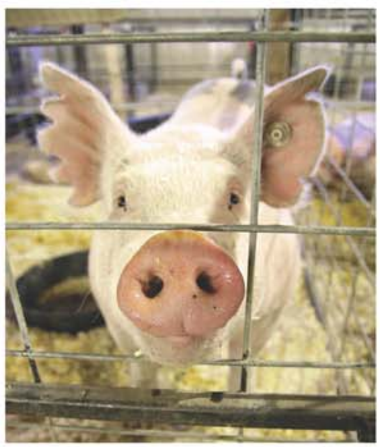
# FIELD DAYS BULLETIN

## UW AES 2015



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*This edition of the Field Days Bulletin is dedicated to our friend and colleague, Ron Pulley. A staunch supporter of the Wyoming Agricultural Experiment Station and the R&E Centers through the years, Ron will be dearly missed by all.*

# Field Days Bulletin
## 2015


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*See all the WAES Field Days Bulletins on our website at:*

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## POWELL

## SAREC

**SHERIDAN**



**OFF-STATION**

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

*B.W. Hess*[1]

I am pleased to introduce the fifth edition of the Wyoming Agricultural Experiment Station (WAES) *Field Days Bulletin*. The *FDB* is one of several vehicles WAES uses to disseminate results of its field investigations to the public. This bulletin contributes to our efforts to inform Wyoming citizens and others of the research being conducted at the four WAES Research and Extension (R&E) centers, by members of the University of Wyoming College of Agriculture and Natural Resources, as well as others who have received funding from WAES.

### Field Days

WAES works with its affiliated R&E centers to support hosting of field days throughout the summer months. This year's field days are July 14 at the Sheridan R&E Center, July 16 at Powell R&E Center, August 20 at the James C. Hageman Sustainable Agriculture R&E Center (SAREC) near Lingle, and August 27 at Laramie R&E Center. Attendees learn about accomplishments and experiments being conducted at the centers and other locations in Wyoming through a combination of field tours, 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.

### Field Day Hosts

Directors of each R&E Center serve as hosts for their respective field days. There is nearly a whole new line-up of hosts for this year's field days. The Sheridan R&E Center event will be overseen by Brian Mealor, who began serving as director of that center on May 18, 2015. John Tanaka is hosting this year's field day at Powell. He took the helm as associate director of WAES before Gary Moss retired the end of May. John will provide administrative support for the Powell center until a co-director of the Wyoming State Seed Laboratory and Powell R&E Center is hired. The long-time host of SAREC's field day, Jim Freeburn, has refocused his career solely on his role as coordinator of the Western Sustainable Agriculture Research and Education's Professional Development Program. Therefore, John Tanaka will lead the SAREC event. John will spend 60% of his effort as director of SAREC starting July 1, 2015. Lastly, now the longest standing R&E Center director, Doug Zalesky, will preside over our final field day of the season at the Laramie R&E Center.

### WAES *Field Days Bulletin*

WAES publishes the *Field Days Bulletin* in an effort to make our constituents aware of research and other activities being conducted at

[1]Director, Wyoming Agricultural Experiment Station.

the R&E centers and other locations in Wyoming, including on-farm trials. 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, so author contact information is provided with each article for those readers who wish to receive more in-depth information about a particular topic.

### Linking to the Production Agriculture Research Priorities

Beginning with the 2014 WAES *Field Days Bulletin*, when relevant, authors have indicated which of the Wyoming Production Agriculture Research Priorities (PARP) is/are addressed in their report. With extraordinary input from numerous producers (refer to last year's introduction to the *Field Days Bulletin*), PARP was developed to document agriculture research needs in Wyoming. The latest version of PARP is included in the appendix at the end of this edition of the *Field Days Bulletin.* Readers are encouraged to keep on the lookout for changes to the electronic copy of PARP located on the WAES webpage under "Important Links" at www.uwyo.edu/uwexpstn/ as we continuously revise the document according to new input we receive. Input was gathered last year during a series of listening sessions throughout northwest Wyoming that WAES held in conjunction with the Powell R&E Center and UW Extension. Readers also should feel free to contact WAES (aes@uwyo.edu) if they have suggestions for PARP objectives not currently listed.

The *Field Days Bulletin* is not the only place that we have begun linking the PARP document to our research activities. Researchers in the college are now asked to volunteer which PARP is/are addressed in all of their research publications when they submit their annual report on accomplishments. Peer-reviewed research papers listed in the 2014 Faculty Refereed Publications, for example, reference PARP. The list is available at www.uwyo.edu/uwexpstn/publications. Scroll to the lower middle of the page to find the link. The WAES effort to link to PARP will not only help demonstrate how researchers are responding to Wyoming's production agriculture needs, but will also help identify areas that require more attention.

**Acknowledgments*:*** I wish to thank all members of WAES for their tremendous effort to keep WAES vibrant. Members of UW Extension are also thanked for assistance with organizing and participating in WAES listening sessions. A special acknowledgment is extended to Tara Kuipers for a wonderful job facilitating the sessions. Of course, a special shout goes out to all of the producers who took time to provide input into PARP. Thank you also to all the contributors to WAES bulletins. Last, and certainly not least, many thanks to editors Joanne Newcomb and Robert Waggener for their exceptional work to make the *Field Days Bulletin* a highly professional document, to David Perry for his help organizing bulletin peer reviews, and to Tana Stith for the cover design.

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Introduction to the
# Laramie Research and Extension Center

*D. Zalesky*[1]

The Laramie Research and Extension Center (LREC) provides a diverse set of resources for numerous departments within the College of Agriculture and Natural Resources. These resources are utilized for efforts in research, teaching, and outreach. Due to LREC's close proximity to campus, numerous classes can utilize the center's resources to provide students with hands-on learning experiences. LREC staff work hard to balance resource needs for all three parts of the land-grant mission and to make sure that the highest quality resources are available for faculty, staff, students, the people of Wyoming, and users from other states.

## Highlights and Accomplishments

During the past year, we lost a valued LREC staff member to retirement, Dave Moore, who worked as *Beef Unit* manager and farm manager for more than 35 years. His knowledge and expertise will be greatly missed. Mark Karlstrum joined LREC in January as an assistant farm manager with primary responsibilities for the Cliff and Martha Hansen Livestock Teaching Arena and equine facilities.

The *Sheep Unit* (Figure 1) successfully completed two producer-consigned ram tests this past year. Additionally, the unit provided animal and facility resources for several research projects, lab classes, judging contests, and other outreach activities.

A research project evaluating vitamin D production in swine was successfully completed at the *Swine Unit.* The unit also completed a successful pig and lamb sale, which is conducted annually for local 4-H and FFA students. Additionally, the Swine Unit provides resources for teaching and outreach activities throughout the year.

The LREC *Greenhouse Complex* (Figure 2) continues to be a very busy location with numerous research projects. Faculty members and graduate students from the departments of Plant Sciences, Ecosystem Science and Management, Molecular Biology, and Botany utilize the facility year-round. Staff members at the greenhouse complex provide resources for teaching and outreach. The complex had a successful open house and field day last year, and we are busy planning for the upcoming field day August 27.

In 2014, the *Beef Unit* continued to provide animals and facilities to conduct research related

Figure 1. White-face rams on test at the Sheep Unit.

[1]Director, Laramie Research and Extension Center.

to feed efficiency in beef cattle. Studies evaluating the impact of feed efficiency on traits such as growth, carcass, and reproduction are under way. Additionally, a study evaluating omega-3 fatty acids fed in the diet of cattle was conducted. The unit also had a busy year providing animals and facilities for a variety of Department of Animal Science classes and other activities.

The *Lab Animal Facility* remains full and is utilized heavily to house rats and mice used in research projects by faculty members, students, and staff in the departments of Animal Science, Veterinary Sciences, and Molecular Biology, as well as the microbiology program.

One of the busiest and most heavily utilized facilities at LREC is the *Hansen Livestock Teaching Arena and Mary Mead Room* (Figure 3). This facility is utilized in excess of 275 days annually for one event or another. Aside from being the home of the UW Rodeo Team, it is also used to conduct lab classes, provide a practice arena for other UW teams and organizations, and host numerous outreach events and meetings.

**Acknowledgments**: The mission of LREC is to provide quality resources for research, teaching, and outreach. The success of accomplishing the mission depends on the quality staff members at LREC. Their efforts make it possible to provide these resources to UW faculty, staff, and students as well as the people of Wyoming and other states.

**Contact:** Doug Zalesky at dzalesky@uwyo.edu or 307-766-3665.

Figure 2. Research plants in one of LREC's greenhouses.


Figure 3. Cliff and Martha Hansen Livestock Teaching Arena and Mary Mead Room.

# Short Reports—LREC

### 1. Does Dalmatian toadflax alter soil microbe communities to the detriment of native rangeland plants?

**Investigators:** Timothy Collier and Naomi Ward

**Issue:** Understanding the mechanisms by which invasive, non-native weeds detrimentally affect native and desirable rangeland plant species could provide insight into the variability of weed management success. A potentially important, but poorly studied, mechanism of invasion is that invasive weeds inhibit soil microbes that are beneficial to native plants.

**Goal:** Use a novel experimental approach to determine whether Dalmatian toadflax alters soil microbes in a way that affects native plant growth.

**Objectives:** Evaluate the growth of native plant seedlings—western wheatgrass (*Pascopyrum smithii*) and a forb commonly called blazing star (*Liatris punctata*)—receiving a small batch of soil microbes from soils altered by Dalmatian toadflax or from unaltered "control" soils.

**Impact:** This research is a starting point for future studies on how different management strategies affect what might be called "microbially mediated" invasion by non-native weeds. The key issue is the extent to which different weed management strategies restore an important ecological service provided by soil microbial communities: promoting desirable vegetation production on rangelands.

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

**Keywords:** soil microbial effects, weed invasion, Dalmatian toadflax

**PARP:** III:3,5

### 2. Vegetables and herbs under high and low tunnels

**Investigators:** Karen Panter, Sadanand Dhekney, Ami Erickson, Chris Hilgert, and Jim Heitholt

**Issue:** Fresh, locally grown produce may not be as readily available in Wyoming as in other states for reasons including short growing season, adverse climatic conditions, and high altitude. Unheated high tunnels, alone or in combination with low tunnels (row covers), may help producers overcome some of these obstacles.

**Goal:** Help Wyoming vegetable and herb growers establish more sustainable production systems utilizing relatively inexpensive season-extension technology.

**Objectives:** We are comparing two season-extension systems for growing tomatoes, basil, peppers, and green beans at the Laramie Research and Extension Center (with a similar study at the Sheridan R&E Center): high tunnel and low tunnel within a high tunnel.

**Impact:** The project should provide important information on the usefulness of low tunnels within high tunnels for production of the four crops. Results may also benefit commercial vegetable and herb producers by providing Wyoming-based research information for extending the growing season.

**Contact:** Karen Panter at kpanter@uwyo.edu or 307-766-5117, or Sadanand Dhekney at sdhekney@uwyo.edu or 307-673-2754.

**Keywords:** vegetables, high tunnel, low tunnel

**PARP:** not applicable

# Effect of Forage Kochia on Growth of Native Grass Seedlings

*P. Aryal*[1] *and M.A. Islam*[1]

Forage kochia (*Bassia prostrata*) is a desirable nonnative perennial species for reclamation of disturbed areas and for forage production during fall and winter in semiarid rangelands. It can grow in harsh, degraded, and weed-infested areas, and it can compete with invasive annual weeds such as cheatgrass (*Bromus tectorum*) and halogeton (*Halogeton glomeratus*). Despite its benefits, there is a fear that it can compete with native plants and spread into native rangelands; however, there is limited information available on its competition with native species. Therefore, growing forage kochia with native grasses could provide insight into interactions between forage kochia and native grasses.

## Objectives

Our objective was to determine the effect of forage kochia on the growth of native perennial grasses.

## Materials and Methods

The experiment was conducted at the Laramie Research and Extension Center (LREC) greenhouse complex. The study consisted of 'Immigrant' forage kochia and native perennial cool-season grasses including 'Anatone' bluebunch wheatgrass, 'Magnar' basin wildrye, 'Critana' thickspike wheatgrass, and 'Rosana' western wheatgrass. Treatments were: forage kochia grown alone, and each native grass grown alone and with forage kochia. The experimental design was completely randomized with five replicates. All treatments were sown in respective pots June 13, 2014, and thinned to the desired number of seedlings in each pot two weeks after sowing. Plant height of all species, branch number of forage kochia, and tiller number of each native grass were measured twice (after thinning and prior to harvesting) to calculate changes in plant height (forage kochia and grasses), branching number (forage kochia), and tiller number (grasses) from thinning to harvest. All plants were harvested separately on October 28, 2014, oven-dried, and weighed to determine aboveground biomass. This experiment was repeated on November 1, 2014, and harvest took place February 16, 2015, using the same protocol, except growth media. The first experiment was performed using greenhouse potting soil, while the repeated experiment used actual field soil (fine-loamy) collected from a field in West Laramie.

## Results and Discussion

Results from the first experiment showed no competitive effect of forage kochia on growth of any native grasses in terms of height, tiller number, and aboveground biomass (data not shown). Similarly, native grass seedlings did not show significant effect on the height, branching, and aboveground biomass of forage kochia seedlings (data not shown). In the repeated experiment, forage kochia moderately reduced the height of bluebunch wheatgrass, but did not affect tiller number of any native grasses (data

[1]Department of Plant Sciences.

not shown). Aboveground biomass of bluebunch wheatgrass and basin wildrye was reduced when grown with forage kochia (Figure 1A). The height of forage kochia seedlings was reduced when grown with each native grass except western wheatgrass. The branching number of forage kochia was reduced when grown with each native grass (data not shown). Similarly, aboveground biomass of forage kochia was also considerably lower when grown with each native grass than when grown alone (Figure 1B). Overall, these results suggest that forage kochia may not be a strong competitor with seedlings of native grasses used in this experiment; however, additional research is needed to better understand the interactions between forage kochia and native grasses at seedling and mature stages in actual field conditions. This information could help land managers, ranchers, farmers, and others in Wyoming and beyond decide whether to plant forage kochia with native grasses to improve pastures, rangelands, and disturbed sites.

**Acknowledgments:** The project was funded by the University of Wyoming Energy Graduate Assistantship Initiative Program.

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**Keywords:** forage kochia, native perennial grass, competition

**PARP:** VI:4,8, XII:1

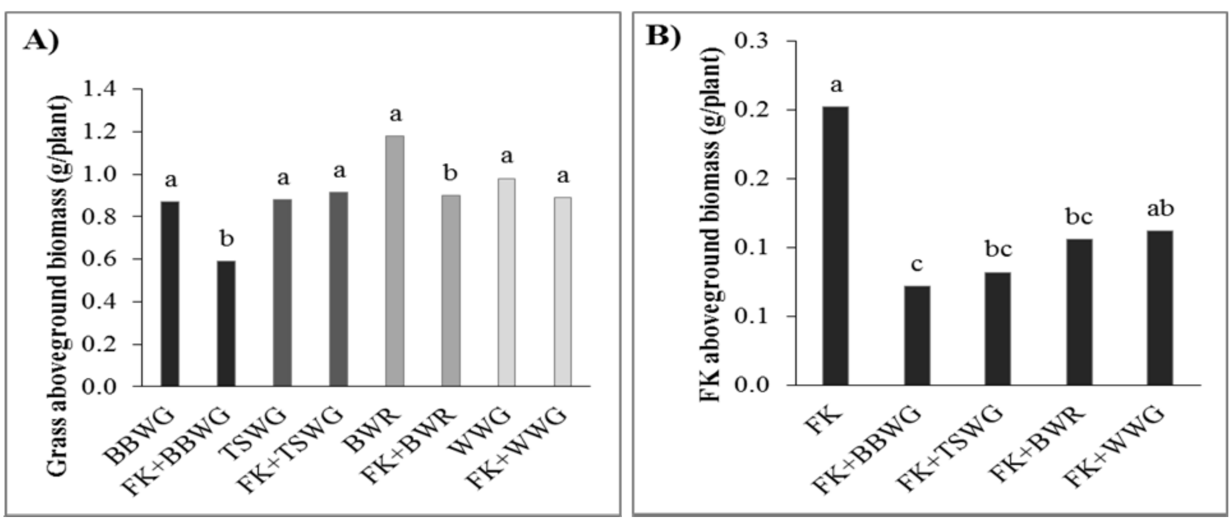


Figure 1. Means of aboveground biomass (per plant) of (A) four native grasses, and (B) forage kochia within each treatment in the repeated experiment. (A) Within each grass species grown alone or with forage kochia, and (B) across all treatments in which forage kochia was grown, means with different lowercase letters were significantly different ($p$<0.05). BBWG, bluebunch wheatgrass; FK, forage kochia; TSWG, thickspike wheatgrass; BWR, basin wildrye; WWG, western wheatgrass. Conversion: 1 g=0.002 pound.

# Mapping Function Value Traits in *Brassica rapa*
## (Field Mustard, Turnip)

*R. Baker[1], M.T. Brock[1], M.J. Rubin[1,2], J.N. Maloof[3], S.M Welch[4], and C. Weinig[1,2,5]*

Yield in agricultural fields is influenced by the shape of developmental growth curves (Figure 1). Developmental variation can have dramatic effects on plant fitness and yield, and it is, consequently, an important target for natural and artificial selection by crop breeders. Characterizing genetic controls and environmental dependencies of organismal development may lead to better predictions of yield. Further, describing the shape of developmental growth curves may reveal genetic controls that single time point analyses cannot because, in theory, there are an infinite number of growth curves that can result in the same final measurement.

Relatively few studies incorporate the entirety of organismal development. In part, this is because studying developmental variation adds not only significant time and cost to experiments, but also complexity to data analysis.

### Objectives

The overarching objective is to understand the genetic underpinnings of plant morphology and the effects on plant yield. Specific goals were to: 1) characterize the mathematical functions that describe the expansion of organs such as leaves and stems, 2) ascertain how micrometeorological variation (for instance, temperature, light intensity, etc.) affects trait expression, and 3) evaluate correlations between aspects of leaf growth and other agronomically important traits such as flowering time.

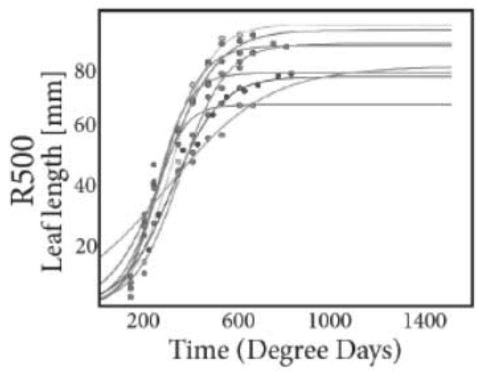


Figure 1. Plots of leaf length as a function of time for one genotype of *Brassica rapa*. Circles are measured leaf lengths, and lines represent growth curves fit by Bayesian modeling to estimate the rate of growth, duration of growth, size when growth is 95% complete, and maximum size. Genotypes of this species differ in all of these growth parameters as estimated from our models.

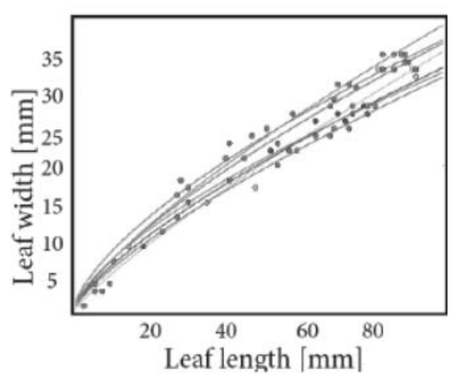


Figure 2. Allometry plots of leaf width as a function of leaf length. Circles are measured leaf lengths and widths, and lines represent curves fit by Bayesian modeling to estimate aspects of leaf shape. Interestingly, shape was genetically independent of size, as shown in Figure 1.

[1]Department of Botany; [2]Program in Ecology; [3]University of California, Davis; [4]Kansas State University; [5]Department of Molecular Biology.

