteria ratios over the short term. Observed changes in PLFA signatures in the experimental surface soils was typically variable and non-significant as the seasons and microbial communities changed. The addition of N fertilizer stimulated bacterial populations to levels greater than untreated controls indicating these communities are able to use this N. As available N is reduced, fungal communities will likely develop. Of particular interest are plant pathogens (diseases). Regeneration of post-fire forest is dependent on numerous factors. This report documents some of the soil microbial community changes immediately after fire. The intent is to continue to follow these as the forest develops since they are key to nutrient cycling, water relations, and pathogen control.

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Key words: compost tea, fire effects, soil microbial communities

PARP: II:5, XII:2

References

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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).

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 north-eastern 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 followed last year's format and took place at both ShREC locations (Watt Agriculture Center and Wyarno). The morning included field tours starting near Wyarno and finishing at the Adams Ranch. Following lunch and tours of the newly renovated laboratories, the afternoon featured 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 Jeliaskov 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 Jeliaskov.

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Short Format Reports—Sheridan R&E Center

1. Utilization of CBM water for irrigation of biofuel crops

Investigators: Shital Poudyal and Valtcho Jeliaskov

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.

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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 Jeliaskov

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) 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.

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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:2,3,4,5, X:1,3

5. Evaluation of alfalfa and sainfoin varieties under dryland environment

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

Key Words: forage, alfalfa, sainfoin

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

6. Sainfoin under test for forage productivity and quality

Investigators: Valtcho Jeliaskov 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 Wyarro. 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 Jeliaskov, vjeliask@uwyo.edu or 307-737-2415.

Key Words: forages, sainfoin, fertility

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, vineyards

PARP: I:1, X:1

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 Jeliakov

Issue: Perennial cool-season grasses comprise about 25% of all hay-field acreage of Johnson and Sheridan counties with smooth brome-grass (e.g., ‘Manchar’) and, to a lesser extent, meadow brome-grass (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 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 and ranch income and profitability.

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

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

PARP: 1:2

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 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 Jeliaskov and Santosh Shiwakoti

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 Jeliaskov, vjeliask@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. We plan to use results 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:3,4,5, 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. Semiarid 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

PARP: I: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.

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Key Words: honey, demand, locally produced

PARP: VII

Developing Weed Management Strategies to Improve Reclamation of Drastically Disturbed Lands

B. Fowers¹, B.A. Meador^{1,2}, 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, U.S. 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, herbicide, weed science

PARP: III:2,5, XII:1

Table 1. Herbicides and rates.

Chemical Name	Abbrev.	Rate
Aminocyclopyrachlor plus chlorsulfuron	Amcp + Chlr	2.2 oz ai/acre
Aminocyclopyrachlor plus chlorsulfuron	Amcp + Chlr	0.9 oz ai/acre
Aminocyclopyrachlor plus chlorsulfuron	Amcp + Chlr	1.1 oz ai/acre
Aminocyclopyrachlor plus chlorsulfuron	Amcp + Chlr	0.4 oz ai/acre
Aminocyclopyrachlor	Amcp	2.2 oz ai/acre
Aminocyclopyrachlor	Amcp	1.1 oz ai/acre
Aminopyralid	Amp	1.3 oz ai/acre
Chlorsulfuron	Chlr	0.8 oz ai/acre
Imazapic ^{1,2}	Imaz	3.7 oz ai/acre
Rimsulfuron ^{1,2}	Rim	1.9 oz ai/acre
2,4-D Amine ¹	2,4-D	24 oz ai/acre
Saflufenacil ¹	Safl	0.4 oz ai/acre

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

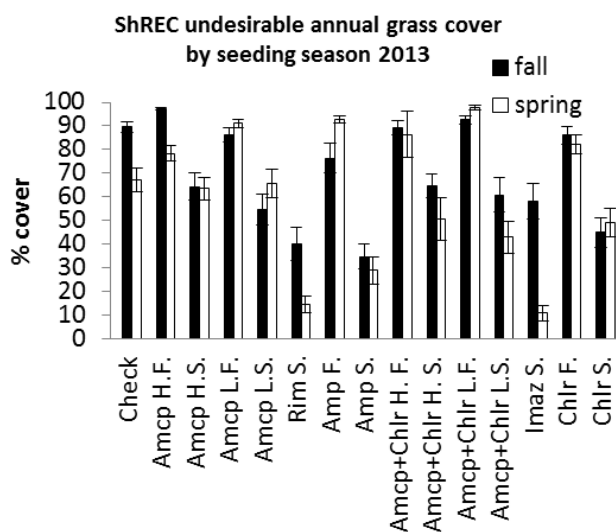


Figure 1. ShREC undesirable annual grass cover. Rate is H (high) and L (low), season of herbicide application is F (fall) and S (spring); refer to Table 1 for herbicide abbreviations.