## Materials and Methods

We studied morphological traits in diverse cultivars of *Brassica rapa* (field mustard), which has been domesticated as turnip, diverse leaf crops such as pak-choi, the flower crop brocoletto, and the original canola oilseed crop. Plants were measured daily for the expression of morphological traits such as leaf length, leaf width, and stem height and phenological traits like flowering time, all of which may affect plant yield, depending on conditions in the growing season. We also recorded high-frequency micrometeorological data at the site, including daily temperature ranges, light intensity, and precipitation; abiotic factors like these can also have a pronounced effect on yield.

## Results and Discussion

We identified mathematical functions of leaf growth (Figure 1) and leaf allometry (or shape) (Figure 2) and estimated coefficients for parameters of these functions for 130 unique genetic lines. We have mapped coefficients for leaf growth curves and allometry to unique genomic regions. Notably, the genomic regions that affect expansion patterns are not always the same as those that affect final size, *indicating that our approach identifies novel genetic controls on leaf development*. Further, the genetic controls on leaf size are often independent of leaf shape, *indicating that agronomists could select for improvements in leaf shape that reduce water use or improve light interception without affecting overall plant size*.

**Acknowledgments:** We are grateful for field assistance from Laramie Research and Extension Center staff members Casey Seals and Ryan Pendleton in maintaining and establishing greenhouse and field conditions. The research was supported by National Science Foundation grant DBI 0605736 to Professor Cynthia Weinig.

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**Keywords** : canola, function-value traits, plant morphology

**PARP:** VIII:1

# Evaluating Direct Herbicide Impacts on Desirable Species Used in Reclamation

*B. Fowers[1], B.A. Mealor[1,2], A.R. Kniss[1]*

Direct disturbance of plant communities occurs with natural resource extraction. Successful reclamation mitigates negative impacts to plant and animal communities. Reclamation commonly includes seeding treatments to return desirable species to the area and herbicide applications to control weed communities that could compete with seeded species. Success is determined by the degree of desirable plant establishment and weed control compared to a reference area and is affected by many variables including competition and environmental factors. Direct effects of herbicides, without additional confounding environmental factors, are not well documented for some herbicides and desirable species. Unintended impacts of herbicides on desirable species may retard the progress of successful reclamation.

## Objectives

Our objective was to evaluate impacts of different herbicides at various timings on growth of desirable and weed species. This study can be used to evaluate a suite of herbicides that may cause unacceptable damage to desirable species used in reclamation at various plant growth stages (herbicide timings) when herbicide applications are used in reclamation weed control.

## Materials and Methods

In a greenhouse experiment, we planted 14 different species in 1 x 6.3-inch containers (2.2 oz) filled with a 3:1 mixture of potting medium and sand. Species included perennial grasses and two forbs commonly used in reclamation and two weed forbs (Table 1). We included the desirable (Lewis flax and scarlet globemallow) and weedy (common lambsquarters and the annual weed kochia) forb species to evaluate herbicide effects on dicots.

We applied 10 different herbicide/rate combinations (Table 2) at three different timings to coincide with growth stages of the grasses. Preemergence herbicides were sprayed the same day as planting. Postemergence treatments were applied 30 days after planting (DAP), growth stage of 3–5 leaves, and 53 DAP, one or more tillers. We applied herbicide treatments in a spray chamber delivering 20.13 gal/ac at 40 PSI.

Table 1. Species used in the greenhouse study.

| Common name | *Scientific name* |
|---:|---|
| 'Arriba' western wheatgrass | *Pascopyrum smithii* |
| 'Sherman' big bluegrass | *Poa secunda* |
| 'Trailhead' basin wildrye | *Leymus cinereus* |
| 'Anatone' bluebunch wheatgrass | *Pseudoroegneria spicata* |
| 'Sodar' streambank wheatgrass | *Agropyron riparium* |
| alkali sacaton | *Sporobolus airoides* |
| 'Hycrest' crested wheatgrass | *Agropyron cristatum* |
| 'Bozoisky' Russian wildrye | *Psathyrostachys juncea* |
| blue grama | *Bouteloua gracilis* |
| squirreltail | *Elymus elymoides* |
| Lewis flax | *Linum lewisii* |
| scarlet globemallow | *Sphaeralcea coccinea* |
| kochia | *Kochia scoparia* |
| common lambsquarters | *Chenopodium album* |

[1]Department of Plant Sciences; [2]Sheridan Research and Extension Center.

Table 2. Herbicides and rates.

| Chemical Name | Rate |
|---|---|
| Aminocyclopyrachlor plus chlorsulfuron | 2.2 oz ai/acre<br>0.9 oz ai/acre |
| Aminocyclopyrachlor plus chlorsulfuron | 1.1 oz ai/acre<br>0.4 oz ai/acre |
| Aminocyclopyrachlor | 2.2 oz ai/acre |
| Aminocyclopyrachlor | 1.1 oz ai/acre |
| Aminopyralid | 1.3 oz ai/acre |
| Chlorsulfuron | 0.8 oz ai/acre |
| Imazapic | 3.7 oz ai/acre |
| Rimsulfuron | 1.9 oz ai/acre |
| 2,4-D Amine* | 24 oz ai/acre |
| Saflufenacil* | 0.4 oz ai/acre |

*herbicides only applied postemergence.

The study consisted of all herbicide application timings and herbicides/rates across all species for a total of 29 treatments including a non-treated check, replicated six times. Visual estimates of plant injury were recorded weekly following herbicide applications (data not discussed). All plants were harvested 83 DAP by clipping biomass (of alive and dead plants) at the soil surface, showing final potential growth of plants with different herbicide treatments. Biomass was dried at 140°F for 48 hours and weighed to the nearest milligram.

## Results and Discussion

Herbicide application timing was important for all species and herbicides ($p$<0.0001). The preemergence application caused the greatest damage, and as DAP increased, damage also decreased. At the postemergence timings, some herbicides that caused little damage or even increased biomass of some species included aminocyclopyrachlor (both rates), aminocyclopyrachlor+chlorsurfuron (low rate), chlorsulfuron, and saflufenacil. Some species observed to be less affected by herbicides by comparing non-treated plants included streambank wheatgrass, blue grama, and crested wheatgrass. Other species such as basin wildrye and big bluegrass showed increased relative sensitivity to herbicides. Most herbicides negatively impacted the forb species indicating the need for care when desirable forbs are included in reclamation. One area of concern is the tradeoff between reduced negative impacts on desirable species through later herbicide application and the potential for reduced weed control if an application occurs after the recommended weed growth stage for effective control. Knowledge of herbicide sensitivities to specific species could help guide reclamation efforts and increase reclamation success.

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

**Contact:** Beth Fowers at bfowers@uwyo.edu, or Brian Mealor at bamealor@uwyo.edu or 307-673-2647.

**Keywords:** herbicide, reclamation, perennial grasses

**PARP:** III:2, XII:1

# Irrigating Chives in a Greenhouse and Two High Tunnels

*T. Gergeni[1] and K. Panter[1]*

Since 2011, we have been conducting research into specialty crop production in the greenhouse and two high tunnels at the Laramie Research and Extension Center (LREC).

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

One purpose of this project is to determine water use characteristics in the greenhouse and in two high tunnels using garlic chives as the test plant. Another is to make these irrigation findings available to Wyoming growers.

## Objectives

This project has the main goal of determining comparative differences in soil moisture levels among the two high tunnels and the greenhouse. The aim is to encourage responsible irrigation practices on specialty crops that can be grown in Wyoming for sale at local venues such as farmers' markets.

## Materials and Methods

Garlic chives are being grown in the greenhouse and two high tunnels at LREC's greenhouse complex. The current project began in January 2015 and will continue through fall 2015. Garlic chives (*Allium tuberosum*) is being grown as the test plant because it is easy to grow and is not susceptible to many insects or diseases.

Seeds were sown in January 2015. The first seedlings were transplanted into the greenhouse in February 2015. Plants are in 6-inch containers in a commercial, soilless growing medium.

In the greenhouse, there are two treatments: hand-watered control and drip irrigation. Within each treatment, one Spectrum® Technologies Inc. WatchDog 1000 Series Micro Station data logger and four WaterScout SM 1000 Soil Moisture Sensors are monitoring growing medium water content. All plants were harvested May 6, 2015.

The project was repeated starting in May 2015 with a new set of plants in the greenhouse plus two sets of plants in each of the two high tunnels. All plants in the high tunnels are being watered by hand on an as-needed basis. Data loggers and moisture sensors were also placed in each location in the high tunnels.

Data being collected on a per-plant basis in each treatment include days to germination, days to transplant, and fresh weight of chives harvested once in fall 2015. Data loggers record

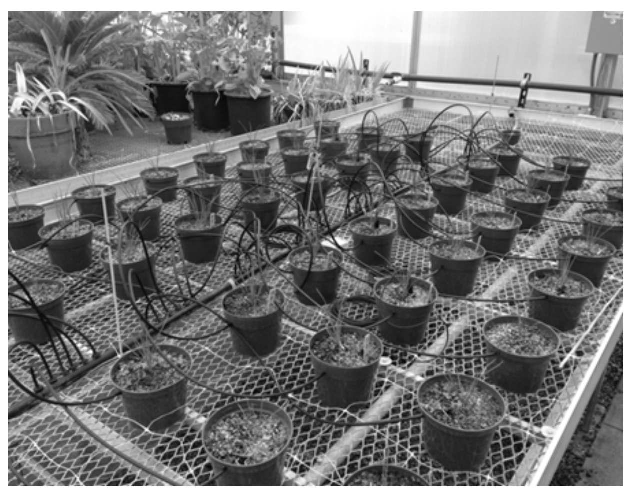

Figure 1. Greenhouse production of chives using drip irrigation.

[1]Department of Plant Sciences.

moisture contents at one-hour intervals; these data will be used to detail watering requirements in the greenhouse and high tunnels. The experimental design is completely randomized with 24 single-plant replications (Figure 1). All data will be analyzed using analysis of variance and mean separations.

### Results and Discussion

Partial results will be available for the August 27 LREC Field Day. Figure 2 shows moisture curves of containers in the greenhouse during February 2015.

**Acknowledgments:** The Wyoming Agricultural Experiment Station provided project funding.

**Contact:** Karen Panter at kpanter@uwyo.edu or 307-766-5117, or Timmothy Gergeni at tgergeni@uwyo.edu.

**Keywords**: irrigation, greenhouse, high tunnel

**PARP**: not applicable

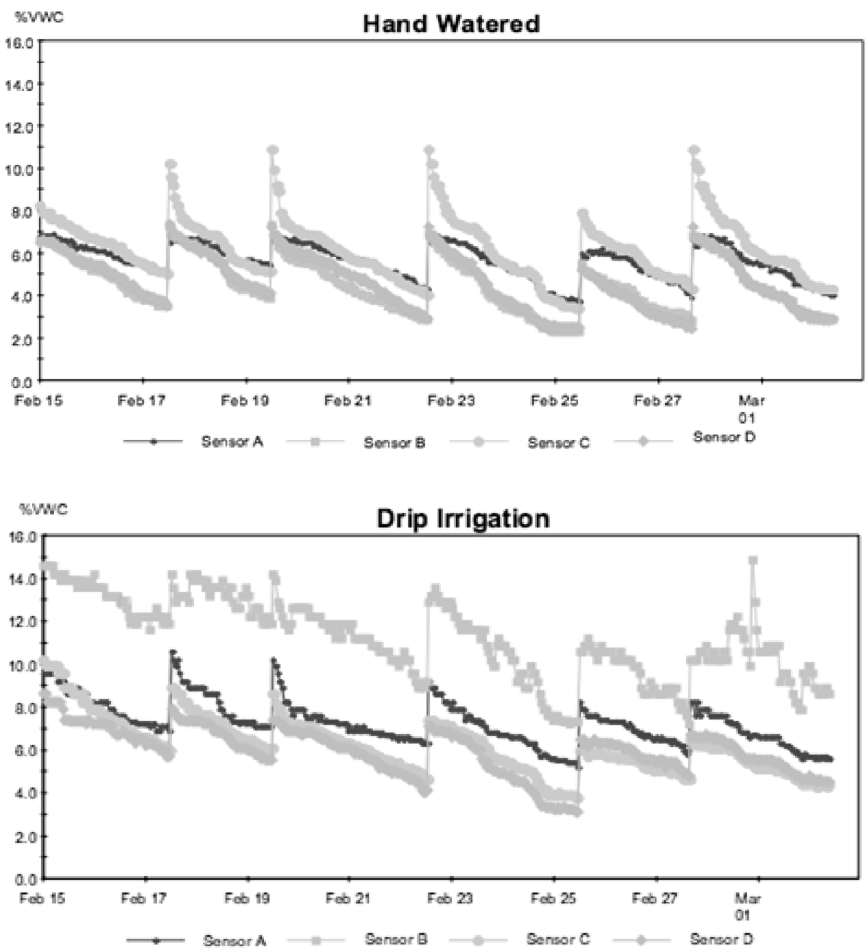


Figure 2. Growing medium moisture curves in February 2015 using hand-watered control (top) and drip irrigation (bottom).

# Priming Science: Writing Emerging Science to Engage Resource Navigators

*K. Gunther[1], A.L. Hild[1], S.L. Bieber[2], and J.J. Shinker[3]*

Researchers and ecosystem managers, including agricultural producers, are focusing increasing attention on the topic of science communication. The way scientists share their findings can affect how and whether those findings can be successfully transferred to useful applications in the field. Commonly, "communication gaps" hinder our application of new ideas and technology.

One reason may be that scientists are taught to share information neutrally, yet we know that our values, beliefs, and emotions play important roles in communication about ecosystems. "Priming" is a psychological effect in which an earlier experience influences a subject's perception of a later experience. We hypothesize that "priming" technical texts with emotional language and values—by indicating either "positive" or "negative" contexts—will affect how readers respond to the information presented. While priming approaches have been used in health and medical outreach, this is a novel application within the context of communicating science relevant to ecosystem management.

## Objectives

We wanted to test the effect of priming technical information with value-loaded language ("positive" or "negative") on audience reception of that science. We sought to identify differences in reception among subpopulations of participants involved in ecosystem management in different ways (e.g., land managers or policymakers). Ultimately, our goal is to develop communication training materials for researchers and educators, including Extension personnel from the University of Wyoming and beyond.

## Materials and Methods

We conducted our pilot study at Wyoming Agricultural Experiment Station (WAES) field days' events in summer 2014, as well as throughout Wyoming at summer and fall meetings of agricultural production and management-oriented groups and by phone and email.

Participants were asked to rate "how true" they found 15 statements related to the topic of ecosystem uncertainty. Next, they were presented with text that provided information related directly to those 15 statements. For two treatment groups, the technical information was introduced with a paragraph using either "positive" language (words like "opportunity" and "profit") or "negative" language (words like "threat" and "loss"). The control group received no introductory paragraph. Participants then reevaluated the same statements. One month later, statements were rated a final time.

## Results and Discussion

Preliminary results from our pilot study indicate that emotional language influences audience

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receptiveness. Differing emotional content (priming) can drive audience perception in different directions (Figure 1). In several cases, treatment groups were not different after priming, but both treatment groups differed from the control group. This suggests that emotional language may be useful as a communication tool regardless of whether the emotion conveyed is positive or negative.

Our pilot data is followed by development of a national study, underway through summer 2015. In the expanded survey, we measure the effects of positive and negative priming texts and add the influence of priming images with "positive" and "negative" audience connotations. This study continues through late 2016.

**Acknowledgments:** We extend our gratitude to 2014 WAES field days' attendees for their participation. This study is supported through the WAES Competitive Grants Program.

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**Keywords**: science communication, adaptive management

**PARP:** IX:2,4,5

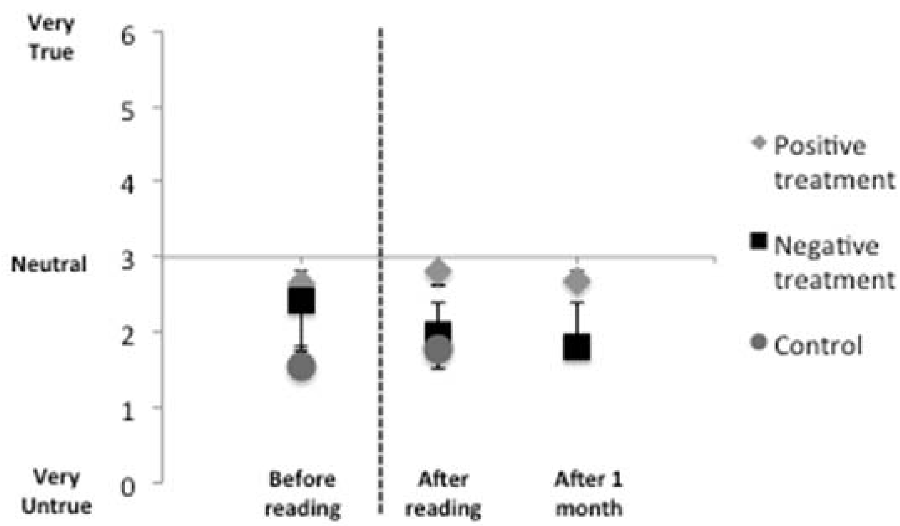


Figure 1. "Managers do not often have opportunities to make good observations of ecosystem complexities." The negative treatment group rated this statement as "more untrue" than participants in the positive treatment group after reading the text; this difference was statistically significant.

# Vitamin D Status from Sun Exposure in Swine in Laramie

*B.C. Ingold[1], S.R. Fensterseifer[2], K.C. Myers[2], E. Larson-Meyer[1], and B. Alexander[2]*

Vitamin D insufficiency increases risk for both chronic diseases and acute illness. Altitude, season, time of day, and latitude are all known factors affecting the amount of vitamin D synthesized by the skin when exposed to sunlight. Since pigs are commonly raised indoors with limited exposure to natural sunlight, the majority of circulating vitamin D in the pig is of dietary source, risking vitamin D insufficiency. Low vitamin D status in all mammals leads to bone disease and may also increase risk of infectious illness and suboptimal health. Even though dietary supplementation is utilized in modern swine operations, bone disorders still occur (Dittmer and Thompson, 2011), suggesting optimal supplementation of diets is not always achieved.

Confinement animal practices serve practical management purposes, but in an era when the consumer is demanding natural products and is 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. Expected benefits to the exposed pigs include enhanced immunity (Konowalchuk et al., 2013) and increased storage of vitamin D in animal tissues. Although animal tissues are not generally regarded as vitamin D rich (Heaney et al., 2009), exposure to sunlight would be expected to increase vitamin D synthesis and storage, increasing the health value of those pork products.

## Objectives

Objectives of this study were to determine the capacity of white pigs to synthesize vitamin D during the spring equinox and summer solstice at altitude in a northern latitude and further determine the vitamin D value of pork products obtained from sun-exposed pigs.

## Materials and Methods

Ten primarily white, Landrace-cross pigs (69.2±9.4 lb) were exposed to sunlight for one hour each day during solar noon (when the sun is directly overhead) for a two-week period surrounding the spring equinox in March 2014 and the summer solstice in June. Control pigs (n=10) were kept indoors as per conventional production practice. Total UV radiation was measured, and UVB was calculated during the exposure periods (the study is taking place at the Laramie Research and Extension Center, elevation ~7,200 feet). Pigs were weighed weekly with blood samples collected prior to and following sun exposure to determine concentrations of vitamin D and a marker of inflammation (TNFα). All pigs were fed conventional grower diets containing 750 IU of vitamin $D_3$/lb of feed. Following the summer solstice exposure period, slaughter-weight pigs were sent to the slaughterhouse. Loin samples were collected to determine muscle vitamin D content.

## Results and Discussion

Average UVB radiation was not different between spring and summer; however, peak inten-

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sity of UVB was greater ($p$=0.006) in the summer than spring. Sun-exposure caused a slight pinking of the skin during exposure periods, but exposed pigs did not demonstrate any sign of pain or discomfort.