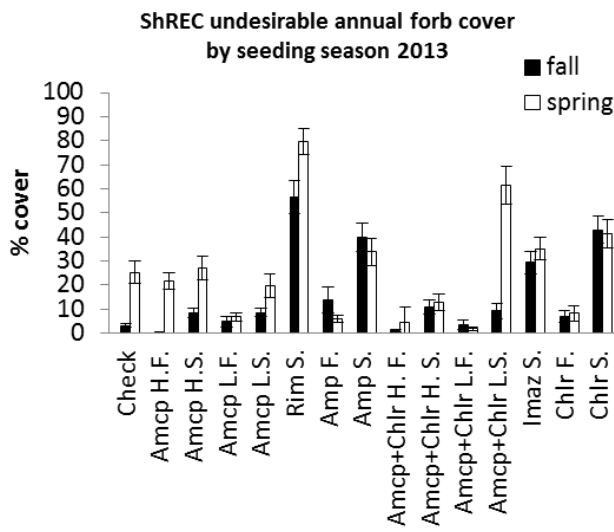


Figure 2. ShREC undesirable annual forb cover. Rate is H (high) and L (low), season of herbicide application is F (fall) and S (spring); refer to Table 1 for herbicide abbreviations.

Developing Strategies to Improve Reclamation Seeding of Drastically Disturbed Lands

B. Fowers¹, B.A. Meador^{1,2}, and A.R. Kniss¹

¹Department of Plant Sciences; ²UW 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 wheat-grasses (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, U.S. 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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ShREC percent stand of seeded species 2013

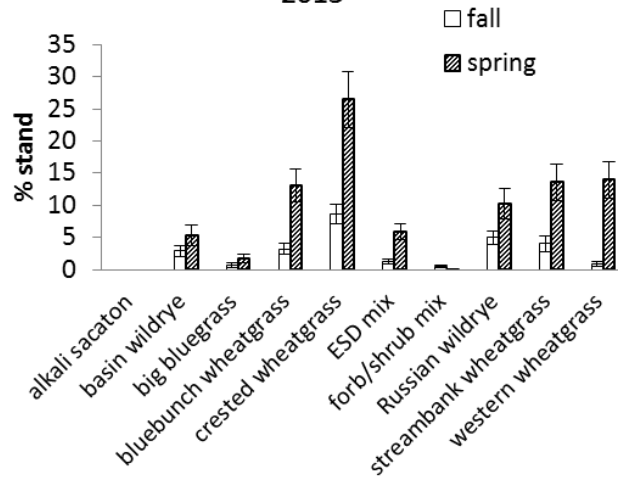


Figure 1. Percent stand of seeded species by season.

ShREC western wheatgrass establishment by herbicide and seeding season 2013

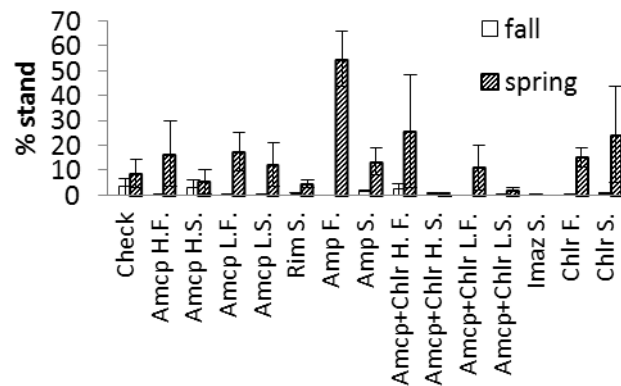


Figure 2. Western wheatgrass establishment by herbicide. Herbicides are listed in the paper titled “Developing weed management strategies to improve reclamation of drastically disturbed lands” on pages 109–110 in this bulletin. Rate is H (high) and L (low); herbicide application season is F (fall) and S (spring).

Key words: reclamation, weeds, grasses and forbs

PARP: III:2,5, XII:1

Camelina as an Alternative Crop in Wheat-Fallow Rotation

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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.

Crop	Plant height (inches)	Seed yield (lb/ac)	Residue biomass (lb/ac)	Yield loss (%)
Wheat	39.3	3,680	7,461	18.7
Camelina	30.1	943	3,556	35.4

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:1,2, XI:1

Seeding Date and Cultivar Affects Growth and Yield of Camelina

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Introduction

Camelina (*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

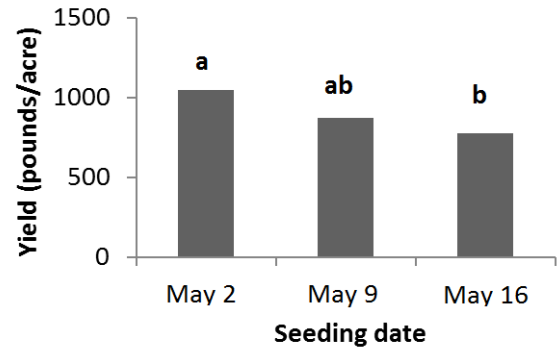


Figure 1. Effects of seeding date on seed yield.

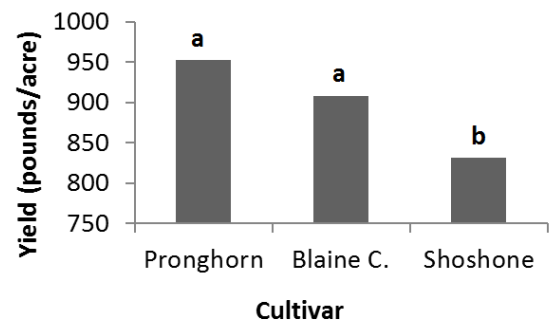


Figure 2. Effects of cultivar on seed yield.

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

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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 (Figure 2). We did not see any stem lodging of the crop. Average yield loss for camelina was 28.9%.

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

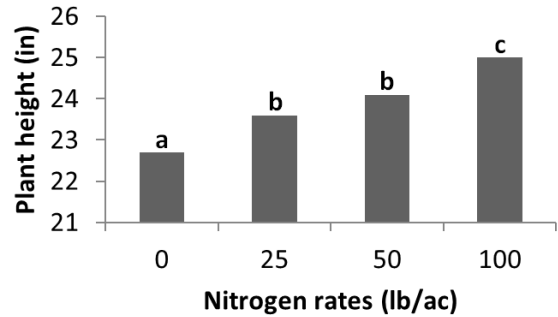


Figure 1. Effects of nitrogen rates on camelina plant height.

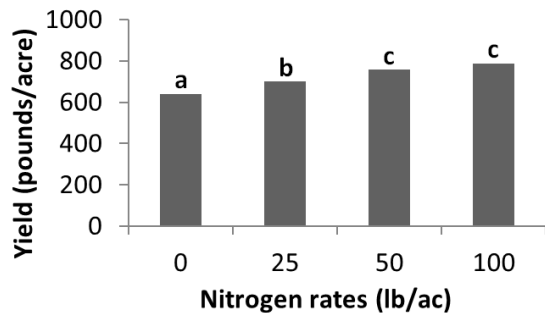


Figure 2. Effects of nitrogen rates on camelina seed yield.

(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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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.



Figure 2. Small seeds of camelina.

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

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Irrigated Grass-Legume Mixtures

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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.)

Grass-legume mixtures offer the potential to reduce costs associated with N fertilization by fixing N in the soil. Grass-legume mixtures can also 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 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 '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 in April and the second in September or October 2014. Data collected includes 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/early 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

PARP: I:2, II:2,7,9, IV:4, VII:1

Table 1. Visual estimation of emergence as a percentage of proportion sown on October 1, 2013.

Treatment	Treatment ratio	Alfalfa	Sainfoin	BFT	MB	Total
1	*Alf100	91.2	-	-	-	91.2
2	Alf50:MB50	48.8			40.0	88.8
3	Alf30:MB70	30.5			50.8	81.3
4	**MB50:Alf25:S25	18.2	23.2		28.8	70.2
5	#S100	-	88.8		-	88.8
6	S50:MB50	-	40.6		33.2	73.8
7	S30:MB70	-	23.2	-	33.1	56.3
8	MB:50:Alf25:BFT25	26.3	-	14.0	29.8	70.1
9	†BFT100	-	-	83.8	-	83.8
10	BFT50:MB50	-	-	40.7	36.8	77.5
11	BFT30:MB70	-	-	27.7	48.5	76.2
12	MB50:Alf16.7:S16.7:BFT16.7	18.4	7.7	10.7	24.5	61.3
13	MB100	-			67.5	67.5
14	MB100-N50	-			66.2	66.2
15	MB100-N100	-			75.0	75.0