During the spring equinox, exposure to sunlight increased ($p$<0.001) serum concentrations of total vitamin D by 177% with control pigs experiencing a 26% dietary-induced increase. All values fall within the reported range of growing pigs (Arnold et al., 2015). Following two months of indoor confinement, all pigs had similar serum concentrations of vitamin D. Exposure to sunlight during the summer solstice again increased ($p$<0.001) serum concentrations of vitamin D by 31% for sun-exposed pigs. Weight gain was unaffected by sun exposure. Total vitamin D content of loin tissue was improved (141%; $p$<0.001) by sun exposure.

Exposing pigs to sunlight is a cost effective way to improve the vitamin D status in swine and improve the nutritional value of their products. Although differences were not noted in measures of inflammation, the improved vitamin D status may improve health outcomes if pigs were exposed to pathogens.

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**Keywords:** swine, sun-exposure, vitamin D

**PARP:** not applicable

**Literature Cited**

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# Effects of Feed Efficiency Ranking and Indexing on Reproductive Performance in Growing Beef Heifers

*S.L. Lake[1] and C.L. Marshall[1]*

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 inefficient herd mates. Recent findings indicate that heifers selected for low residual feed intake (RFI) values—these are high feed-efficient animals—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.

## Objectives

The overall objective of this study was to evaluate effects of RFI on reproductive efficiency. Specific goals were to evaluate the effects of RFI on body weight (BW), BCS, conception rate, pregnancy rate, and age at first calving (AFC). Additionally, we wanted to create an equally weighted index incorporating RFI and growth.

## Material and Methods

Seventy-five Angus x Hereford heifers were utilized for this study. Following weaning (average age=217 days±2.88 days), all heifer progeny were managed as a common group.

Following breeding, all heifers had *ad libitum* access to a GrowSafe system where a high-fiber pelleted ration was offered for 42 days to determine individual intake. Residual feed intake was calculated as actual dry matter intake (DMI) minus predicted DMI. An index was created with equally weighted RFI, average daily gain (ADG), and gain:feed (G:F). The groups were sorted into the top 20% indexing, which represents the likely percentage to be kept by cattle producers, and then the remaining heifers were sorted into two groups based on the index. All animal procedures were approved by the University of Wyoming Institutional Animal Care and Use Committee.

## Results and Discussion

As expected, heifers sired by high RFI bulls had a greater RFI than heifers sired by low RFI bulls (Table 1). As has been reported in the literature, there was no difference in DMI, ADG, or conception rate due to feed efficiency ranking. Therefore, it appears that selecting for heifers

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Table 1. Effects of RFI and INDEX on reproductive performance.

| Item | RFI Ranking* LOW | MED | HIGH | *p*-value |
|---|---|---|---|---|
| RFI | -1.26 c | 0.04 b | 1.26 a | 0.01 |
| ADG, lb/day | 2.89 | 3.04 | 3.02 | 0.79 |
| Conception, % | 72.0 | 58.3 | 66.7 | 0.61 |
| Pregnancy, % | 96.0 | 91.7 | 87.5 | 0.57 |
| INDEX | | | | |
| RFI | -1.18 c | -0.08 b | 0.65 a | 0.01 |
| ADG, lb/day | 3.61 a | 3.06 b | 2.22 c | 0.01 |
| AI Conception, % | 72 | 69 | 58 | 0.08 |

*Means with different letters (a,b,c) differ ($p$<0.05). The INDEX was created with equally weighted RFI, ADG, and G:F. The groups were High (top 20%), with the remaining into MED and LOW groups.

with a low RFI could result in feed savings without compromising growth parameters. But in an arid region such as Wyoming, where cattle spend much of the year on low-quality ranges, it could be argued that selection of heifers that eat large quantities of food is essential to be able to consume enough low-quality forage to meet their requirements. It may seem like semantics, but why select for animals that eat below average and perform to the population average, when you could select for animals that eat about average, but perform well above average? In most years and systems, animal weight drives profitability, so why not select for higher growth animals?

The second portion of this study was to create an index equally weighted between efficiency and growth. For this example, we selected the top 20% indexing heifers to keep as potential replacements. Our top indexing heifers still had a decreased DMI, still had a negative RFI, had significantly greater ADG, and had almost a 15% increase in AI conception rate (Table 1). The conception rate is not statistically different, but that large of a difference certainly is worth monitoring as the project increases observations.

**Acknowledgments:** Thanks to all students and staff involved.

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**Keywords:** beef, feed efficiency, reproduction

**PARP:** V:1,4,7,8

# All-America Selections' Vegetables and Herbs

*K. Panter*[1]

All-America Selections (AAS) is an international, independent, non-profit organization devoted to testing and highlighting the best of the best in vegetables, flowering annuals, and perennials. There are currently more than 70 AAS Trial Grounds plus almost 200 Display Gardens in the U.S. and Canada, including a Display Garden at the University of Wyoming. Ours 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 on the UW campus. It initially encompassed flowering annuals and perennials as well as vegetables. Flowering annuals and perennials are still located west of Old Main, but vegetables have since been moved to the Laramie Research and Extension Center (LREC) greenhouse complex.

The three purposes of AAS are to 1) test new, unsold cultivars, 2) inform gardeners about AAS winners, and 3) earn gardeners' trust in those winners. One goal of the UW AAS project is to highlight new vegetables as part of our agreement with AAS. Another is to determine which of the AAS selections can be grown successfully in Laramie's often harsh climate.

## Objectives

The specific objective is to determine varieties and yields of various vegetables that will grow, thrive, and produce in Laramie.

## Materials and Methods

Seeds from AAS arrived in October 2014 and January 2015. For the 2015 gardens, seeds were sown starting in February with transplant dates dependent upon species. The AAS vegetables and cultivars we are growing this year are detailed 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). Data collected include days to germination, days to transplant, and fresh weight of harvested vegetables on a per-plant basis.

## Results and Discussion

On June 8, 2014, a late frost killed all 20 cultivars planted in raised beds outdoors at the LREC greenhouse complex. Therefore, no data exists from 2014. Initial 2015 results should be available for the August 27 LREC Field Day.


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

[1]Department of Plant Sciences.

Table 1. All-America Selections' vegetables and herbs for 2015.

| Vegetable/Herb | Cultivar |
|---|---|
| Basil | 'Dolce Fresca', 'Persian' |
| Bean | 'Mascotte' |
| Beet | 'Avalanche' |
| Broccoli | 'Artwork' |
| Chives | 'Garlic Geisha' |
| Cucumber | 'Pick a Bushel' |
| Lettuce | 'Sandy' |
| Pepper | 'Cayennetta', 'Emerald Fire', 'Flaming Flare', 'Hot Sunset', 'Mama Mia Giallo', 'Orange Blaze', 'Pretty N Sweet', 'Sweet Sunset' |
| Pumpkin | 'Hijinks' |
| Radish | 'Rivoli', 'Roxanne' |
| Tomato | 'Chef's Choice Orange', 'Fantastico', 'Jasper', 'Lizzano', 'Mountain Merit', 'Terenzo' |
| Melon | 'Melemon' |
| Squash | 'Bossa Nova', 'Butterscotch' |
| Watermelon | 'Faerie', 'Harvest Moon' |

**Acknowledgments:** Thank you to Andy Smith, Cody Barry, and Charity Burkey for assistance.

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**Keywords:** vegetables, herbs, gardening

**PARP:** not applicable

# A Novel Method for Removing Cheatgrass from Reclamation Seed

*W. Rose*[1]*, B.A. Mealor*[1,2]*, and A.R. Kniss*[1]

Disturbances such as oil and gas extraction and surface mining create an opportunity for infestation by weeds such as downy brome (commonly called cheatgrass). Reclamation is implemented on these sites in an effort to restore native vegetation; however, cheatgrass seeds 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 45 million cheatgrass seeds.

Since cheatgrass germinates at lower temperatures and more rapidly than native species, exposing cheatgrass seed to conditions that encourage its germination—and then withholding moisture—may kill cheatgrass while leaving desirable seeds unharmed. This could allow selective removal of cheatgrass from desirable seed before it is used in reclamation efforts.

## Objectives

Two previous experiments tested this concept with limited success using various temperatures and durations of treatment. This experiment focused on improving the removal of cheatgrass contaminants from desirable seed using several drying methods following the germination treatment.

## Materials and Methods

We conducted a germination treatment in which native seeds and cheatgrass contaminants were subjected to moisture for 12 days at 43°F. Following treatment, we subjected eight replicates of each native species and associated contaminants to one of five drying methods: 1) drying at room temperature on the laboratory bench, 2) a combination of mechanical removal (sieve) and drying on the laboratory bench, 3) drying at 14°F in the freezer, 4) drying at 86°F in a forced-air oven, and 5) drying at 140°F in the oven. Mechanical removal involved passing seeds through a 5/32-inch round, commercial sieve with the intention of retaining cheatgrass seedlings with an extended root or shoot.

After seeds were dried, we placed half the replicates of each species and their associated contaminants back into germination chambers, and we planted the remaining half in potting soil in the greenhouse. We conducted seedling counts after three weeks in the chamber and after 5.5 weeks in the soil.

## Results and Discussion

Blue grama and thickspike wheatgrass had the highest survival compared to cheatgrass (Figure 1). Drying seeds in commercial dryers at 86°F and 140°F severely reduced cheatgrass survival while maintaining high blue grama survival. Results were similar for thickspike wheatgrass in the 86°F dryer. Squirreltail had the lowest survival among desirable species in almost all treatments. Bluebunch wheatgrass and Sandberg bluegrass also appeared to be negatively affected by treatments. The mechanical treatment result-

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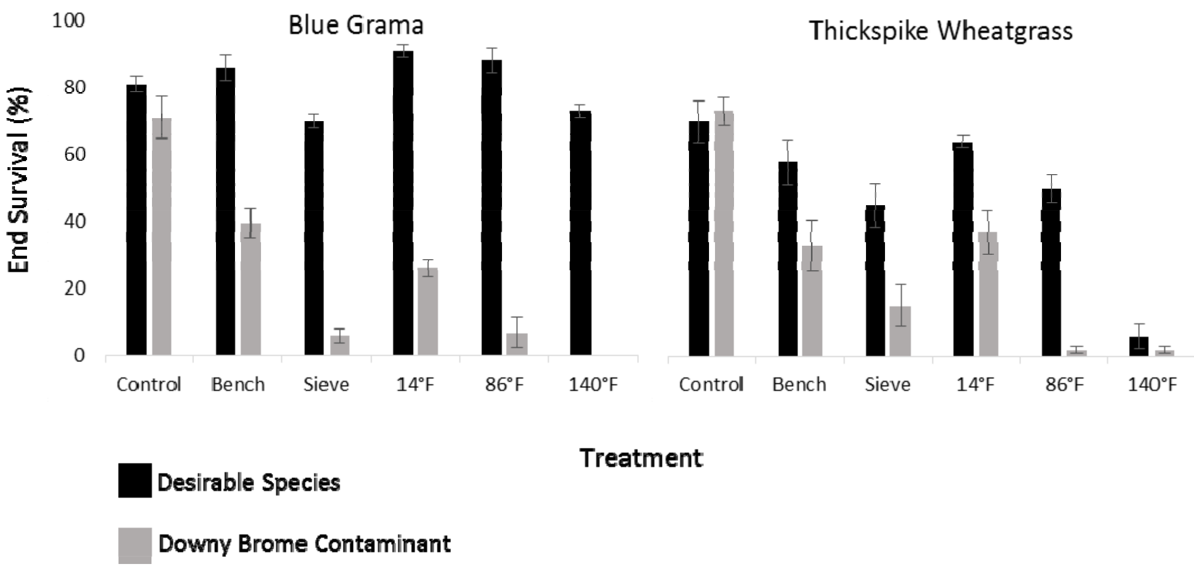


Figure 1. End survival (%) of blue grama and thickspike wheatgrass and their associated cheatgrass contaminants for each drying method following the second-phase germination trial in the chambers.

ed in higher survival of desirable seeds relative to cheatgrass seeds, but lower desirable species survival than their controls. When compared to the germination chambers, the soil medium tended to alleviate the effects of the drying treatments, especially for cheatgrass.

Results show that selectively harming—and thereby removing—cheatgrass contaminants in native seed is possible. Blue grama and thickspike wheatgrass were identified in these experiments as good candidates for this kind of germination treatment; however, when treated seeds were planted in soil, cheatgrass survival appeared to be higher. More research is needed to understand how these methods would perform in field conditions.

**Acknowledgments:** We thank the University of Wyoming 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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**Keywords**: cheatgrass, reclamation, germination

**PARP**: III:5, XII:1

# Impact of Dietary Forage Quality on Ruminal Bypass of Calcium Salts of Long-Chain Omega-3 Fatty Acids in Beef Heifers When Provided in Dried Molasses Lick Tubs

*D.C. Rule[1], P.A. Ludden[1], and T.D. Draney[1]*

Fish oil contains high levels of the omega-3 fats eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Omega-3 fatty acids are higher in muscle of grass-fed compared with feedlot-fed beef. Additionally, deposition of EPA and DHA into reproductive tract tissue of heifers could improve female reproductive performance in cattle. Feeding unsaturated fatty acids to ruminant livestock results in loss of many of these fatty acids because of ruminal biohydrogenation. We supplemented steers grown on irrigated pasture with calcium salts of fish oil, which are resistant to ruminal biohydrogenation, and observed that variation in intake of the fish oil treatment resulted in similar variation in concentrations of EPA in muscle, liver, and serum. This indicates that serum concentrations reflect tissue uptake (thus rumen bypass) of EPA and DHA. We also observed less variation in muscle concentration of the two fatty acids in cattle fed harvested forage when supplemented with fish oil calcium salts contained within dried molasses lick tubs compared with feeding as a beet pulp-based supplement. Greater serum EPA and DHA were observed when forage quality was decreased; thus, forage quality could impact ruminal bypass of fish oil calcium salts.

## Objectives

Our objectives were to compare three forage qualities (low, medium, and high) fed to heifers supplemented with dried molasses lick tubs formulated to contain 30% by weight of calcium salts of fish oil fatty acids and quantify bypass potential by measuring changes in plasma concentrations of EPA and DHA.

## Materials and Methods

Twenty-seven crossbred beef heifers (initial BW [bodyweight] 681±6 lb) were obtained from the University of Wyoming beef herd and randomly assigned to one of three treatments based on forage type: alfalfa hay, bromegrass hay, or a grass hay containing approximately an 80:20 ratio of Garrison creeping meadow foxtail and bromegrass to represent high-, medium-, and low-quality forage (based on crude protein). Heifers were offered forage-free choice and provided dried molasses lick tubs (250 lbs) containing calcium salts of fish oil (30% by weight), which were placed into each pen (115 × 16.4 ft) with three heifers per pen. Every seven days from the start of lick tub feeding, bodyweights and blood samples for EPA determination were obtained.

## Results and Discussion

Crude protein content was the primary measure of forage quality with alfalfa being greatest (15.3%), brome intermediate (9.4%), and Garrison the least (5.5%). Concentrations of EPA and DHA in the dried molasses lick tubs were 0.38 and 0.26 oz/lb, respectively. Forage intake

[1]Department of Animal Science.

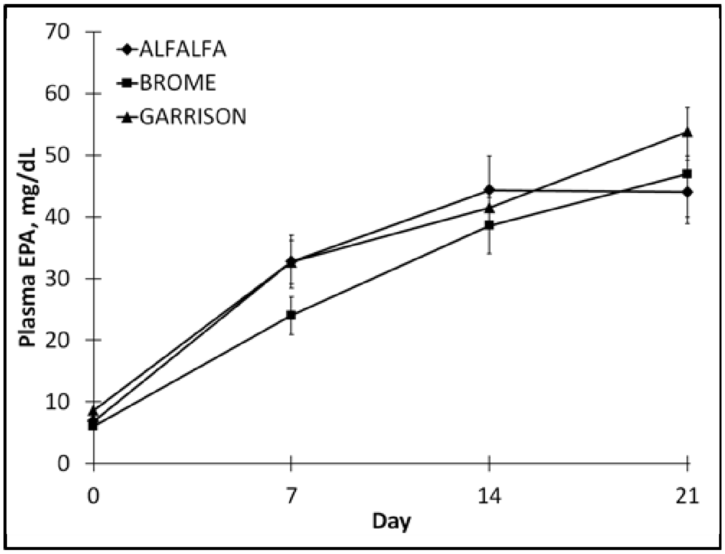


Figure 1. Plasma concentrations of eicosapentaenoic acid (EPA; mg/dL) in heifers fed alfalfa, brome, or Garrison during free-choice access to molasses lick tubs containing calcium salts of fish oil fatty acids.

was less for Garrison than for either alfalfa or brome, which were similar. Tub intake and intake of EPA and DHA were not affected by forage treatment. Average daily gain during supplementation was greater for alfalfa than brome or Garrison, and ADG was greater for brome than with Garrison, wherein heifers lost bodyweight while on Garrison. The changes in plasma concentrations of EPA during the 21-day supplementation phase for each forage are illustrated in Figure 1.

While EPA increased in plasma as days fed the fish oil calcium salts increased, concentrations in heifers fed alfalfa plateaued at day 14; whereas, EPA continued to increase when fed brome and Garrison. Confounding the results of Garrison further was the noted weight loss that occurred for heifers while fed this forage. Generally, with high-quality forage, the concentration of EPA increased for 14 days; whereas, with lesser-quality forages, the concentrations appeared to continue increasing by 21 days. The time fed the fish oil calcium salts needed to allow plasma concentrations of EPA to stabilize when fed brome or Garrison could not be determined in the present study. The results, however, indicate that greater concentrations of these fatty acids in blood may occur if supplementation continues for a longer period. If group-fed in a pasture tub, intake will likely be less because typical intakes range from 0.50 to 0.75 lb/day depending on bodyweight. We conclude that plasma concentrations of EPA in beef heifers fed forage-based diets and supplemented with fish oil calcium salts delivered within a dried molasses lick tub blood will peak earlier when fed higher-quality forage than when fed medium- or lower-quality forage.

**Acknowledgments:** We thank Virtus Nutrition LLC™ (Corcoran, California) for providing calcium salts of fish oil, and Ridley Block Operations (Whitewood, South Dakota) for preparing the dried molasses lick tubs. This project was supported by a Wyoming Agricultural Experiment Station competitive grant.

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**Keywords**: livestock production, heifers, fat supplementation

**PARP:** V:1,4

# Matching Cow Size to Wyoming Rangeland Conditions

*J.D. Scasta[1], L. Varelas[1], and T. Smith[2]*

Cow size has been suggested to be an important consideration for selecting cattle to match their production environment. Over the last several decades, the trend in genetic selection for maximum growth has led to gradual increases in beef cow size. An unrelated trend during this same period in the western United States has been an increase in temperature, drought frequency, and drought severity. Unfortunately, there is disagreement whether small cows are more efficient than large cows under semiarid and high-elevation rangeland conditions, like those in Wyoming. Because cow size influences nutritional maintenance costs—and taking into account the recent trends in cow size and drought, but lack of empirical studies on their interaction—we assessed the effect of cow size on weaning weight and efficiency in relation to drought on a semiarid, high-elevation ranch in Wyoming.

## Objectives

Our objectives were to 1) quantify the effect of drought on weaning weight regardless of cow size, 2) compare how cow size influenced the weaning weights of calves relative to precipitation variability, and 3) determine how efficiency was influenced by cow size and drought.

## Materials and Methods

This study was conducted at the Wyoming Agricultural Experiment Station's (WAES) McGuire Ranch 26 miles northeast of Laramie. The ranch (elevation 7,220 feet) is composed of 5,550 acres of native rangeland dominated by native cool-season species and a minor component of planted forages. From 2011 to 2014, a period with very dry and very wet years, we measured calf weaning weights (WW) of 80 Angus x Gelbvieh cows and assessed how

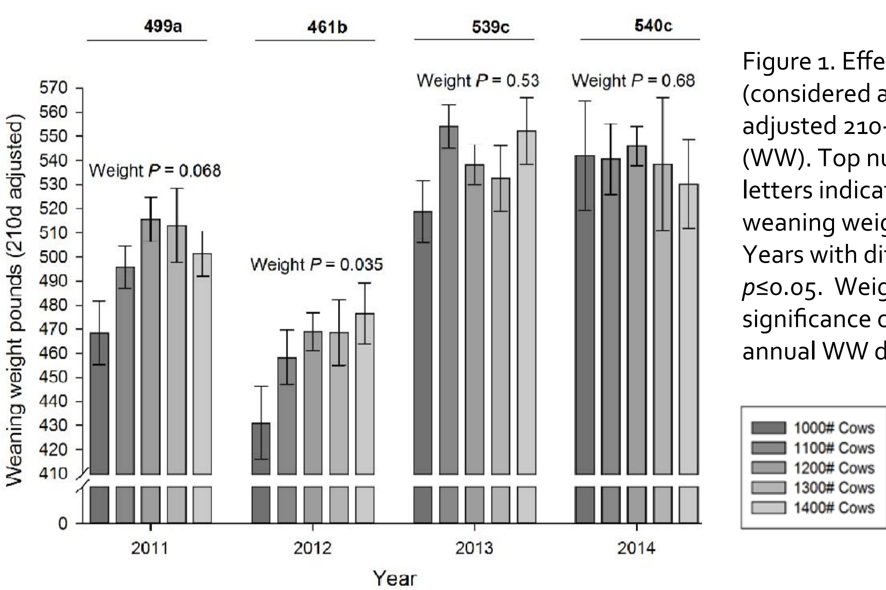


Figure 1. Effect of drought and cow weight (considered a proxy for cow size) on adjusted 210-day calf weaning weights (WW). Top numbers indicate mean WW and letters indicate comparison of mean annual weaning weight regardless of cow size. Years with different letters are different at $p \leq 0.05$. Weight $p$-values indicate significance of cow size in explaining intra-annual WW differences at $p \leq 0.05$.

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Table 1. Comparison of mean efficiency by cow size class and year using ANOVA (α 0.1) at the McGuire Ranch, 26 miles northeast of Laramie, from 2011 to 2014. Different letters indicate differences at 90% confidence level.

| Cow size class | 2011 efficiency | 2012 efficiency | 2013 efficiency | 2014 efficiency |
|---|---|---|---|---|
| 1,000 lbs | 0.45 ± 0.02a | 0.41 ± 0.02a | 0.49 ± 0.01a | 0.52 ± 0.02a |
| 1,100 lbs | 0.43 ± 0.01ab | 0.40 ± 0.01a | 0.48 ± 0.01a | 0.47 ± 0.01b |
| 1,200 lbs | 0.42 ± 0.01b | 0.38 ± 0.01b | 0.43 ± 0.01b | 0.44 ± 0.01c |
| 1,300 lbs | 0.38 ± 0.01c | 0.35 ± 0.01c | 0.40 ± 0.01c | 0.40 ±0.02d |
| 1,400 lbs | 0.35 ± 0.01d | 0.33 ± 0.01c | 0.38 ± 0.01c | 0.37 ± 0.01d |

drought affected WW and efficiency relative to cow size. We calculated efficiency as a ratio of calf weight relative to cow weight. This measurement of biological efficiency can be interpreted as the percent of a cow's bodyweight that she weans. A common efficiency target is 0.50, or a calf that weighs 50% of the dam's body weight at weaning. We stratified cows into five weight classes (1,000, 1,100, 1,200, 1,300, and 1,400 lbs) as a proxy for cow size and adjusted WW to a 210-day adjusted value. We compared WW regardless of cow size, the influence of cow size on WW, and the influence of cow size on efficiency, relative to drought. We calculated change in efficiency (ΔE) for cow size between the wettest year (2014; total precipitation 11.1 inches from January 1 through October 1) and the driest (2012; total precipitation 4.2 inches from January1-October 1).

## Results and Discussion

During the wettest years, cow size was not a significant factor, but during the driest year cow size was significant ($p<0.05$) (Figure 1). A quadratic trend of increasing WW due to cow size in 2012 indicates that the greater rumen capacity benefit increased initially, but plateaued at the three largest sizes. Efficiency for the smallest cows (1,000 lbs) was always greater than efficiency for the largest (1,400 lbs) ($p<0.001$) (Table 1). Efficiency for the smallest cows was greater in the driest year (0.41±0.02) than efficiency of the largest cows in the wettest year (0.37±0.01) (Table 1). The change in efficiency between wet and dry years (considered as ΔE), was 0.11 for the smallest cow size and 0.04 for the largest cow size (Table 1). Furthermore, ΔE decreased linearly as cow size increased. This is an indication of the ability of smaller cows to better adapt to negative changes in the production environment with optimal upside potential when conditions are favorable. These results indicate that large cows (1,300 to 1,400 lbs) do not equal larger calves in this environment and provide no advantage over smaller cows (1,000–1,200 lbs). The rumen capacity of larger cows may actually be a slight advantage in dry years when considering weaning weights; however, when considering the efficiency ratio, smaller cows are optimum.

**Acknowledgments:** Appreciation is extended to Laramie Research and Extension Center staff. This study is under review at a journal.

**Contact:** John Derek Scasta at jscasta@uwyo.edu or 307-766-2337.

**Keywords:** cow size, drought, efficiency

**PARP:** I:1, V:7, VI:3, VIII:3

# Wyoming Fresh Herb Production Completion Report

*C. Seals[1] and K. Panter[1]*

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 was to successfully grow fresh oregano, chives, marjoram, and basil for local market. Another was to make the methods used available to Wyoming growers.

Our study on herb crops began April 2013 and ended late October 2014. Four herb crops were grown in the Laramie Research and Extension Center (LREC) greenhouse and two high tunnels.

## Objectives

This project had the main goal of adding niche crops for Wyoming growers who use high tunnels or greenhouses. The aim was to study specialty crops that can be grown in Wyoming for sale at local venues such as farmers' markets. We hope to expand the array of specialty crops produced in Wyoming.

## Materials and Methods

Four species of herbs were grown in the greenhouse and two high tunnels at the LREC greenhouse complex. The project began in April 2013, and the last data were collected October 2014. The four herbs grown were 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*)—were grown as edge rows surrounding test plants.

Seeds of the four species were sown in April 2013 with another set started in March 2014. The seedlings were transplanted into the high tunnels and greenhouse in May 2013 and repeated in May 2014. Data collected included days to germination, days to transplant, and fresh weight of harvested herbs on a per-plant basis. Plant tissue analyses were performed during summer 2014. The experimental design was completely randomized with 16 single-plant replications (Figure 1). All data were analyzed using analysis of variance and mean separations.

## Results and Discussion

Comprehensive results from the entire project will be available for the August 27 LREC Field Day. Results indicate total yields were higher in the high tunnels than in the greenhouse for all four species in 2013. In 2014, total yields for

Figure 1. Greenhouse production of herbs, June 2014.

[1]Department of Plant Sciences.

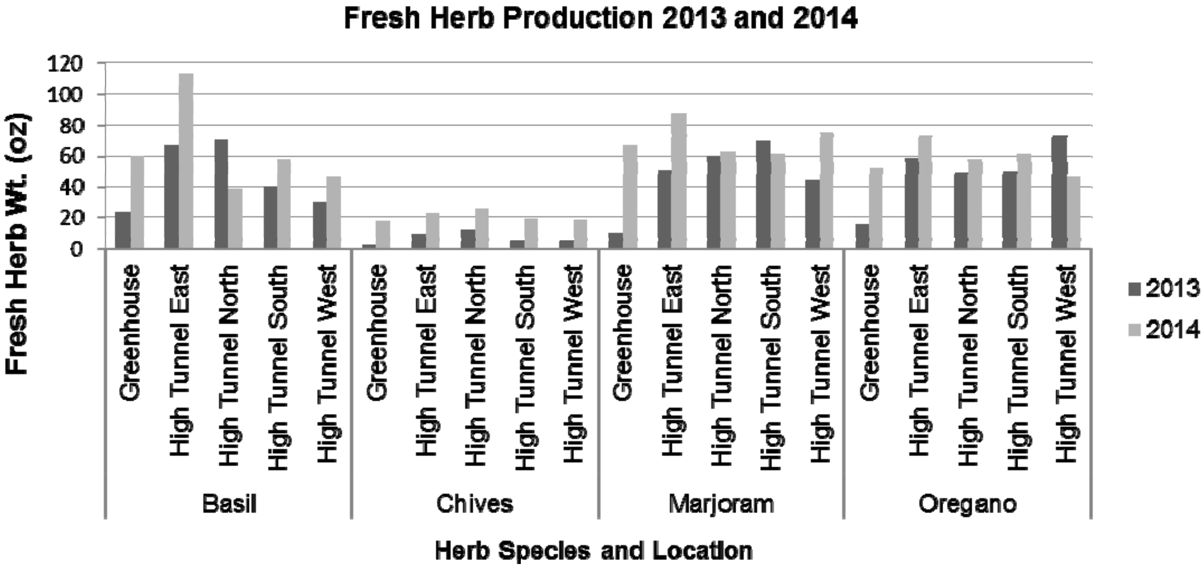


Figure 2. Greenhouse and high tunnel total fresh weight herb yields for 2013 and 2014 growing season.

chives were higher in the high tunnels than the greenhouse, but the other three herbs showed no clear pattern. There were also differences in yields among locations within the two high tunnels (Figure 2). Days to first harvest varied from 85 to 161 depending on the crop.

**Acknowledgments**: Tissue testing funding was provided by the Wyoming Groundskeepers & Growers Association Inc.

**Contact**: Karen Panter at kpanter@uwyo.edu or 307-766-5117, or Casey Seals at seals@uwyo.edu or 307-766-4734.

**Keywords**: herbs, greenhouse, high tunnel

**PARP**: not applicable

# Shade Avoidance as a Mechanism of Yield Loss in Sugarbeet

*T. Schambow[1] and A.R. Kniss[1]*

It is well known that weeds reduce crop yield, but our understanding of the underlying mechanisms that cause yield loss is incomplete. Resource depletion is undoubtedly a major contributor to crop yield loss; as weeds use water, nutrients, and light, there is less available for the crop. But other mechanisms also contribute to yield loss due to weeds, including phytochrome-mediated changes in growth collectively called shade avoidance responses. Plant leaves efficiently absorb red light for photosynthesis. Light that is reflected from plant leaves, therefore, is deficient in red light compared to direct sunlight. The ratio of red light to far red light (R:FR) can be 'sensed' in the plant by neighboring plants. Developing plants receiving reduced R:FR light signals exhibit a variety of morphological responses that may allow them to better compete for light such as an increase in stem elongation rate, upright growth, and reduced branching. These changes in plant growth can reduce yield potential on annual crops like corn and soybean; however, it is unclear what the impact (if any) shade avoidance responses may have in sugarbeet.

## Objectives

Our objective was to determine whether shade avoidance, in the absence of direct competition for resources, can cause yield loss in sugarbeet.

## Materials and Methods

Sugarbeet was planted into 5-gallon buckets at the Laramie Research and Extension Center (LREC). In some of the buckets, a weedy grass ring was planted around the sugarbeet plants on top of white plastic to prevent any interaction between root systems (Figure 1). White plastic covered by soil was used as a control treatment (no weeds). Leaf counts and measurements were made weekly between emergence and harvest. *Beta vulgaris* (sugarbeet) plants were harvested 90 days after planting. Leaf area was measured and roots were weighed to determine the impact of reflected light on yield.

Figure 1. Illustration of the large-pot design.

[1]Department of Plant Sciences.


Figure 2. Shade avoidance response from season-long presence of weedy environment compared to no weeds, LREC, 2014.

## Results and Discussion

Sugarbeet leaf appearance rate was slowed significantly by the presence of nearby weeds (Figure 2). This caused a 63% reduction in leaf area and 70% reduction in root yield at the end of the growing season (Table 1). Results of this work suggest that the mere presence of weeds can contribute to yield reduction in sugarbeet. This means that no amount of added resources (like irrigation or fertilizer) could reverse the impact of shade avoidance responses caused by early season weeds.

Table 1. Leaf area and root fresh weight at harvest (90 days after planting) of sugarbeet in response to weedy and non-weedy environments, LREC, 2014.

| Treatment | Leaf area ($in^2$) | Root fresh weight (oz) |
|---|---|---|
| No weeds | 1,953 | 10.1 |
| Weeds | 728.5 | 3.0 |

**Acknowledgments:** The work was funded by grants from the Wyoming Agricultural Experiment Station and Western Sugar Cooperative Grower Joint Research Committee.

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

**Keywords:** weed management, sugarbeet, shade avoidance

**PARP:** III:7

# Targeted Grazing for Dalmatian Toadflax and Geyer's Larkspur Management

*J.M. Workman*[1] *and B.A. Mealor*[1,2]

Dalmatian toadflax (*Linaria dalmatica*) is a noxious, competitive forb found in Wyoming and across the West. Both livestock and wildlife will eat it, but it provides poor forage. Repeated grazing is predicted to reduce toadflax density over time, but defoliation studies have shown mixed results.

Geyer's (plains) larkspur (*Delphinium geyeri*) is a toxic native forb of the High Plains of the Intermountain West linked with early summer cattle deaths. Sheep are more resistant to alkaloids and were historically grazed in dense larkspur areas before cattle to reduce cattle poisoning. This practice has not been well researched for Geyer's larkspur.

Targeted grazing is a land-management tool that can be used for weed control. Managers may manipulate defoliation timing, intensity, and frequency to maximize stress on weeds and minimize native community impact. Effective weed control generally requires multiple defoliations separated by periods of regrowth.

## Objectives

Objectives are to quantify effects of targeted sheep grazing and herbicides on Dalmatian toadflax, Geyer's larkspur, and the native plant community.

## Materials and Methods

We established four experimental sites in 2014 on northern mixed-grass prairie at the High Plains Grasslands Research Station near Cheyenne. Two herbicide treatments, four grazing treatments, and a non-treated check were applied in a randomized complete block design to 30 x 60-ft. cells, with each site serving as a block. Herbicide treatments—Perspective® (4.5 oz/acre) and Escort® (0.5 oz/ac)—were applied June 19, 2014, when both target species were flowering. Grazing treatments varied in density and timing with the annual stocking rate held constant at 1.6 animal unit months/ac over the growing season. Two treatments received grazing only in the spring: a high-density (HD) treatment, in which 40 sheep grazed a cell for 6 hours, and a 1x treatment, in which 20 sheep grazed a cell for 12 hours. Grazing was distributed throughout the growing season in the other two treatments. In the 2x treatment, 20 sheep grazed for 6 hours in spring and again in summer. In the 3x treatment, 20 sheep grazed for 4 hours each in spring, summer, and fall.

We estimated initial weed density by counting live toadflax stems in a belt transect in each cell, and by counting larkspur plants in the entire cell. We counted both species again after grazing, but toadflax stems that showed signs of grazing or trampling were excluded from the second count to allow estimation of impacted stems.

## Results and Discussion

Sheep use of both toadflax and larkspur increased with increasing grazing intensity. Sheep impacted more than 90% of toadflax stems in

[1]Department of Plant Sciences; [2]Sheridan Research and Extension Center.

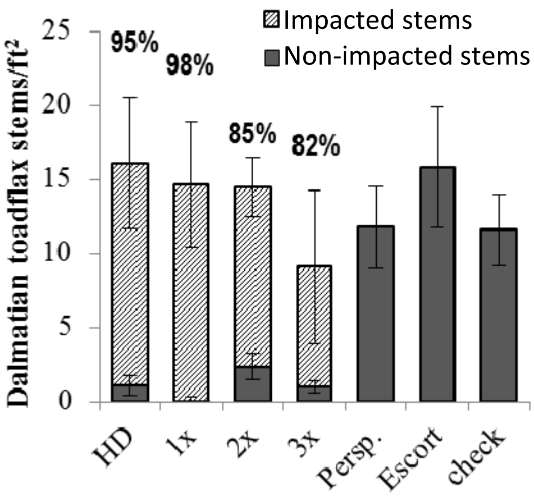

Figure 1. Dalmatian toadflax stem density after spring grazing treatment, with percent stem impact values for each treatment. Error bars show standard error.

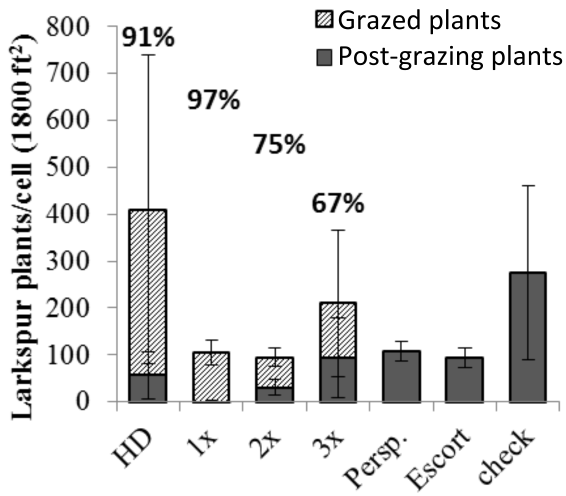

Figure 2. Larkspur density after spring grazing treatment, with percent plant reduction values for each treatment. Error bars show standard error.

both the HD and 1x treatments and more than 80% of toadflax stems in the 2x and 3x treatments (Figure 1). Similar use patterns of the 2x and 3x treatments were also observed in later grazing events, but toadflax density was consistent across all treatments after any period of regrowth in 2014. To achieve high toadflax use, we also heavily impacted desirable perennial grasses. Only the 3x treatment had perennial grass biomass similar to the check in midsummer, two months after the spring treatment. Although further defoliations may be required for toadflax control, we must balance weed injury with grass damage.

Grazing treatments greatly reduced larkspur density (Figure 2), and many of the remaining plants were reduced in size. Use was highest in the 1x and HD treatments, which received the highest spring grazing intensity. By midsummer, larkspur regrowth was minimal. We believe that a lower grazing intensity may satisfactorily reduce larkspur with reduced perennial grass impact, but no studies are planned at this time that might verify this conclusion.

**Acknowledgments:** This project was supported by funding from the University of Wyoming Minority and Women's Graduate Assistantship Program and UW Department of Plant Sciences, with sites provided by the U.S. Department of Agriculture's High Plains Grasslands Research Station near Cheyenne and animals from the Laramie Research and Extension Center. Special thanks go to the UW Weed Science crew for project assistance.

**Contact:** Julia Workman at jworkma2@uwyo.edu, or Brian Mealor at bamealor@uwyo.edu or 307-673-2647.

**Keywords:** weed management, rangelands

**PARP:** III:3,5, V:3, VI:5, VII:1

## Introduction to the
# Powell Research and Extension Center

*C. Reynolds[1], A. Pierson[1], and G. Moss[1]*

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 under on-surface drip, 1.2 acres under sub-surface drip, and 54 acres under sprinkler. The remainder is under surface irrigation using gated pipe. Research at the center focuses on irrigation, weed control, cropping systems, protected agriculture (hoop house), variety trials, and alternative crops (Figures 1 and 2). We serve northwest Wyoming, including Bighorn, Fremont, Hot Springs, Park, and Washakie counties.

Figure 1. Strip tillage in cropping systems study.

Personnel at PREC include one researcher, a farm manager, a research associate, two assistant farm managers, and an office associate. This year, we are excited to welcome our new faculty member, Associate Professor Gustavo Sbatella. Gustavo has initiated many new and exciting

Figure 2. PREC high tunnel.


Figure 3. Camby Reynolds explaining to last year's PREC Field Day participants the new grain drying system, sponsored by IntelliAir™.

[1]Powell Research and Extension Center.