*Alf = Alfalfa, **MB = meadow brome grass, #S = sainfoin, †BFT = bird's-foot trefoil

Effects of Coal-Bed Methane Water on Spearmint

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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 (*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 (17.6 ounce samples) in steam distillation units for one hour. The resulting oil was separated from water, weighed, and computed as a percentage. Qualitative and quantitative analyses of the spearmint essential oil from all treatments was performed using a 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 Jeliaskov.

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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

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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.

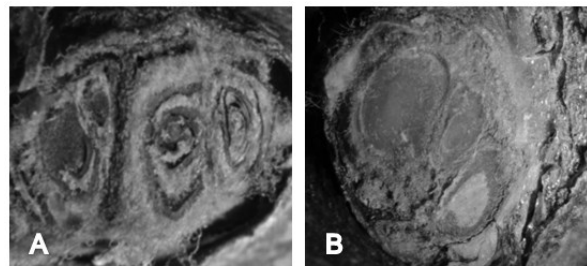


Figure 3. Microscopic examination of a budwood sample collected from a vineyard in Wheatland reveals (A) freeze-induced damage compared to (B) control sample.

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Key words: grape

PARP: I:1, X:1

Short Format Reports—Off-Station

1. Understanding epigenetic mechanisms of lactation failure

Investigator: Brian Cherrington

Issue: Across species, obesity negatively affects lactational performance.

Understanding of the role of obesity in altering hormonal control of lactation is improving; yet, the downstream effects on changes in milk gene expression not due to alteration in DNA sequence (i.e., epigenetics) is unclear.

Goal: The goal is to study if an epigenetic enzyme family termed peptidylarginine deiminases is negatively affected by obesity resulting in changes in milk production. These enzymes convert the amino acid arginine in histone tails to the non-coded residue citrulline to regulate gene expression.

Objectives: The specific objectives for this project are to 1) determine how prolactin increases expression of peptidylarginine deiminases in mammary epithelial cells and 2) determine the role of peptidylarginine deiminases and histone citrullination in regulating mammary gland gene expression.

Impact: Given the growing obesity rate in Wyoming and nationwide, viable, cost-effective strategies are needed to combat the growing epidemic. Project results should determine how obesity influences lactational performance at the cellular level with the ultimate goal of promoting breastfeeding to combat obesity.

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Key Words: epigenetics, lactation, obesity

PARP: VII:1,2

2. Regulation of nuclear size in cancer cells

Investigators: Daniel Levy, Predrag Jevtić, and Karen White

Issue: The nucleus is a compartment within each cell that contains the genetic information directing the growth and identity of that cell. The size of the nucleus is often inappropriately enlarged in cancer cells, a change that pathologists use to diagnose and stage disease. Yet, little is known about the causes or effects of nuclear morphology changes in cancer.

Goal: The goal is to determine how nuclear size impacts cell function and contributes to cancer development and progression.

Objectives: Specific objectives are to 1) quantify nuclear size in normal and cancer tissue culture cell lines, 2) manipulate nuclear size in these cells by transfection, and 3) determine how altering nuclear size affects cell growth, death, and migration.

Impact: Results should identify novel approaches and targets for cancer diagnosis and treatment, and new cancer susceptibility factors could be identified to aid in prevention.

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Key Words: nuclear size, cancer cell biology, health

PARP: None applicable

3. Social and economic survey of public land ranchers

Investigators: Bree Lind, John Tanaka, and Kristie Maczko

Issue: There is a lack of information regarding the social and economic contributions public land ranchers have to their communities on a national scale. Understanding these relationships could lead to better decision-making strategies by public land policymakers.

Goal: The goal of this study is to determine how public land ranchers contribute to the economics and social structure of their local communities on a national scale.

Objectives: Specific objectives include collecting economic and social data through a national survey. This data can be used to create accurate socio-economic models, which in turn could be used for decision-making.

Impact: Results could assist public land agencies and policymakers in their decisions about public land management at the local to national scales. Accurate economic and social models could also assist public land agencies in social and economic impact analyses for required planning documents, e.g., environmental assessments and environmental impact statements.

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Key Words: impact analysis, ranching, public lands

PARP: VII:3, IX:1,3

4. Mapping socio-economic and ecological impacts of development projects in Wyoming

Investigators: Leticia Varelas, John Tanaka, Ben Rashford, and John Ritten

Issue: Agencies such as the U.S. Bureau of Land Management (BLM) are required to estimate potential impacts of development projects on federal lands in a timely manner. These agencies, however, are often limited by available resources for data collection, expertise for thorough project analysis, and strict time requirements necessary to comply with National Environmental Policy Act guidelines, especially socio-economic impacts.

Goal: Goals are to 1) use spatial data and ArcGIS to map the human footprint of wind energy development in Wyoming by estimating impacts on ecological and socio-economic systems and 2) determine the optimal land use scenario given potential impacts and land management objectives.

Objectives: Specific objectives include modeling 1) spatial relationships between wind energy development and ecological factors such as wildlife, plant communities, and soil erosion and 2) relationships between wind energy development and socio-economic factors such as watershed, current land uses, and local communities.

Impact: Project results should assist the BLM in conveying social and economic impacts of proposed development—including wind energy—to the public. The project should also help the BLM more efficiently assess future projects based on limited staff resources.

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Key Words: impact analysis, landscape analysis, human footprint

PARP: XII

5. Myxobacteria as biocontrol agents against crop pathogens

Investigator: Dan Wall

Issue: Crop pathogens have a significant detrimental impact on Wyoming and U.S. agriculture. Biocontrol agents can offer an environmentally friendly and cost-effective means to help suppress crop diseases.

Goal: The goal is to investigate the feasibility of using myxobacteria as a biocontrol agent to protect crops against pathogens. Since myxobacteria can produce spores that allow for long-term storage and because they prey on soil microbes, they hold promise as commercial biocontrol agents.

Objectives: Specific objectives include
1) assessing the ability of myxobacteria to live in the rhizosphere, the soil environment immediately surrounding plant roots,
2) identifying and characterizing myxobacteria gene products that block crop pathogen growth, and 3) testing whether myxobacteria can protect sugarbeet seedlings in the laboratory.

Impact: Results should provide both a theoretical and practical analysis of how myxobacteria might be used to suppress crop disease.

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Key Words: biocontrol, myxobacteria, pathogens

PARP: VIII:2

6. Variations of soil phosphorus chemical forms in a cold, semiarid climate

Investigators: Mengqiang Zhu, Larry Munn, David Williams, Jay Norton, Yongfeng Hu, and Teresa Lehmann

Issue: Phosphorus (P) deficiency in soils is prevalent in Wyoming, and increasing soil P availability for plant uptake is an important strategy to enhance productivity and sustainability of both farmland and rangeland ecosystems.

Goal: The goal is to determine P chemical forms in Wyoming soils that determine P short- and long-term availability for plant uptake.

Objectives: Specific objectives are to address
1) what the P chemical forms are in natural and disturbed Wyoming rangeland soils,
2) how the P forms depend on climate variables, and 3) how these forms developed to the current state as soil formed over thousands of years.

Impact: Results should help land managers, ranchers, and others evaluate sustainability of rangeland ecosystems in terms of nutrient availability. They could also benefit ranchers and farmers improve P use efficiency.

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Key Words: phosphorus, rangeland soils, chemical forms

PARP: I:1, X:1

Landowner Preferences for Conservation Markets in Sublette County

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Introduction

The Upper Green River Basin in western Wyoming is a headwater for the Colorado River System, home to many bird and wildlife species with environmental and recreational significance, and an important area for livestock and hay production. In recent decades, the basin has experienced an energy boom from natural gas and oil extraction. This activity has increased economic opportunities in the basin, but has also placed development pressures on the area, including the natural resource base.

A partnership of scientists, wildlife managers, and landowners is developing a conservation exchange called the Upper Green River Conservation Exchange (UGRCE) to help mitigate development pressures. UGRCE will provide financial incentives to landowners for engaging in beneficial activities that might not otherwise be undertaken or continued. The current focus is on three ecosystem services: greater sage-grouse habitat, mule deer habitat, and riparian function (Fig. 1).

Through the UGRCE, an energy company seeking off-site mitigation for its development activities might pay a landowner to implement practices on their land that maintain or enhance wildlife habitat and

water resources. In this case, the energy company is a “buyer” of conservation, and landowners are the “sellers.” Other buyers might be recreational users looking for ways to support the basin’s high-quality environmental amenities.