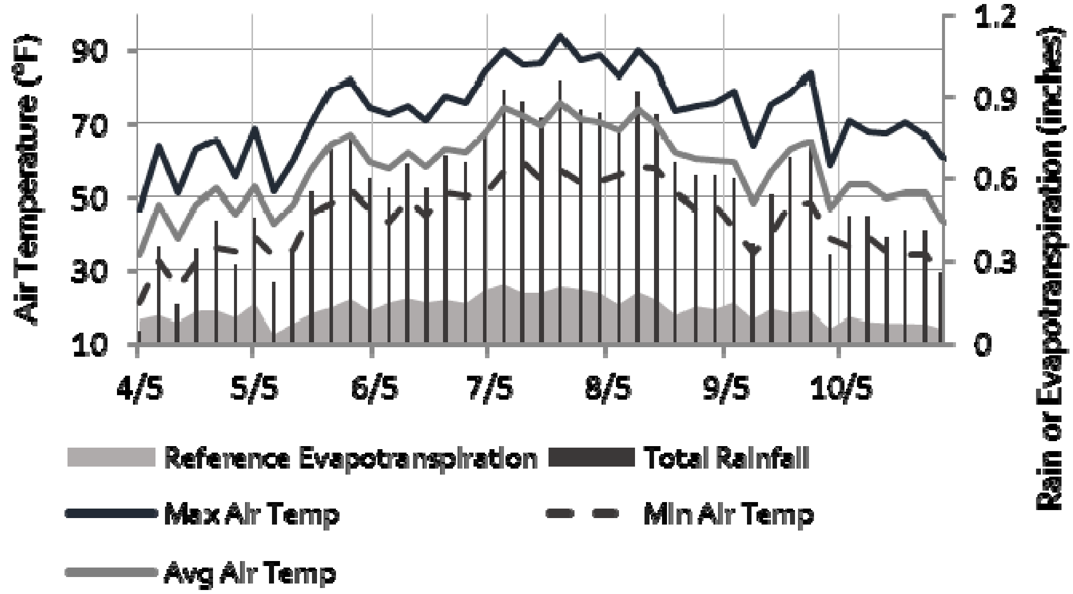


Figure 4. Weather conditions during the 2014 growing season at PREC.

research projects. We are also seeking to hire a new irrigation specialist and are very excited to see what the future brings. We are continually trying to upgrade facilities and equipment to ensure our ability to meet the requirements of any research projects to be launched and completed at PREC. This year, we have many new and exciting projects and look forward to sharing the results (Figure 3).

Additionally, PREC annually conducts variety trials for seed suppliers. Data from those trials are provided to the respective sponsors to aid in the identification and selection of varieties best suited for production in the region. Recurring trials are in process for MillerCoors, J.R. Simplot Company, Wyoming Sugar, Betaseed Inc., SunOpta Inc., and Briess Malt & Ingredients Company.

## 2014 Growing Season

The 2014 growing season was characterized as relatively short, with 122 frost-free days, from May 13 to September 13. Overall, the growing season was wet and cool. PREC received 5.52 inches of rainfall; 19, 25, and 18% of the year's total fell in April, June, and August, respectively. As a consequence, the barley harvest was greatly affected due to barley sprouting in the field. The average air temperature was 44°F in April. This, coupled with rain showers, created poor planting conditions. The highest air temperature was recorded July 23 at 98°F. The average reference evapotranspiration (ETo), an indicator of the water needs of plants, was .14, .19, and .14 inches per day in June, July, and August, respectively (Figure 4).

**Acknowledgments**: We appreciate PREC staff members for their hard work in day-to-day operations and for efforts in establishing and harvesting variety trials.

**Contact**: Camby Reynolds at sreynol3@uwyo.edu or 307-754-2223.

# Short Reports—PREC

## 1. Screening and development of dry bean genotypes for drought tolerance

**Investigators:** Jim Heitholt and Camby Reynolds

**Issue:** Dry bean production continues to be an important contributor to Wyoming crop production, but more research is needed to develop and evaluate novel genotypes—plants with unique genetic makeups that have not yet been documented or discovered. Without these studies, producers will lack having competitive and profitable dry bean genotypes adapted for the short growing season and drought conditions of the Bighorn and Wind River basins and southeast Wyoming.

**Goal:** Identify dry bean genotypes with superior drought tolerance and, using these genotypes, develop progeny lines that help in the discovery of specific genes associated with drought tolerance.

**Objectives:** Using field and greenhouse environments, compare the growth and yield of experimental dry bean lines under drought and well-watered conditions.

**Impact:** Results have the potential to provide breeders, plant physiologists, producers, and the commercial seed industry with quantitative data on the drought tolerance of multiple dry bean genotypes. Hybridization and genetic analyses of promising genotypes could lead to the development of novel experimental dry beans for testing in regional trials.

**Contact:** Jim Heitholt at jim.heitholt@uwyo.edu or 307-766-3104.

**Keywords:** water stress, dry bean, sustainability

**PARP:** X:3

## 2. Participatory breeding of winter-hardy vegetable peas for Wyoming

**Investigators**: Christopher Hilgert and Robin Groose

**Issue**: Wyoming's environment is challenging for vegetable growers, whether home gardeners or commercial producers, and a significant limitation to local vegetable production is that virtually no vegetable varieties have been bred in Wyoming for local adaptation. This study involves development of local food pea varieties (shell, snow, and snap) to extend the growing season, increase yield, and improve success for Wyoming gardeners.

**Goal**: The goal of this U.S. Department of Agriculture Specialty Crop Block Grant Program-funded research (via the Wyoming Department of Agriculture) is to involve Wyoming Master Gardeners in an effort to develop winter-hardy food peas for home and commercial production.

**Objectives**: Evaluate and advance experimental winter-hardy food pea lines in Wyoming gardens for eventual release as "open source" varieties. (Open source varieties are available to anyone and cannot be patented.)

**Impact**: Winter food peas—seeded in autumn, overwintering in a dormant state, and waking in spring—could provide vegetable produce from the Wyoming garden earlier than almost any other plant.

**Contact**: Christopher Hilgert at chilgert@uwyo.edu or 307-766-6870.

**Keywords**: winter pea, food pea, participatory plant breeding

**PARP**: not applicable

## 3. Wyoming production of locally bred winter pea to integrate crop and livestock production

**Investigators**: Anowar Islam, Tim Anderson, Dave Bowman, Gregor Goertz, Jerry Nachtman, and Robin Groose

**Issue**: The two-year winter wheat–summer fallow system has made possible successful wheat establishment every other year on the central Great Plains, but has resulted in significant soil organic matter loss and utilizes only 20–30% of precipitation received during the long fallow period. Breeding winter feed pea for Wyoming adaptation has produced lines superior to existing varieties and may serve to integrate cereal and livestock production in our state.

**Goal**: Study the integration of Wyoming-bred winter feed pea into a wheat production farming system to produce forage and/or grain for livestock.

**Objectives**: Evaluate effects of 'WyoWinter' winter feed pea on wheat yields and overall farming system productivity.

**Impact**: We have already bred superior winter feed pea varieties for adaptation to Wyoming. This State of Wyoming-funded research, via the Agriculture Producer Research Grant Program, involves University of Wyoming researchers, in collaboration with three progressive southeast Wyoming producers, evaluating potential adoption of superior winter feed pea varieties in our state.

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

**Keywords**: winter pea, winter wheat, livestock feed

**PARP**: I:2,3,5,6,9, II:7,9

## 4. Efficacy and economics of cultural and mechanical weed control practices for herbicide-resistant weed management

**Investigators**: Andrew Kniss, John Ritten, Robert Wilson, and Prashant Jha

**Issue**: Modeling is currently the most common approach for comparing the impact of weed control practices on herbicide-resistant weed evolution. Nearly all modelers recognize the importance of validating assumptions and results of predictive models through field research, yet there is a lack of field studies that quantify the impact of non-herbicide weed management practices on the evolution of herbicide-resistant weed populations.

**Goal**: Determine the impact of crop rotation diversity and tillage on enrichment of an herbicide -resistance trait within a weed population.

**Impact**: By determining the efficacy and economic impacts of non-herbicide practices on development of herbicide resistance, we hope to decrease the reliance on herbicides, thereby reducing the evolution and spread of new herbicide-resistant weed biotypes.

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

**Keywords:** kochia, herbicide resistance, crop rotation

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

## 5. Evaluate sugarbeet seed treatments under field conditions

**Investigators:** Andrea Pierson, Camby Reynolds, and Gustavo Sbatella

**Issue:** Sugarbeet establishment is critical to ensure a successful crop. Seed treatments are an integral part in allowing crop establishment by protecting seedlings from diseases.

**Goal:** Evaluate the performance of different seed treatments for sugarbeet under field conditions in the Bighorn Basin.

**Objectives:** Assess seed treatments' efficacy by determining impact on crop stand establishment.

**Impact:** Results should provide information regarding performance of different sugarbeet seed treatments that can potentially be used in the Bighorn Basin.

**Contact:** Gustavo Sbatella at gustavo@uwyo.edu or 307-754-2223.

**Keywords:** sugarbeet, seed treatment

**PARP:** IX:4

## 6. Evaluation of elite malting barley varieties

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

**Issue**: The U.S. Department of Agriculture's Agricultural Research Service (USDA-ARS) seeks information to grade and select varieties of elite malting barley suitable for production in the northwest region of the United States.

**Goal**: The goal is to collect data to determine and grade varieties of elite malting barley.

**Objectives:** Conduct malting barley variety performance trials in cooperation with USDA-ARS to evaluate production characteristics including lodging (when stems bend over to near ground level), days to maturity, test weight, and yield.

**Impact:** Data collected should assist in the selection process of elite malting barley varieties for Wyoming and other areas of the Northwest. Varieties will be overall ranked depending on how they cumulatively perform across the region and, in time, should provide producers with a greater selection of malting varieties.

**Contact:** Andrea Pierson at apierso1@uwyo.edu or Camby Reynolds at sreynol3@uwyo.edu or 307-754-2223

**Keywords:** malting barley, variety trial

**PARP:** VIII:1

## 7. Weed control in seedling alfalfa

**Investigators:** Gustavo Sbatella

**Issue:** Weed control in seedling alfalfa is critical to ensure long-term productivity. Seedling alfalfa plants can be very sensitive to herbicide applications, but this differs with the active ingredients in herbicides that are applied.

**Goal:** Evaluate the performance of different options for weed control in seedling alfalfa for the Bighorn Basin.

**Objectives:** Assess herbicide efficacy and crop safety of herbicides applied to seedling alfalfa for weed control.

**Impact:** Results should provide information regarding performance of different herbicides for weed control in seedling alfalfa.

**Contact:** Gustavo Sbatella at gustavo@uwyo.edu or 307-754-2223.

**Keywords:** alfalfa, seedling, weed control

**PARP:** III:7

## 8. Weed control in dry beans

**Investigators:** Gustavo Sbatella

**Issue:** Late-emerging weeds are difficult to control in dry beans because weed control relies mainly in herbicides that are applied to soil before planting. Although late-emerging weeds will not impact individual plant yield, they can interfere with crop harvest, result in yield losses, and affect crop quality.

**Goal:** Evaluate the performance of different options for late-season weed control in dry beans in the Bighorn Basin.

**Objectives:** Assess herbicide efficacy and crop safety of herbicides applied to dry beans for late weed control.

**Impact:** Results should provide information regarding local performance of different herbicides for late weed control in dry beans.

**Contact:** Gustavo Sbatella at gustavo@uwyo.edu or 307-754-2223.

**Keywords:** dry beans, late emergence, weed control

**PARP:** III:4,7

## 9. Weed control in dormant alfalfa

**Investigators:** Gustavo Sbatella

**Issue:** Herbicide applications to dormant alfalfa allow the use of active ingredients that otherwise would injure the crop if applied during active vegetative growth. However, new active ingredients have to be tested for efficacy and crop safety before they can be labeled for use.

**Goal:** Evaluate the performance of new active ingredients for weed control in dormant alfalfa in the Bighorn Basin.

**Objectives:** Assess herbicide efficacy and crop safety of herbicides applied to dormant alfalfa for weed control.

**Impact:** Results should provide information regarding local performance of new herbicides that could potentially become commercially available and compare them to current labeled options for weed control in dormant alfalfa.

**Contact:** Gustavo Sbatella at gustavo@uwyo.edu or 307-754-2223.

**Keywords:** alfalfa, dormant, weed control

**PARP:** III:2,7

## 10. Testing for suitable soybean maturity group for the Bighorn Basin

**Investigators:** Gustavo Sbatella and Camby Reynolds

**Issue:** Some growers in the Bighorn Basin are considering planting soybean as an alternative for their crop rotation; however, information is lacking concerning which maturity group is best adapted to local growing conditions.

**Goal:** Evaluate different soybean maturity groups in the Bighorn Basin.

**Objectives:** Determine which soybean maturity groups are best adapted for local growing conditions.

**Impact:** Results should provide local farmers information regarding the performance of different soybean maturity groups in the Bighorn Basin. This, in turn, could provide a feasible alternative crop for rotations.

**Contact:** Gustavo Sbatella at gustavo@uwyo.edu or 307-754-2223.

**Keywords:** soybean, maturity group, alternative crops

**PARP:** I:9, II:9

## 11. Technical and economic evaluation for on-farm drying of confection sunflowers and grain corn in the Bighorn Basin

**Investigators:** Gustavo Sbatella and Camby Reynolds

**Issue:** Growers in the Bighorn Basin face the problem of having to harvest grains with high moisture content in the fall. The technical and economic possibility of drying crops on-farm needs to be further evaluated.

**Goal:** Provide producers with information that can assist them when deciding to implement on-farm drying of confection sunflowers and grain corn.

**Objectives:** Evaluate different methods to dry grains and if drying on-farm is an economically viable alternative for crops planted in the Bighorn Basin.

**Impact:** Results from this study should provide local growers with information on whether to implement on-farm drying for grains.

**Contact:** Gustavo Sbatella at gustavo@uwyo.edu or 307-754-2223.

**Keywords:** on-farm drying, corn, confection sunflower

**PARP:** I:2, IX:2

## 12. Pre-plant weed control in sugarbeet

**Investigators:** Gustavo Sbatella and Andrew Kniss

**Issue:** Herbicide-resistant weeds can be particularly difficult to control in sugarbeet because this crop is sensitive to a variety of active ingredients in herbicides, which limits control options. It is important, therefore, to research if there are alternatives for weed control prior to planting time.

**Goal:** Evaluate alternatives for pre-plant weed control for sugarbeet in the Bighorn Basin.

**Objectives:** Assess herbicide efficacy and crop safety of herbicides applied pre-plant to sugarbeet for weed control.

**Impact:** Results should provide valuable information regarding local performance of different herbicides for pre-plant weed control in sugarbeet.

**Contact:** Gustavo Sbatella at gustavo@uwyo.edu or 307-754-2223.

**Keywords:** sugarbeet, pre-plant weed control

**PARP:** III:1,7

## 13. Inter-planting forage legumes with grain corn for late-season forage production

**Investigators:** Gustavo Sbatella and Camby Reynolds

**Issue:** Growers who plant grain corn in the Bighorn Basin usually graze the planted area after harvest despite possible lack of quality and available forage elsewhere. Because of this, there is a need to evaluate ways to increase the production and nutritional value of this late-season forage.

**Goal:** Determine if it is possible to inter-plant grain corn and forage legumes to maximize grain and forage production and improve forage quality.

**Objectives:** Evaluate different corn/soybean planting ratios to provide maximum corn grain production and late-season forage quantity and quality.

**Impact:** Results should provide growers information regarding the possibility of inter-planting grain corn and forage legumes in the Bighorn Basin for grain and increase late-season forage quantity and quality.

**Contact:** Gustavo Sbatella at gustavo@uwyo.edu or 307-754-2223.

**Keywords:** corn, forage legumes, inter-planting

**PARP:** I:3,6,9

## 14. Effects of limited irrigation on herbicide efficacy and herbicide carry-over

**Investigators:** Gustavo Sbatella and Andrew Kniss

**Issue:** A major future challenge for sustainable agriculture is to increase production with limited resources, particularly water. All farm practices will likely need to adjust to a water-limited environment, including weed control programs.

**Goal:** Study the effects that restrictions on water use for farming can have on weed control programs, particularly to soil-applied herbicides.

**Objectives:** Determine the impact of limited irrigation on efficacy, soil dissipation, and carry-over (herbicides remaining in the soil from the previous growing season) of soil-applied herbicides commonly used in corn and dry bean production.

**Impact:** Results should help farmers to develop weed control programs aimed to optimize agriculture production with less water, while maximizing the economic use of herbicides and minimizing environmental impacts.

**Contact:** Gustavo Sbatella at gustavo@uwyo.edu or 307-754-2223.

**Keywords:** herbicides, carry-over, efficacy

**PARP:** III:4,7, X:1

## 15. Broadleaf weed control in barley

**Investigators:** Gustavo Sbatella

**Issue:** Management of herbicide-resistant weeds requires an integrated approach; therefore, the ability to control weeds in all crops included in a rotation is essential.

**Goal:** Evaluate alternatives for the Bighorn Basin to control broadleaf weeds such as kochia, common lambsquarters, and pigweeds in barley.

**Objectives:** Assess herbicide efficacy and crop safety of postemergence herbicides for broadleaf weed control in barley.

**Impact:** Results should provide information regarding local performance of potentially new commercially available herbicides when compared to current options for broadleaf weed control in barley.

**Contact:** Gustavo Sbatella at gustavo@uwyo.edu or 307-754-2223.

**Keywords:** barley, broadleaf, weed control

**PARP:** III:1,7

## 16. A comparison of foliar band treatments for season-long Rhizoctonia control in the Bighorn Basin sugarbeet production area

**Investigators:** William Stump, Wendy Cecil, and Matthew Wallhead

**Issue:** Growers in the Bighorn Basin have been using Quadris® foliar applications predominantly for management of sugarbeet diseases caused by Rhizoctonia. Reliance on one fungicide chemistry is not recommended because of the potential for fungicide resistance development.

**Goal:** Determine the efficacy of other labeled fungicides for season-long Rhizoctonia management compared to the grower Quadris standard.

**Objectives:** Specific objectives will be to compare the efficacy of in-furrow fungicide treatments of Proline®, Priaxor®, Vertisan™, and Quadris in combination with a Kabina seed treatment for Rhizoctonia disease incidence, severity, final yield, and sugar content.

**Impact:** Results should increase awareness for growers of alternative fungicides for Rhizoctonia management in sugarbeets and assist them in selecting the most effective fungicide treatments for season-long control.

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

**Keywords:** Rhizoctonia, sugarbeet, fungicide efficacy

**PARP:** not applicable

# Deficit Irrigation Possible in Confection Sunflower Production in Northwest Wyoming

*V.R. Joshi[1], J.J. Heitholt[1], and A. Garcia y Garcia[2]**

Deficit irrigation is an approach to cope with limited water and to enhance water-use efficiency in agriculture. It consists of either limiting irrigation during crop growth stages that are less sensitive to water stress, or in some cases not irrigating at all. In recent years, confection sunflower has shown to be a reliable cash crop for conditions in Wyoming, especially the Bighorn Basin. Since sunflower has a deep taproot system, it has the capacity to extract water from deep soil layers, which can reduce risks associated with water stress. This ability makes the sunflower a suitable candidate for production under limited irrigated conditions in the region.

## Objectives

The objectives were to (1) quantify the yield response of confection sunflower to deficit irrigation and plant density and (2) determine the optimum combination of plant density and amount of irrigation for higher yield in the growing conditions of northwest Wyoming.

## Materials and Methods

The experiment was conducted on a clayey-loam soil during the 2014 growing season at the Powell Research and Extension Center (PREC). The confectionary sunflower hybrid 9579 (SunOpta Inc.) was planted May 27 using 22-inch row spacing under a lateral sprinkler irrigation system. Four levels of seeding rate (P1=16,000, P2=19,000, P3=22,000, and P4=25,000 seeds/acre) were used. The experimental field was uniformly irrigated once after seed sowing to provide enough soil moisture for uniform crop establishment before applying irrigation treatments. Irrigation treatments were 50%, 75%, and 100% replacement of total crop evapotranspiration ($ET_o$) until the R4 stage (when flower begins to open). This was followed by full irrigation until physiological maturity, denoted by I-50, I-75, and I-100, respectively. Differential irrigation treatments were applied from 16 days after sowing. Data on total yield, large seed yield (seeds left after screening on 20/64-inch, round-hole sieve). Yield components were also collected, but data are not presented here.