No conservation will occur through UGRCE without willing participation from landowners. What contract terms would appeal to landowners? What management practices would likely be undertaken? Who should run the market?

Objectives

The objective of this study was to understand landowner preferences for contract and market design in a conservation exchange. This, in turn, should help foster landowner participation in the UGRCE.



Figure 1. The New Fork River valley, Sublette County, with the Wind River Range in the background.

Materials and Methods

A survey was mailed to Sublette County ranchers in fall 2012. Survey recipients were asked about their current land-use practices (Figure 2) and conservation program participation. They were also asked to choose between a series of hypothetical programs that had different management practices, contract lengths, and payment levels.

Results and Discussion

This survey has increased awareness about the UGRCE project and provided key insights into landowner program design preferences. Findings suggest that the exchange may be more popular and appeal to more landowners than existing conservation incentive programs such as conservation easements and off-site mitigation undertaken through the Jonah Interagency Office/Pinedale Anticline Project Office. Many landowners like the idea of a “two-sided” market, where private rather than public money (including state and federal) is used to fund conservation. They prefer local program administration as well as the potential for term contracts (of five, 10, or 20 years) rather than permanent easements. Landowners have a distinct preference for practices that do not directly interfere with their ranching operations¹ over those that do². (¹Opening gates during wildlife-migration periods, installing wildlife-friendly fencing, and managing irrigation water to maximize late-season flows, which, in turn, benefits



Figure 2. Baseline monitoring data collection.

riparian areas; versus, ²removing fencing and altering grazing management.)

These findings and the resulting conversations between UGRCE developers and landowners should help guide contract and market design for the exchange.

Acknowledgments

This project was funded by a grant from the Wyoming Agricultural Experiment Station and based on earlier research funded by a Conservation Innovation Grant from the Wyoming office of the U.S. Department of Agriculture’s Natural Resources Conservation Service. Thanks to project partner Melanie Purcell (Sublette County Conservation District) and area landowners for help developing the survey.

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Key words: landowner survey, conservation markets, conservation exchange

PARP: VII:4,6, XII:1

Composition and Synthesis of a Cell Surface Exopolysaccharide Coat that Protects *Listeria monocytogenes* Cells from Killing by Disinfectants

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Introduction

Listeria monocytogenes is a foodborne bacterial pathogen that causes hundreds of cases of the severe disease listeriosis in the United States every year. One of the most deadly outbreaks of the disease occurred in 2011 when 33 people died and nearly 150 were sickened after eating cantaloupe contaminated with the pathogen. This bacterium employs a number of strategies to survive on the surfaces of food products and on equipment used in food production.

Earlier in this project, we showed that mutant listerial cells that overproduce an unknown cell surface exopolysaccharide (EPS) coat of normal composition are protected against killing by bleach and the disinfectant benzalkonium chloride (see more about this in the 2013 *Field Days Bulletin*, pages 153–154, at www.uwyo.edu/uwexpstn/publications).

The strain that overproduces EPS (EPS1⁺) is a derivative of the wild type (WT) strain EGDe, which has been genetically manipulated in the lab to overexpress EPS. EPS1⁺, therefore, is a useful strain for determination of the composition of this EPS and the mechanism of its synthesis.

The attainment of these goals ultimately will be important to designing better control measures to help prevent the growth of *L. monocytogenes* in foods.

Objectives

The objectives of the research are to determine the composition of the *L. monocytogenes* EPS and define the genes needed for its synthesis.

Materials and Methods

Listerial EPS was isolated by boiling isolated EPS1⁺ cells in water, followed by ethanol precipitation. Most contaminants in the EPS sample were enzymatically removed, and the EPS sample was sent to the Complex Carbohydrate Research Center (Athens, Georgia) for monosaccharide composition analysis.

Genes required for EPS synthesis were determined by eliminating one-by-one the genes in the *pssA-E* biosynthesis gene cluster in the EPS1⁺ strain. The effects of gene inactivation were analyzed by evaluating EPS-induced clumping of cells (aggregation in a protective coat of EPS) grown in culture medium, which is indicative of EPS synthesis.

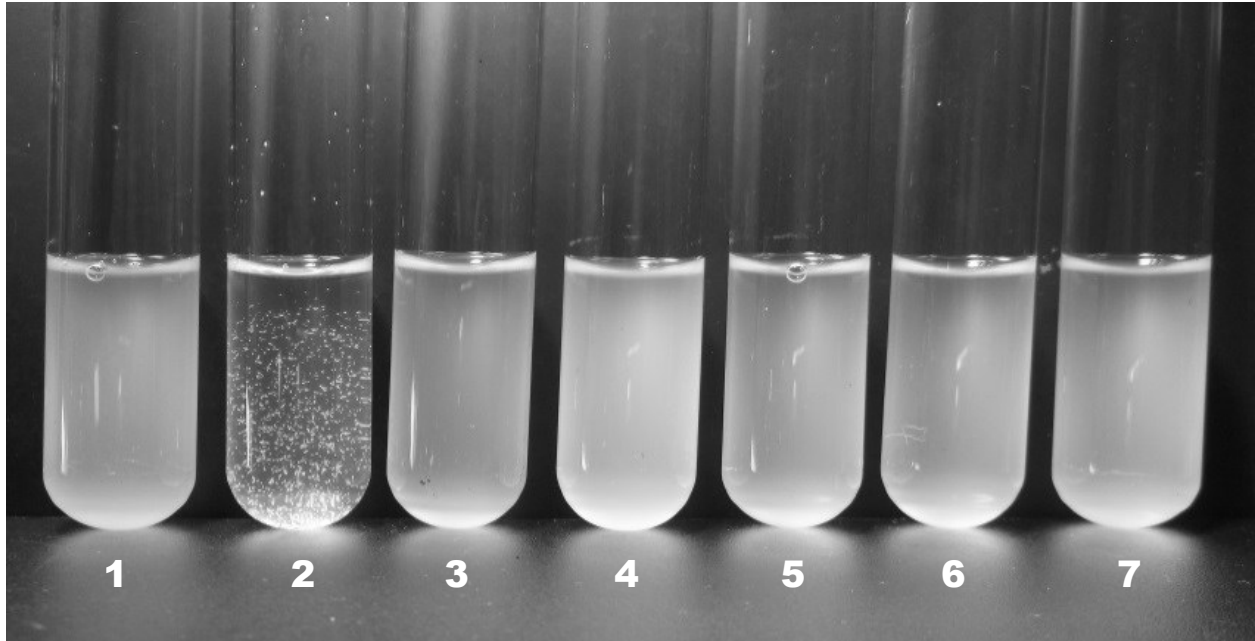


Figure 1. Cell clumping analysis. 1: WT; 2: EPS1⁺; 3: EPS1⁺ $\Delta pssE$; 4: EPS1⁺ $\Delta pssD$; 5: EPS1⁺ $\Delta pssC$; 6: EPS1⁺ $\Delta pssB$; 7: EPS1⁺ $\Delta pssA$.

Results and Discussion

The composition of the EPS was determined to consist of a two-to-one ratio of the monosaccharide sugars *N*-acetylmannosamine and galactose. The future elucidation of the chemical structure of the EPS polymer containing these sugars should benefit researchers who are working to devise methods to overcome its protective effects on cell survival.

The results of gene deletion studies are shown in Figure 1. The data are for cultures of the WT, EPS1⁺ overproduction, and EPS1⁺ with *pss* deletion strains. The data show how the WT strain (number 1) does not clump whereas EPS1⁺ (number 2) does. In each case, the deletion of a *pss* gene abolished clumping (numbers 3–7),

which indicates that all five *pss* genes are involved in EPS production.

In summary, the composition of an EPS that protects listerial cells from disinfectants and the genes required for its synthesis were determined during this year of the project.

Acknowledgments

This project is being funded by the Wyoming Agricultural Experiment Station Competitive Grants program.

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Key Words: *Listeria monocytogenes*, food contamination, disinfectant resistance

PARP: None applicable

Statewide Prioritization of Cheatgrass Infestations in Wyoming

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Introduction

Cheatgrass is an exotic winter annual grass present in North America and prevalent in Wyoming. This invasive species displaces native plant communities, increases fire frequency, and reduces wildlife habitat and livestock forage. In Wyoming, cheatgrass has not reached the magnitude or severity we see in areas such as the Great Basin. Despite this, it is a problem in many areas of the state, and there is still a chance that land managers can coordinate efforts to keep it from advancing. Currently, there is no Wyoming-wide map of cheatgrass distribution that depicts more than presence/absence data. A statewide map of both distribution and severity of invasion will be helpful for land managers by identifying invasion hotspots and providing a common tool for cooperative efforts across boundaries, including the prioritization of areas for management on a landscape scale.