## Results and Discussion

The total amount of irrigation applied in the I-100 treatment was 10.2 inches, and the total amount applied in the I-50 treatment was 7.4 inches. The effect of irrigation was significant ($p<0.05$) on total and large seed yield. Averaged across all seeding rates, the total yield from I-50 was 15% and 26% less as compared to I-75 and I-100, respectively (Table 1). The reduction in large seed yield was even more severe. The large seed yield from I-50 was 47% and 59% less as compared to I-75 and I-100, respectively, indicating a significant reduction in large seed; however, the total yield and large seed yield reduction from I-75 as compared to I-100 were less drastic (9% and 15%, respectively).

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Table 1. Total yield and large seed yield of confection sunflower as affected by irrigation treatments at different levels of seeding rate. I-50, I-75, and I-100 are 50, 75, and 100% replacement of total crop evapotranspiration until the R4 stage followed by full irrigation until physiological maturity.

| Seeding rate (~seeds/ac) | Total yield*(lb/ac) | | | Large seed yield*†(lb/ac) | | |
|---|---|---|---|---|---|---|
| | I-50 | I-75 | I-100 | I-50 | I-75 | I-100 |
| 16,000 | 2105 | 3109 | 3058 | 1018 | 2661 | 2674 |
| 19,000 | 2254 | 2613 | 3051 | 1033 | 2037 | 2572 |
| 22,000 | 2115 | 2534 | 2972 | 1003 | 1876 | 2637 |
| 25,000 | 2380 | 2649 | 2877 | 1033 | 1866 | 2026 |
| Average | 2214 | 2726 | 2990 | 1022 | 2110 | 2477 |

*seed moisture maintained at 10%

†seeds left after screening on 20/64-inch, round-hole sieve.

Averaged across the three irrigation levels, the total yield and large seed yield decreased slightly as seeding rates increased (2,760, 2,640, 2,540, and 2,635 lbs/ac). Table 1, however, shows that there was a small increase in total yield with increase in seeding rate in I-50 treatment (but the seeding rate-by-irrigation effect was non-significant).

Results showed that the combination of 16,000 plants per acre and the replacement of 75% $ET_o$ yielded higher in the growing conditions of the Bighorn Basin. Our preliminary one-season results indicate that producers may be able to reduce water use for growing confection sunflower by replacing only 75% of water needed by the crop from crop establishment to R4 stage without any significant yield loss. In terms of water amount, I-75 saved up to 14% (1.4 inches) of water. The clayey-loam soil type in the experimental site, which can store a significant amount of moisture (2.3 in/ft), certainly played an important role in this experiment. Results may be different in sandy soils because of their low water-holding capacity. Thus, these irrigation and seeding rates are being retested to confirm 2014 results and to identify effects of soil type, climate, and agronomic practices. A seeding rate study was planted this year.

**Acknowledgments:** We thank PREC staff members for support and assistance. This study was funded by the Wyoming Agricultural Experiment Station and by PREC's Big Horn and Wind River Basins Applied Research Fund program.

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**Keywords:** irrigation management, planting density, confection sunflower

**PARP:** I:2, IV:4

# On-Farm Determination of the Effect of Early Termination of Irrigation and Seeding Rates on Yield and Quality of Confection Sunflower

*V.R. Joshi[1], A. Samet[1], J.J. Heitholt[1], and A. Garcia y Garcia[2,*]*

The Powell Research and Extension Center (PREC) has been working in close collaboration with farmers in northwest Wyoming to discover and disseminate practical as well as science-based approaches in agriculture, which could help promote sustainable farming practices. In this attempt, field experiments have been carried out on producers' fields (on-farm) as well as at PREC (on-station). In response to the growing interest in confection sunflower among farmers, PREC has been conducting several on-station as well as on-farm experiments to learn what management practices will optimize the production and quality of confection sunflower, those grown for consumption vs. oil.

## Objectives

Objectives of the studies were to understand the yield response and quality of confection sunflower to rate and type irrigation and seeding rates on fields managed by producers.

## Materials and Methods

Study A: During the 2014 growing season, an on-farm study on the yield response of confection sunflower to early termination of irrigation was conducted. This study was a follow-up of a PREC study (2012–2013). The 2014 on-farm test was conducted on a producer's field equipped with a furrow irrigation system. Treatments were withholding irrigation at R5.5 stage (when 50% of the disk flowers have completed flowering, IR1), R6 stage (when flowering is complete, IR2), and R7 stage (when back of the head changes color to light yellow, IR3).

Study B: This 2014 study evaluated the effects of seeding rates on confection sunflower yield and was conducted on a producer's field equipped with center pivot sprinkler irrigation. This on-farm test matched a replicated 2014 PREC trial. In study B, four seeding rates were compared (P1=16,000, P2=19,000, P3=22,000, and P4=25,000 seeds per acre).

In both studies, hybrid 9579 (SunOpta Inc.) was planted in 22-inch row spacing. Both fields were located near Powell and were within the Heart Mountain Irrigation District, which is composed of 31,120 irrigable acres in the Bighorn Basin. Data on total yield and large seed yield (determined by screening the total seed on a 20/64 round-hole sieve) were collected.

## Results and Discussion

I. Study A (early termination of irrigation): Previous results at PREC (reported in the 2014 Wyoming Agricultural Experiment Station *Field Days Bulletin*; available on pages 47–48 at http://www.uwyo.edu/uwexpstn/_files/docs/2014-field-days-bulletin.pdf) showed comparable yields from IR1 and IR3, but the results from this on-farm trial during the 2014 growing season showed 20% reduction in total yield from IR1 as compared to IR3 (Figure 1). In all treatments, large seed yield was above 90% of

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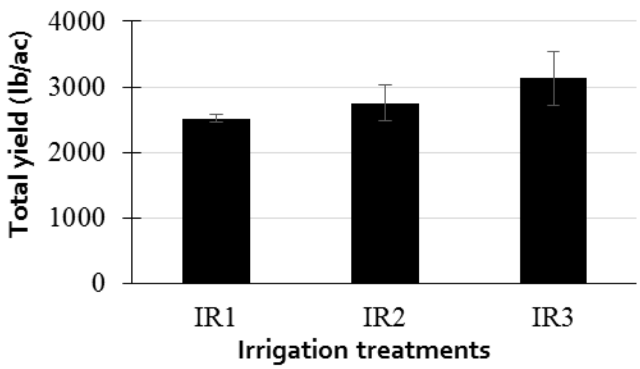


Figure 1. Total yield of confection sunflower as affected by irrigation treatments at on-farm trial (IR1, IR2, and IR3 are irrigation termination at 50% flowering, full flowering, and when back of the head turns into a light yellow color, respectively). Vertical lines denote standard error.

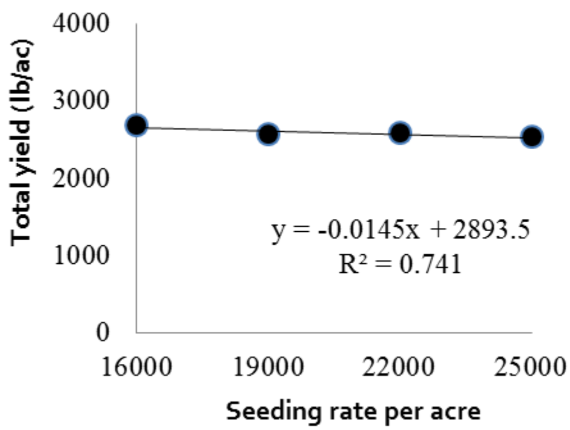


Figure 2. Total yield of confection sunflower at different seeding rates at on-farm trial.

total yield (data not shown). The difference in soil type and its water-holding capacity likely contributed to greater yield reduction at the on-farm site. The coarse-loamy soil at the on-farm field has lower water-holding capacity (1.7 in/ft) than the clayey-loam soil at the on-station site, which can store greater amounts of water (2.4 in/ft). Thus, confection sunflower grown in a field with a higher proportion of coarse soil might need to be irrigated until the R7 stage.

II. Study B (seeding rate): The total yield decreased slightly (denoted by the negative slope) with an increase in seeding rate at the on-farm trial (Figure 2). This suggests that higher seeding rates above 16,000 seeds per acre would not have paid off. A similar trend has also been observed at the on-station 2014 test (separate report in this *Field Days Bulletin*). Thus, preliminary studies suggest that confection sunflower can thrive at a planting density of 16,000 seeds per acre. The optimal level of seeding rate, however, varies depending on soil type, rate and type of irrigation, weather, and agronomic practices. Tests that include seeding rates below 16,000 per acre are underway this year.

**Acknowledgments:** We thank PREC staff members for help and appreciate the kind collaboration of three producers, Tim Duyck, Brian Duyck, and Lyle Evelo, for support and assistance. This study was funded by the University of Wyoming Agricultural Experiment Station and by PREC's Bighorn and Wind River Basins Applied Research Fund program.

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**Keywords**: irrigation management, seeding rate, confection sunflower

**PARP**: I:2, IV

# Yield Response of Confection Sunflower to Delaying the Onset of Irrigation

V.R. Joshi[1], A. Samet[1], J.J. Heitholt[1], K. Hansen[2], and A. Garcia y Garcia[3,*]

In recent years, confection sunflower (those grown for consumption instead of oil) has become an increasingly important crop to Wyoming farmers, especially those in the Bighorn Basin. Therefore, sunflower acreage in the region has been on the rise. In response to this increasing interest, the Powell Research and Extension Center (PREC) has been conducting studies on its agronomic management practices, especially in regards to irrigation. Past studies have shown sunflower to be moderately tolerant to water stress and may be a good candidate for limited-irrigation strategies; however, information on when irrigation can be limited without compromising yield is still lacking. Identifying an irrigation strategy that significantly reduces water use but maintains yield could contribute to water savings for Wyoming and other states.

## Objectives

The objectives of the study were to 1) determine the effects of delaying irrigation on sunflower seed yield and quality and 2) develop a water-management strategy that could reduce the number of irrigations without compromising yield.

## Materials and Methods

The experiment was conducted on a clayey-loam soil during the 2014 growing season at PREC. The confectionary sunflower hybrid 9579 (SunOpta Inc.) was planted May 26 at 19,000 seeds per acre using 22-inch row spacing under a furrow-irrigated system. Irrigation treatments were: full irrigation for the whole growing season (FI), starting irrigation at R1 stage when miniature floral head appears (R1), starting irrigation at R4 stage when floral head begins to open (R4), and rain-fed (RF). All treatments received an initial establishment irrigation to ensure plant stand. The RF sunflower trial received approximately 3.5 inches of precipitation during the 2014 growing season, which is about 60% of the historical average. Data were collected on total yield and large seed yield (seeds left after screening on a 20/64-inch, round-hole sieve). Yield component data were also collected but are not reported here.

## Results and Discussion

Delaying irrigation until R1 and R4 stages of plant growth averaged 254 and 525 lb/ac less total yield and 244 and 672 lb/ac less large seed yield as compared to full irrigation (Figure 1). Our results indicate that irrigation can be minimized in confection sunflower production during the vegetative growth stage since the reduction in total yield as well as large seed yield from R1 treatment was only 7% as compared to full irrigation. In R4 treatment, the reduction in total yield and large seed yield was 15 and 20%, respectively, as compared to full irrigation. This suggests that large seed yield is more influenced by delaying the on-set of irrigation after the crop enters into reproductive stage; however,

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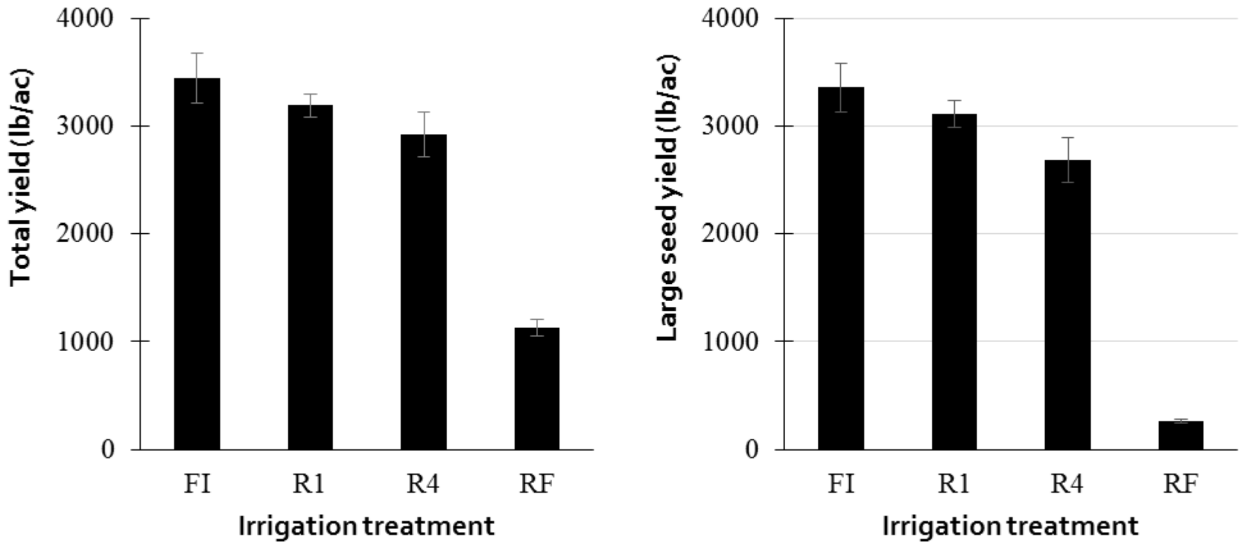


Figure 1. Total yield (left) and large seed yield (right) response of confection sunflower to delaying irrigation in an experiment conducted at PREC during the 2014 growing season. Vertical error bars indicate standard error. (Statistically not analyzed). FI refers to full irrigation for the whole growing season; R1 refers to starting irrigation at R1 stage when miniature floral head appears; R4 refers to starting irrigation at R4 stage when floral head begins to open; and RF refers to rain-fed treatment, which received irrigation only at seedling establishment stage. Large seed yield refers to the seeds left after screening on a 20/64-inch, round-hole sieve.

producers are cautioned to avoid R4 irrigation management until more is known about the economics of this practice. An economic analysis of these practices is ongoing.

Our results suggest that the RF treatment is not viable, but it is noteworthy to mention briefly its dramatic effects. The total yield from RF treatment was 67, 65, and 61% less as compared to FI, R1, and R4 treatments, respectively, and the reduction in large seed yield was even more pronounced (Figure 1). Large-seed yield was reduced by more than 90% in RF as compared to other irrigation treatments, indicating a marked reduction in seed quality.

**Acknowledgments:** We thank PREC staff members for support and assistance. This study was funded by the Wyoming Agricultural Experiment Station and by PREC's Big Horn and Wind River Basins Applied Research Fund program.

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**Keywords**: irrigation management, confection sunflower

**PARP**: I:2, IV:4

# Crop Response to Nitrogen and Phosphorus Fertilizer in Sugarbeet/Bean/Barley Rotations under Conservation Tillage and Limited Irrigation

*J.B. Norton[1], O. Ng'etich[1], U. Norton[2], J. Vardiman[3], and C. Carter[3]*

As producers convert flood systems to overhead sprinklers and conventional tillage practices to conservation tillage methods, new approaches to soil fertility management are needed. Improved control over water application leads to less nutrient loss, while increased soil organic matter (SOM) from conservation tillage increases water- and nutrient-supplying potential of soils. Both present opportunities for improved crop nutrient management, but altering irrigation and tillage without changing fertilizer practices can reduce yield and quality of crops such as sugarbeet and malting barley from oversupply of nitrogen (N). Phosphorus (P) fertilizer management on calcareous soils is also a long-term issue for Wyoming producers and could be affected by management changes. Also, many Wyoming production areas do not receive adequate irrigation water for whole growing seasons. Improved understanding of interactions among conservation tillage, water supply and use, and nutrient management are needed.

## Objectives

Evaluate sugarbeet, dry bean, and malt barley response to five levels of N fertilizer and five levels of P fertilizer under: 1) conservation and typical tillage management; 2) typical full irrigation and 75% of full irrigation, and 3) combinations of fertilizer, tillage, and irrigation treatments (interactions).

## Materials and Methods

The study began in 2014 with establishment of four replicated plots of 1) two tillage approaches (reduced till and conventional till), 2) two irrigation levels (full irrigation as typically applied at the Powell Research and Extension Center [PREC] and 3/4 irrigation), 3) three crops (sugarbeet, barley, and dry beans), 4) five levels of N fertilizer, and 5) five levels of P fertilizer. (A separate study in the same framework will evaluate effects of a mixed cover crop following barley.)

## Results and Discussion

Fertilization studies often show no results during the first year because of high variability associated with residual N and P from previous years. This was the case for this study for N, P, tillage, and irrigation level in beans and barley, and for P and tillage approach in sugarbeet. But we did see a significant response to N in sugarbeet when averaged across tillage and irrigation treatments (Figure 1). These early results indicate that application of more than 150 pounds of N per acre did not increase yield of roots or sugar, but this could change with more data from 2015 and 2016. Sugarbeet yield also responded to irrigation level, with the lower level yielding 24.9 pounds per acre and the higher level yielding only 17.2 lbs/ac averaged across fertility and tillage treatments. Lower yield from

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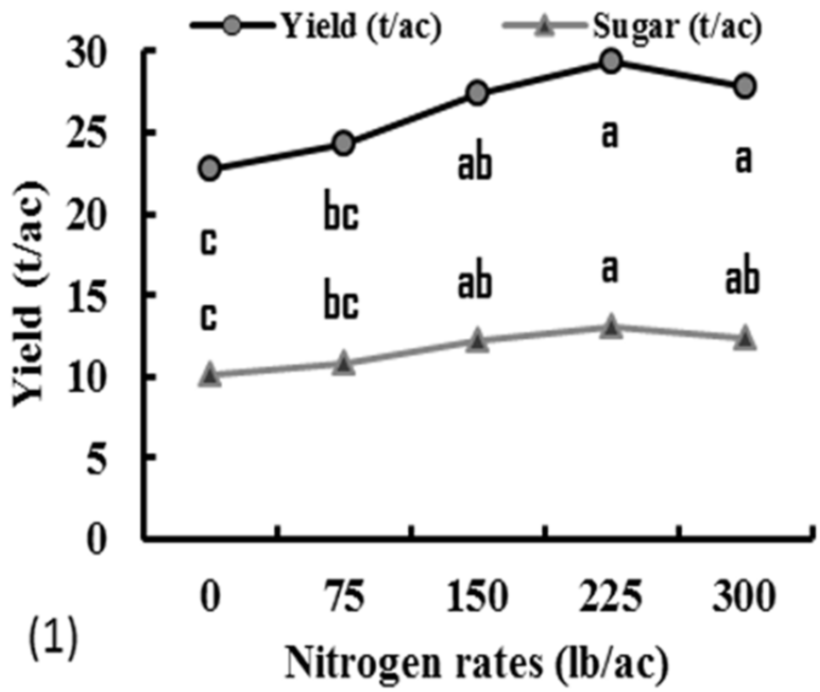


Figure 1. Sugarbeet root and sugar yield, 2014. Points along the line with different letters differ significantly.

more irrigation water suggests that in 2014 the higher irrigation level may have leached nutrients below the root zone. This indicates the importance of proper irrigation water management for optimal yield. Starting with the 2015 growing season, we are using weather and crop information to precisely apply water to meet the needs of crops, and we'll also use 3/4 of that amount for the two irrigation treatments. Evaluation of treatment effects on soil quality also began in 2015.

**Acknowledgments:** We thank PREC field crews for assistance in plot establishment and harvesting. The study is supported by grants from the Wyoming Agricultural Experiment Station and Wyoming Department of Agriculture's Agriculture Producer Research Grant Program.

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**Keywords:** conservation tillage, sugarbeet, fertilizer

**PARP:** I, II, VII, IX

# Policy Experiments for the Intermountain West Native Seed Industry

*B.R. Mock[1], K.M. Hansen[1], and R. Coupal[1]*

Wyoming is a significant producer of oil, natural gas, and coal. Reclaiming lands after energy extraction can be a challenge, especially in the fragile and harsh climate conditions often present in the Intermountain West, including Wyoming. Land managers increasingly turn to native rather than introduced plant materials for reclamation efforts, as the former may provide greater long-term reclamation success and ecological function. *The Gold Book*[2], which provides a regulatory overview for reclamation on federal lands—including those managed by the U.S. Bureau of Land Management (BLM)—and on private surface lands over federal minerals, specifically identifies native seeds as part of the due diligence expected from oil and gas firms. Native seed, however, is not always used in reclamation, in part due to lack of availability. Also, production costs for native seed are generally higher than those for conventional agricultural crops, and yields are more variable. Both factors tend to discourage producer participation in the native seed market.