Objectives

The goal of this project is to determine cheatgrass distribution and state of invasion for Wyoming and develop a model for landscape-scale prioritization. This information will be useful in developing a state-wide management strategy for cheatgrass.

Materials and Methods

This project will encompass the entire state. Existing data sets will be combined with local expert knowledge, new field surveys, and potentially remotely sensed data. This information has been collected in the form of geographic information systems (GIS) data, aerial imagery, and drawings on maps obtained at workshops. Data collection for summer 2014 will include field surveys to validate gathered datasets and to fill in gaps. Field surveys will be conducted using a “cheatgrass rapid assessment protocol” involving a photograph, a GIS point, and visual estimates of size of infestation and of cover for cheatgrass, native species, shrubs, and bare ground. The invasion states used in this protocol are in Table 1.

Table 1. Defined invasion states used to determine severity of cheatgrass. Gathering information beyond presence and absence will allow for future management prioritization.

Invasion State	Cheatgrass Cover (%)
Cheatgrass-free	0
Trace	1–5
Low	6–25
Moderate	26–50
Dominant	51–100

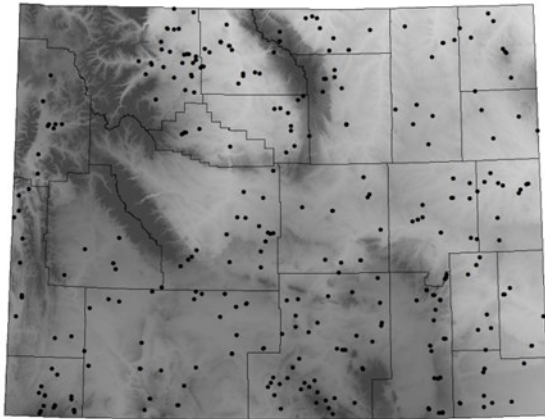


Figure 1. Survey points from summer 2013.

The final compilation of data will be used to create a distribution prediction model. This model will be used to prioritize areas for management based on invasion status. Finally, computer modeling will be used to further prioritize management based on overlap and proximity to, for example, critical wildlife habitat.

Results and Discussion

This project began in fall 2012. About 360 points were surveyed across the state in summer 2013 (Figure 1). These surveys have been used to begin developing the distribution prediction model (Figure 2). More surveys will be conducted in summer 2014, and the information will be included into the model along with data gathered from agencies. We will evaluate model accuracy in more depth when data from this final season have been collected. The full model validation process will be carried out after this point. Summer 2014 surveys will focus on local expert knowledge data, old burns, and areas known to be dominated by cheatgrass. The

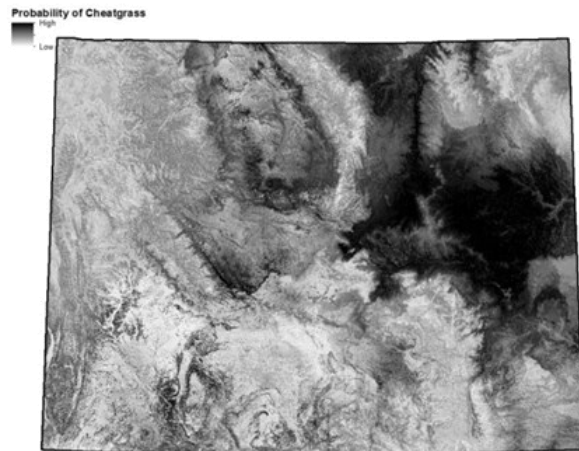


Figure 2. Preliminary model (accuracy= \sim 80%) depicting the probability of cheatgrass occurrence in Wyoming. The process of model validation will not be carried out until data from the 2014 field season are included.

model resulting from this project will be coarse in detail, but confidence is high that it will be a useful tool for statewide efforts to better manage cheatgrass.

Acknowledgments

The project is funded by the Wyoming Reclamation and Restoration Center, Wyoming Weed and Pest Council, Wyoming office of the U.S. Bureau of Land Management, and the UW Department of Plant Sciences. Thanks to Amy Pocewicz and The Nature Conservancy, Jeff Beck, Travis Decker, Beth Fowers, Amanda VanPelt, and the helpful agencies and local experts across the state.

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Key words: weed management, cheatgrass, rangeland management

PARP: III:5,7, XII: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*, other media outlets, and radio programs).
- 4) Work with commodity groups to enhance adoption of new technologies.
- 5) Conduct hands-on classes at Research and Extension 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.*

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