BLM is responsible for regulating reclamation efforts on the federal lands that it manages in the West, including those in Wyoming. The agency is, consequently, interested in securing a consistent seed supply and decreasing risk for seed producers (Figure 1 [Indian ricegrass as an example of native forage]). BLM is currently considering two policy options to encourage native seed production. *First* is forward contracting. Most native grass seed is currently bought and sold on a spot market, meaning that production occurs in advance of trading and seed producers bear the risk that their inventory is not sold. Under forward contracting, producers have a contract in place with buyers before they begin production, which encourages higher production levels. The BLM has already funded small-scale forward contracting to encourage new cultivar development and could expand this policy. *Second* is demand variability. A major driver of demand for native seed is restoration after wildfire; consequently, BLM's demand for native seed varies markedly from year to year. BLM is considering smoothing its demand for native seed, at least for those species that can be stored. Further, BLM accounts for between 65% and 90% of market demand for native seed—depending on the fire year—through a biannual consolidated seed buy. How are outcomes affected by the "big buyer" nature of the market?


Photo courtesy Santa Fe Botanical Garden

Figure 1. Indian ricegrass.

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[1]Department of Agricultural and Applied Economics.

[2]*The Gold Book*, formally titled the *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development*, is a joint publication of the BLM and U.S. Forest Service. It is available online at http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/gold_book.html

Table 1. Benefits from forward contracting and demand smoothing relative to current market situation.

| Treatment | Earnings* | Improvement over current market situation (%) |
|---|---|---|
| Big buyer, spot contracts, variable demand | 800 | 0 |
| Big buyer, spot contracts, constant demand | 883 | 29 |
| Big buyer, forward contracts, variable demand | 997 | 69 |
| Big buyer, forward contracts, constant demand | 1047 | 87 |
| Competitive market, forward contracts, constant demand | 1083 | 100 |

*earnings for all treatments are different from the current market situation at $p<0.05$.

## Objectives

The objective is to examine whether forward contracting and/or reducing demand variability in the native seed industry would increase seed price and volume traded, and improve the net revenues of seed producers.

## Materials and Methods

Lack of real-world data makes a study of the native seed industry using conventional economic analysis difficult. We instead implement a laboratory market experiment to explore how different policy options might affect market efficiency, price, transaction volume, and seller earnings. Students in a computer laboratory trade native seeds in a private negotiation trading environment, with forward or spot deliveries, and constant or variable demand. At the conclusion of the session, student earnings are converted from the laboratory currency of "tokens" to U.S. dollars. Students are compensated according to how wisely they buy and sell native seeds. Most laboratory market experiments use students as subjects due to ready access to the subject pool and convenience in recruiting. Student decision-making might not be representative of producer decisions; however, there is still benefit in testing policies first in the laboratory before implementing them, at potentially great cost, in the real world.

## Results and Discussion

Results indicate that both forward contracting and smoothing variable demand increase volume traded, seed price, and net revenues of seed producers. Forward contracting, though, increases efficiency, volume traded, and net revenues more than smoothing demand (Table 1). If BLM signed forward contracts with producers and smoothed its demand for native seeds, efficiency would increase further, nearly to the price and volume levels we would expect to see in a competitive market (thus compensating for the effects of market power). These laboratory results suggest that there may be benefits to implementing such policies in the real world.

**Acknowledgments:** We thank seed producers in the Powell area for helpful conversations and information on costs and returns for their operations. This study was funded by the Wyoming Reclamation and Restoration Center.

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**Keywords:** reclamation, native seed species, economics experiments

**PARP:** VII:6, XII:1

# 2014 Dry Bean Performance Evaluation

*M. Moore[1], C. Reynolds[2], J. Sweet[1], and A. Pierson[2]*

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

## 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 2 pints Outlook™. The plots received 65 units of nitrogen (N), 50 units of phosphorous (P), and five units of zinc (Zn). 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 27. 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 acceptable. Summer temperatures were reasonable, but a hard frost the first week of September had an impact on all entries and is at least part of the reason for the high coefficient of variation for the trial. Days to maturity data were not reported due to data errors.

**Acknowledgments**: This study would not be possible without assistance of PREC staff.

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**Keywords:** dry bean, performance evaluation, yield trial

**PARP:** VIII:1

[1]Wyoming Seed Certification Service; [2]Powell Research and Extension Center.

Table 1. Agronomic data, 2014 cooperative dry bean nursery, Powell, Wyoming.

| Name | Market class | Yield lbs./A | Seeds per pound | Days to 50% bloom |
|---|---|---|---|---|
| 23ST-27 | black | 2554 | 1144 | 49 |
| 96-148 | black | 2398 | 1688 | 50 |
| T39 | black | 1908 | 2248 | 55 |
| Gypsy Rose | flora de mayo | 2785 | 1503 | 51 |
| UCD 9623 | flora de mayo | 1877 | 1254 | 49 |
| Powderhorn | great northern | 3041 | 1132 | 51 |
| Majesty | kidney dark red | 2102 | 679 | 51 |
| ND061210 | kidney dark red | 943 | 1000 | 50 |
| Inferno | kidney light red | 3633 | 721 | 49 |
| NY105 | kidney light red | 1185 | 726 | 41 |
| ND061106 | kidney light red | 1079 | 1025 | 50 |
| CELRK | kidney light red | 986 | 870 | 41 |
| NY104 | kidney light red | 879 | 798 | 45 |
| Yeti | kidney white | 2043 | 903 | 49 |
| Snowdon | kidney white | 1599 | 812 | 49 |
| Fathom | navy | 2528 | 1900 | 49 |
| Rosetta | pink | 3068 | 1224 | 51 |
| UCD 9634 | pink | 2067 | 1234 | 48 |
| PT11-13 | pinto | 2981 | 1004 | 51 |
| CO 91212-4 | pinto | 2855 | 1089 | 49 |
| ISB-19 | pinto | 2823 | 1161 | 49 |
| PT12-37 | pinto | 2710 | 1152 | 50 |
| ISB-20 | pinto | 2477 | 1113 | 49 |
| Maverick | pinto | 2476 | 1161 | 49 |
| ElDorado | pinto | 2286 | 993 | 50 |
| Othello | pinto | 2232 | 1204 | 41 |
| SF103-8 | pinto | 2018 | 1061 | 45 |
| ND060197 | pinto | 1918 | 1343 | 49 |
| ISB-P1 | pinto | 1891 | 1290 | 49 |
| ISB-P3 | pinto | 1509 | 1297 | 49 |
| R12859 | red | 2834 | 1217 | 49 |
| 28-1 | yellow | 4712 | 887 | 49 |
| 60-1 | yellow | 3578 | 1063 | 45 |
| 24-2 | yellow | 3546 | 828 | 50 |
| 54-1 | yellow | 2509 | 936 | 51 |
| Mean | | 2285 | 1123 | 49 |
| LSD | | 649 | 4 | 2 |
| CV | | 20 | 7 | 3 |

LSD = least significant difference; CV = coefficient of variation

# Effect of Irrigation and Nitrogen Rates on Yield of Corn for Silage

*A. Nilahyane[1], M.A. Islam[1], and A.Garcia y Garcia[1,*]*

Corn for silage requires adequate amounts of water, nutrients, and good management practices for profitable production. Corn has been reported to have high irrigation requirements; however, the great challenge is to increase productivity with less water use.

Nitrogen (N) is required in large amounts and is one of the best crop-input investments for corn production, but N is the most expensive nutrient for farmers. Thus, best management practices for N—including use of proper application rates, appropriate application methods, and timing of application—are important for improved yield and quality of corn for silage production. The correct N requirement for silage corn production can be quantified by different rates of N fertilizer application under different irrigation systems.

## Objectives

Objectives are to determine the effects of different irrigation levels and N rates on dry matter yield of corn for silage grown under on-surface drip irrigation (ODI) and sub-surface drip irrigation (SDI) systems.

## Materials and Methods

The study was conducted in 2014 at the Powell Research and Extension Center (PREC). The study area is characterized by an arid climate with an average temperature of 62°F for the growing season and an average annual precipitation of 6.9 inches.

Two separate studies were conducted under SDI and ODI systems. The hybrid Pioneer 'P8107HR' was planted with row spacing of 22 inches. Each experiment consisted of three different irrigation treatments and five N rates in a randomized complete block design in a split-plot arrangement with four replications in the SDI and three replications in the ODI system. Irrigation treatments (main) included 100% (which is equivalent to 10 inches of water applied during the growing season), 80%, and 60% ETo (crop evapotranspiration, an indicator of the water needs of plants). Irrigation treatments were initiated after crop establishment. N rates were the sub-treatments and consisted of 0, 80, 160, 240, and 320 pounds per acre of a urea-ammonium-nitrate aqueous solution (UAN, 32% N) applied in two- to four-split applications at planting, V4, V8, and V10 stages of plant (the Vn stage is when the collar of the nth leaf is visible). Aboveground plant biomass was harvested at the R3–R4 (milk-dough) stage to determine dry matter yield. ODI and SDI data were analyzed using the statistical software R.

## Results and Discussion

ODI and SDI curves indicate that the irrigation levels and N rates had an effect on corn dry matter yield (Figure 1). For both studies, the irrigation levels 100% and 80% ETo produced the highest yield while 60% ETo produced the

[1]Department of Plant Sciences; *now at University of Minnesota.

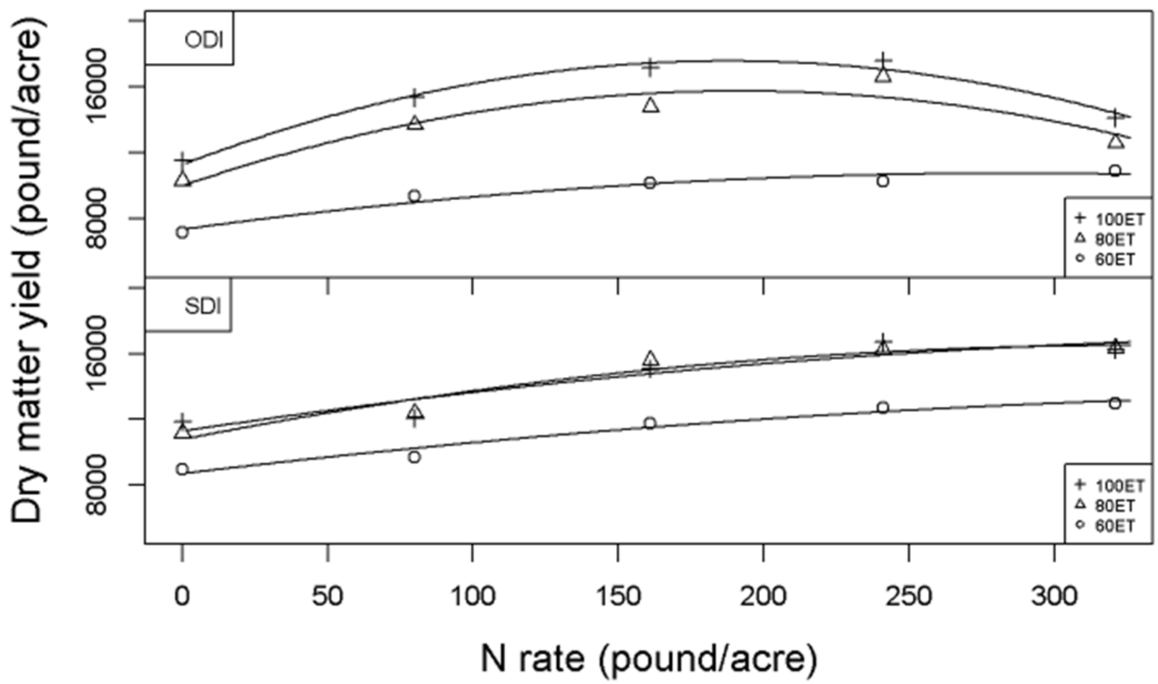


Figure 1. Dry matter yield response to different N rates and different irrigation levels under ODI and SDI systems. The means are presented for each N rate used in the study.

lowest. No difference was observed between 100% and 80% ETo treatments. As a consequence, 80% ETo might be used for both irrigation systems for higher corn production.

Within irrigation systems, N affected corn silage yield. ODI curves showed a maximum yield response at 284, 190, and 187 pounds N per acre for 60%, 80%, and 100% ETo irrigation treatments, respectively. These results suggest that such rates might be more effective for corn production under an ODI system. Regarding SDI, results showed an increasing trend of yield response to added N; however, maximum yield within the range of N rates used in this study was not achieved. This was probably due to the fact that water was applied at one foot deep, and perhaps N was leached.

The irrigation level 80% ETo under SDI and ODI seems to have potential for beneficial corn silage production without compromising yield loss. Results also show an increasing yield response to added N. At least 187 pounds N per acre might be needed to make profitable corn for silage production under ODI and SDI systems.

**Acknowledgments:** Appreciation is extended to the field and lab assistants at PREC. This project was supported by the Department of Plant Sciences and Wyoming Agricultural Experiment Station.

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**Keywords**: irrigation, nitrogen, corn

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

# 2014 Spring Barley Variety Performance Evaluation

*A. Pierson[1], C. Reynolds[1]*

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

## Objectives

The purpose of this nursery is to evaluate the performance of both 2- and 6- rowed feed and malting barley grown under all climatic conditions in Pacific Northwest and Northern Great Plains regions, including Wyoming. Our state's climatic conditions vary greatly as does spring barley variety performance. Data on grain yield, test weight, and protein are important to local and regional producers, as some malt and/or feed varieties may not perform in some areas, and there is potential for some tested varieties to outperform the regional checks.

## Materials and Methods

The experiment was located at the Powell Research and Extension Center (PREC) during 2014. Fertilizer was applied March 11 at the rate of 120 pounds/acre of nitrogen (N) and 50 lb/ac of $P_2O_5$ in the form of urea (46-0-0) and monoammonium phosphate (11-52-0). The experimental design of all trials was randomized complete block with three replications. On April 8, 33 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 lbs of seed per acre. Weeds were controlled by a post application of a tank mixture of bromoxynil octanoate (1 pt Huskie®) and pinoxaden (1 pt Axial® XL) broadcast at 0.50 and 0.05 pounds active ingredient/ac on June 4. Furrow irrigations were May 5, June 8, June 19, June 23, July 4, and July 15. Measurements included height, heading date, lodging (when stems bend to the ground), grain yield, test weight, and kernel plumpness. Subsamples, 5.3 by 15 feet, were harvested August 10 using a Wintersteiger plot combine.

## Results and Discussion

Results from 2014 are presented in Table 1 on the following page. The highest yielding malting entry was 2ND27705 at 116.75 bu/ac, while the highest yielding feed/food entry was 09WA-203.24 at 136.0 bu/ac. Results are posted annually at http://www.uwyo.edu/uwexpstn/variety-trials/index.html.

**Acknowledgments:** Appreciation is extended to the Powell Research and Extension Center staff and summer crew for assistance during 2014 and also to Briess® Malt & Ingredients Company for providing entries for testing.

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**Keywords:** spring barley, variety trial

**PARP:** VIII

[1]Powell Research and Extension Center.

Table 1. Agronomic performance of spring barley genotypes grown at PREC during 2014.

| Variety | Row type | Grade | Height (inches) | Heading date (days from Jan 1) | Lodging* (1–9) | Grain yield (bu/ac) | Test weight (lb/bu) | Plump (% above screen) 6/64 | Plump (% above screen) 5.5/64 |
|---|---|---|---|---|---|---|---|---|---|
| *Malting* | | | | | | | | | |
| 2ND27705 | 2 | malting | 24 | 164 | 1 | 117 | 51 | 94 | 98 |
| 2Ab08-X05M010-82 | 2 | malting | 26 | 165 | 1 | 113 | 50 | 87 | 94 |
| 2Ab07-X04M219-46 | 2 | malting | 20 | 165 | 1 | 113 | 47 | 85 | 93 |
| 2B11-5166 | 2 | malting | 27 | 165 | 1 | 108 | 49 | 87 | 95 |
| 2B10-4162 | 2 | malting | 25 | 168 | 1 | 105 | 50 | 81 | 93 |
| 2B11-4949 | 2 | malting | 27 | 168 | 1 | 105 | 49 | 88 | 95 |
| 2B09-3425 | 2 | malting | 28 | 165 | 1 | 104 | 50 | 91 | 96 |
| Harrington | 2 | malting | 29 | 165 | 1 | 102 | 49 | 88 | 96 |
| 2B10-4378 | 2 | malting | 26 | 168 | 1 | 101 | 51 | 90 | 97 |
| 2Ab07-X031098-31 | 2 | malting | 27 | 168 | 1 | 101 | 50 | 89 | 96 |
| AC Metcalfe | 2 | malting | 31 | 165 | 1 | 94 | 50 | 90 | 97 |
| 2Ab04-X01084-27 | 2 | malting | 29 | 168 | 1 | 94 | 49 | 86 | 94 |
| 2ND30724 | 2 | malting | 26 | 165 | 1 | 93 | 50 | 96 | 98 |
| 2ND28065 | 2 | malting | 27 | 168 | 1 | 90 | 49 | 94 | 98 |
| *Feed/Food* | | | | | | | | | |
| 09WA-203.24 | 2 | feed | 25 | 165 | 1 | 136 | 50 | 88 | 95 |
| UT2183-85 | 6 | feed | 28 | 165 | 1 | 124 | 50 | 95 | 99 |
| BZ509-443 | 2 | feed | 34 | 168 | 1 | 120 | 50 | 88 | 96 |
| UT2136-96 | 6 | feed | 28 | 165 | 1 | 117 | 47 | 90 | 96 |
| MT100120 | 2 | feed | 29 | 165 | 1 | 117 | 52 | 95 | 99 |
| BZ509-216 | 2 | feed | 27 | 165 | 1 | 114 | 51 | 90 | 97 |
| MT100126 | 2 | feed | 31 | 165 | 1 | 113 | 50 | 96 | 99 |
| Steptoe | 6 | feed | 27 | 165 | 1 | 113 | 46 | 92 | 97 |
| MT090180 | 2 | feed | 31 | 168 | 1 | 112 | 50 | 95 | 99 |
| 09WA-228.13 | 2 | feed | 32 | 168 | 1 | 109 | 51 | 90 | 96 |
| 10WA-106.18 | 2 | feed | 19 | 165 | 1 | 107 | 51 | 85 | 94 |
| 10WA-105.33 | 2 | feed | 28 | 168 | 1 | 107 | 50 | 89 | 97 |
| 10WA-113.16 | 2 | feed | 29 | 168 | 1 | 106 | 50 | 88 | 96 |
| 2Ab09-X06F084-51 | 2 | H,F** | 27 | 168 | 1 | 103 | 49 | 82 | 94 |
| 10WA-106.19 | 2 | feed | 29 | 168 | 1 | 103 | 50 | 88 | 96 |
| Baronesse | 2 | feed | 26 | 164 | 1 | 103 | 50 | 90 | 96 |
| MT090190 | 2 | feed | 23 | 168 | 1 | 101 | 52 | 96 | 98 |
| 09WA-231.5 | 2 | feed | 30 | 168 | 1 | 96 | 54 | 89 | 97 |
| 2Ab09-X06F058HL-31 | 2 | H,F** | 27 | 168 | 1 | 74 | 50 | 91 | 97 |
| Location Mean | | | 27.38 | 166.39 | 1 | 106.53 | 49.97 | 89.83 | 96.24 |
| LSD (.05) | | | | | | 14.93 | 3.3 | 4.11 | 3.4 |
| CV % | | | | | | 9.8 | 4.5 | 3.4 | 5.2 |

# Assessment of Alfalfa Pest Management Challenges in Wyoming

*R. Jabbour[1] and S. Noy[2]*

Alfalfa is a major crop throughout the Intermountain West, including Wyoming (Figure 1), but is susceptible to a suite of insect pests, most notably the alfalfa weevil. Considerable economic and environmental costs of chemical pest management highlight a critical need to develop more effective and efficient control strategies. This need aligns with the goal of Wyoming producers to "improve agricultural productivity considering economic viability and stewardship of natural resources (Wyoming Production Agriculture Research Priorities 2012)." An essential first step to accomplishing this goal is to assess the current state of alfalfa pest management challenges and strategies in Wyoming so that new or modified approaches align with farmer priorities.

## Objectives

Our specific objective is to define farmer priorities and decision-making strategies regarding pest management through focus groups with farmers and surveys distributed statewide.

## Materials and Methods

In 2014 and 2015, we conducted focus groups with farmers in Goshen, Platte, Fremont, and Park counties, ranging in size from 3–9 farmers, with an average of six farmers per group. Randa Jabbour moderated the discussions, and Shiri Noy and one student were present as note-takers. We asked farmers which alfalfa pests they had encountered, which pests they considered most problematic, and how they solved these pest problems. We also asked farmers

Figure 1. Alfalfa hay is the most important crop in Wyoming in terms of value (in 2013, for example, its value was $278 million).

[1]Department of Plant Sciences, [2]Department of Sociology.

which pest management information would be useful for them.

## Results and Discussion

We are currently analyzing and summarizing the wealth of information gained from this project. We present an initial summary here. In all four focus groups, farmers agreed that alfalfa weevil was the most problematic pest in alfalfa hay, due to how quickly and dramatically they can defoliate alfalfa. The most common pest management strategies used included chemical control prior to the first cutting and an early first cutting. The second most problematic pest in alfalfa hay differed depending on the focus group, with groups either being more concerned about late-season infestation of aphids or grasshoppers moving in from the edges of fields. Finally, in Park County, there were also alfalfa seed producers who participated in the focus group. They uniformly agreed that their most problematic pest is the Lygus bug, which they attempt to control using a series of chemical applications.

**Acknowledgments:** We are grateful to the farmers for taking the time participate. We thank Caleb Carter, Dallas Mount, Jeremiah Vardiman, Kelly Spiering, Ken Watts, and Tina Russell for assistance recruiting farmer participants. Seth Gill, Wendy Cecil, Makenzie Benander, and Chloe Skaggs assisted with note-taking and transcription of recordings.

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

**Keywords:** alfalfa pests, decision-making, focus groups

**PARP:** X:2

# Improving Mycorrhizal Status of Soil Using Cover Crops

*B. Alsunuse[1], P.D. Stahl[1], J. Norton[1], and U. Norton[2]*

Cover crops have a multitude of benefits for agriculture production including improvement in soil structure, nutrient retention, weed control, increased soil organic matter, and continued arbuscular mycorrhizal associations. Cover crops also significantly reduce soil loss from both wind and water erosion.

Intensive agriculture practices in many parts of the West require close monitoring of soil fertility, but much less attention has been paid to the mycorrhizal status of Western agricultural soils. Establishing temporary cover crops on agricultural soils can be used to increase presence of arbuscular mycorrhizal (AM) fungi in cultivated soil, but research is required to assess the potential for improving soil health characteristics such as aggregate formation and stable soil organic matter (SOM) content.

AM fungi form a symbiosis with land plants, including many that are agriculturally important. AM can increase the uptake of nutrients such as phosphorus and zinc from the soil. The management of AM fungi may be useful because AM fungal inoculum potential can be reduced significantly during fallow periods, or when non-mycorrhizal plant species occur in a crop rotation. The consequence of reduced inoculum potential may be a significant reduction in nutrient uptake and yield of subsequent mycorrhizal crops. Some studies show that AM fungi increase water uptake, which is associated with increased soil hyphal biomass when mycorrhizal plants are subjected to severe water stress (hyphae are filaments that constitute the body—or mycelium—of fungus). Other researchers have stated that tillage can lead to decreased root colonization by AM fungi because tillage cut network hyphae and also impact major components in the rhizosphere, i.e., water, temperature, and soil structure.

## Objectives

Determine if use of AM cover crops 1) can increase the microaggregate and macroaggregate content as well as the concentration of stable SOM of cultivated soil and 2) have a positive impact on biomass production in soil by AM fungi.

## Materials and Methods

This study was initiated in 2014 (with its continuation to be made this year and 2016) at the Powell Research and Extension Center (PREC). The experiment was designed to examine the influence of different levels of irrigation (75% and 100%), conventional tillage (CT) and strip tillage (ST) practices, and different crops (bean and barley) have on the development of AM. Soil samples and root samples were collected for the analysis of arbuscular fungal presence in June 2014. Roots were examined using the methods of Phillips and Hayman (1977), and arbuscular fungal biomass in soil was estimated using a biochemical technique that utilized lipid biomarkers.

[1]Department of Ecosystem Science and Management; [2]Department of Plant Sciences.

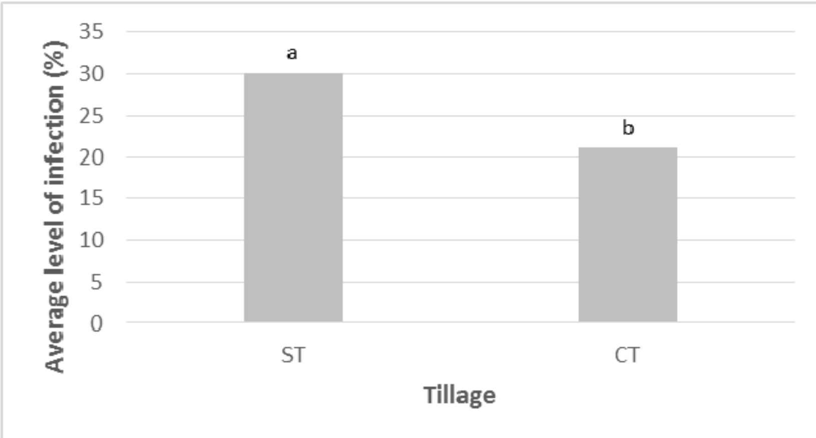


Figure 1. Average level of mycorrhizal fungi colonization in plant roots as influenced by tillage practices (conventional tillage [CT]; strip tillage [ST]).

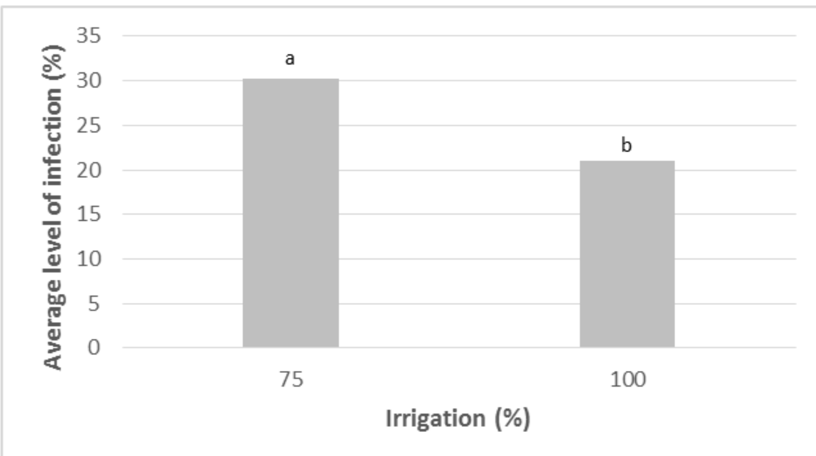


Figure 2. Average level of mycorrhizal fungi colonization in plant roots as influenced by irrigation practices.

## Results and Discussion

Results from the first year (before cover crops were established) indicate AM fungi colonizing the root of bean and barley were affected by both soil tillage practices and level of irrigation. Preliminary results show that AM fungi were more prevalent on roots of plants grown under strip-till treatment (Figure 1). Results also indicate that crops grown at the 75% irrigation level developed more AM than those grown at the 100% irrigation level (Figure 2).

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**Keywords:** arbuscular mycorrhizal fungi, cover crop, soil aggregation

**PARP:** I:3,7, IV:3

**Literature Cited**

Phillips, J.M., and Hayman, D.S., 1970, Improved procedures for clearing roots and staining parasitic and vesicular-arbuscular mycorrhizal fungi for rapid assessment of infection: Transactions of the British Mycological Society, v. 55, p. 158–161.

### Introduction to the

# James C. Hageman Sustainable Agriculture Research and Extension Center

*B. Baumgartner*[1]

The James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) began fully conducting research in 2006. SAREC is composed of roughly 400 acres of irrigated cropland, of which 300 acres are irrigated by overhead irrigation through three center pivots and one lateral-move sprinkler. The center has 47 acres of furrow irrigation. The remaining balance of irrigated cropland has been converted to dryland corners. The station also has roughly 1,200 acres of dryland cropland and another 2,000-plus acres of rangeland. A 400-head feedlot is also on site, along with 40-plus mother cows.

Employees at SAREC are dedicated to performing the highest level of research possible. Those on station include the University of Wyoming Extension beef specialist, a research scientist with the Department of Agricultural and Applied Economics, a research associate, the UW pesticide applicator training coordinator and his associate, the director of operations, a farm manager, four assistant farm mangers, a part-time secretary, and the office manager.

All of the above people help in achieving the highest quality of research, from small-plot contract work for private industry, to larger grant-funded, multi-state, multi-year projects, to more applied-type research suggested by local interest groups, including the Wyoming Wheat Growers Association, irrigated and dryland farmers, and ranchers.

## Background Information

The weather in southeast Wyoming has been extremely variable the last few years, with 2013 being extremely dry and one of the worst winters for wind. The wind and dry weather took a toll on the dryland in winter 2013–14. Crop-year 2014 allowed the dryland to heal considerably. We had a good spring in 2014, which allowed us to plant some spring crops and produce a good quantity of stubble (Figure 1). This helped to protect soil from wind and to retain a considerable amount of snow over the 2014–15 winter. Overall, the 2014 crop year proved to be good for the dryland, yet another challenge

Figure 1. Stubble produced from 2014 crop year.

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


Figure 2. SAREC employees, kneeling, from left, Dan Bebo, Logan Cecil, Justin Polkowske, and Trey Faessler; standing, from left, Kelly Greenwald, Troy Cecil, Larry Miller, Jill West, Jim Freeburn, Jerry Nachtman, Rupesh Kariyat (visiting scientist), Al Unverzagt, Brian Lee, Larry Howe, and Bob Baumgartner (not present Steve Paisley).

for irrigated production with limited rainfall throughout summer and an early freeze.

### Facility Improvements and Activities

SAREC was able to add a few improvements this last year. In spring 2014, we purchased and installed a new center pivot with VRI (variable-rate irrigation) technology, which should enable the farm to someday create a precision agriculture showcase. We were also able to upgrade planters, including one with a hydraulic drive to facilitate variable-rate seeding. Additional upgrades to this particular planter permits us to place liquid fertilizer as a popup along with the ability to vary that rate as well. These planter improvements allow the center to perform more site-specific research. We were able to upgrade an existing lateral-move sprinkler in spring 2015 to a VRI system. SAREC was also able to acquire a new 15,000 bushel grain bin to help store our yearly corn crop. SAREC delivers a good share of the commodities, both corn and hay produced on-site, to the Laramie Research and Extension Center, which uses it for cattle, sheep, swine, horses, and other animals.

### Rogers Research Site

The Rogers Research Site continues to be a work in progress. Research led by UW Professor Emeritus Steve Williams is continuing with much effort by local contractors to cut and clear timber. The ground that sustained much damage from a 2012 wildfire continues to heal with the help of Mother Nature. The fire itself created an opportunity for Williams and his team to study long-term consequences of post-fire resource management.

**Acknowledgments**: The dedication and effort of the SAREC team (Figure 2) cannot be overstated. Employees are who make research happen. Without them, a lot of the studies would not be possible. We are totally indebted to them for the work and effort to serve the agricultural community of Wyoming and beyond. Our work is funded in part by the Wyoming Agricultural Experiment Station.

**Contact**: Bob Baumgartner at baumgart@uwyo.edu or 307-837-2000.

# Short Reports—SAREC

## 1. Pollinator food plots demonstration

**Investigators**: Jeff Edwards, Catherine Wissner, and Tina Russell

**Issue**: Interest in pollinator health is steadily increasing due, in part, to media reports concerning colony collapse disorder (CCD). Many factors have been implicated in CCD including loss of diverse flowering plant habitat.

**Goal**: Educate the public about pollinators and the ability to improve pollinator habitat by planting and maintaining pollinator food plots.

**Objectives**: Establish pollinator food plots in a variety of irrigated and dryland plots around the state and determine which pollinators are utilizing the sites.

**Impact**: Results should increase pollinator awareness statewide and assist individuals in selecting flowering seed mixes that will benefit pollinators. This demonstration will be established in 2015 at the James C. Hageman Sustainable Agriculture Research and Extension Center, at Powell R&E Center, and in the Evanston, Fort Washakie, Laramie, and Cheyenne areas.

**Contact**: Jeff Edwards at jedward4@uwyo.edu or 307-837-2956.

**Keywords**: pollinator health, flowers

**PARP**: not applicable

## 2. Management of sugarbeet cyst nematode with a combination of seed treatments and in-furrow nematicides

**Investigators:** William Stump, Wendy Cecil, and Matthew Wallhead

**Issue:** Sugarbeet cyst nematode can affect sugarbeet production in Wyoming and is difficult to manage. Newer nematicides are becoming available to manage the sugarbeet cyst nematode, but require field testing to determine efficacy and safety of use over a wide range of agricultural environments.

**Goal:** Determine the efficacy of these newer nematicides applied in-furrow for sugarbeet cyst nematode management.

**Objectives:** Specific objectives will be to compare the efficacy of a new nematicide applied in-furrow and in combination with a foliar nematicide for both sugarbeet cyst nematode management and their effects on the sugarbeet crop.

**Impact:** Results should provide efficacy data for federal pesticide labeling efforts and could provide growers potential new products for sugarbeet cyst nematode management.

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

**Keywords:** sugarbeet cyst nematode, nematicide efficacy

**PARP:** not applicable

## 3. Management of soil-borne disease in dry bean with in-furrow fungicide applications at planting

**Investigators:** William Stump, Wendy Cecil, and Matthew Wallhead

**Issue:** Several soil-borne fungal organisms can affect dry bean production in Wyoming. Newer fungicides that are applied in-furrow are becoming available to manage various soil-borne diseases.

**Goal:** Determine the efficacy of fungicides applied in-furrow for soil-borne disease management.

**Objectives:** Specific objectives will be to compare the efficacy of a new fungicide that combines conventional chemistry and a biological product with other conventional in-furrow fungicide treatments for management of diseases caused by Fusarium and Rhizoctonia.

**Impact:** Results should increase grower awareness of the use of in-furrow fungicides for soil-borne disease management in dry bean and provide efficacy data for federal pesticide labeling efforts.

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

**Keywords:** dry bean, soil-borne bean disease, fungicide efficacy

**PARP:** not applicable

## 4. Management of potato early blight with foliar fungicide programs in potato

**Investigators:** William Stump, Wendy Cecil, and Matthew Wallhead

**Issue:** Early blight is a common foliar disease of potato that can cause potentially high losses, but can be controlled with foliar fungicide applications. New chemistries and formulations are continuingly being developed, but require field testing with other fungicides to determine compatibility with other pesticides.

**Goal:** Determine the efficacy of newer fungicide formulations and fungicide rotations for season-long early blight management.

**Objectives:** Specific objectives will be to evaluate the efficacy of new fungicide formulations and overall efficacy of various fungicide rotations for early blight disease management.

**Impact:** Results should provide efficacy data for federal pesticide labeling efforts and provide effective fungicide rotation programs to reduce fungicide resistance development.

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

**Keywords:** early blight, fungicide efficacy

**PARP:** not applicable

## 5. Management of diseases caused by Rhizoctonia in sugarbeet with in-furrow fungicide applications at planting

**Investigators**: William Stump, Wendy Cecil, and Matthew Wallhead

**Issue**: In-furrow fungicides at planting can provide longer term management of Rhizoctonia in sugarbeet compared to seed treatments. Newer fungicides that are applied in-furrow are becoming available to manage various soil-borne diseases, but they require field testing to determine if they're effective over a wide range of soils.

**Goal**: Determine the efficacy of fungicides applied in-furrow for soil-borne Rhizoctonia disease management.

**Objectives**: Specific objectives will be to compare the efficacy of a new fungicide that combines conventional chemistry and a biological product with other conventional in-furrow fungicide treatments for management of diseases caused by Rhizoctonia.

**Impact**: Results should increase awareness for growers of the use of in-furrow fungicides for soil-borne disease management in sugarbeet and provide efficacy data for federal pesticide labeling efforts.

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

**Keywords**: sugarbeet, Rhizoctonia disease, fungicide efficacy

**PARP**: not applicable

## 6. Compost carryover and cover crop effects on soil quality, profitability, and cultivar selection in organic dryland wheat

**Investigators:** Jay Norton, Urszula Norton, Axel Garcia y Garcia, and collaborators from Utah State, Oregon State, and Washington State universities

**Issue:** Southeast Wyoming dryland crop producers face challenges in maintaining soil productivity because large-scale production and low profit margins prevent extensive use of soil amendments. More than 20 percent of Wyoming wheat producers are certified organic, which makes maintaining soil productivity even more challenging because of intensive tillage used for weed control.

**Goal:** Study the feasibility and effectiveness of one-time compost application together with appropriate wheat varieties and use of cover crops in fallow periods.

**Objectives:** Evaluate effects of different rates of compost applied one time—along with interactions with different cultivars and cover crops—on soil quality and profitability in dryland winter wheat cropping systems in three on-farm trials near Slater and Albin and one on-station trial at the James C. Hageman Sustainable Agriculture Research and Extension Center.

**Impact:** Results should allow both conventional and organic wheat farmers to evaluate the option of a one-time, high-rate compost application; this could increase soil water-holding capacity and support use of cover crops, which could result in healthier, more productive soil. Wheat cultivar trials will provide information on which varieties perform best under the alternative practices.

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

**Keywords:** winter wheat, compost, cover crop

**PARP:** I, II, VII, IX, X

## 7. Weather monitoring in winter wheat variety trials

**Investigators**: Keith Kennedy, Jerry Nachtman, Axel Garcia y Garcia, and Caleb Carter

**Issue**: Hard winter wheat variety trials have been conducted by the University of Wyoming Agricultural Experiment Station in partnership with the Wyoming Wheat Marketing Commission/Crop Research Foundation of Wyoming since 1992. The scarcity of weather data correlating to these trials, however, impedes the ability of farmers to select hard winter wheat (HWW) varieties suited to their location, which also complicates the selection of experimental lines for public release.

**Goal**: Establish mobile weather stations at five HWW variety trial locations across southeast Wyoming, including dryland and irrigated trials.

**Objectives**: Correlate weather events, including frost dates, low temperatures, and factors affecting breaking of spring dormancy, among them day length and air/soil temperatures.

**Impact**: Data obtained should aid dryland and irrigated wheat farmers throughout southeast Wyoming in varietal selection and the timing and type of cultural practices. Selecting varieties for release will be eased, and plant breeders should be better equipped to develop traits to mitigate stresses occurring in Wyoming's climate.

**Contact**: Caleb Carter at ccarte13@uwyo.edu or 307-532-2436, or Keith Kennedy at agrimind@wyoming.com or 307-223-0010.

**Keywords:** winter wheat, variety trial, weather

**PARP:** VIII, X

## 8. Evaluating variable-rate irrigation system at SAREC

**Investigators**: Brian Lee, Robert Baumgartner, and Milton Geiger

**Issue:** Variable-rate irrigation (VRI) systems allow farmers to irrigate more efficiently based on an electrical conductivity map overlay for the pivot to determine different watering zones. Such systems, however, take time to pay off.

**Goal:** Conduct an economic evaluation of the VRI system that has been installed on a 61.48-acre pivot at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC), including a determination of the payback period and energy savings.

**Objectives:** Evaluate the VRI system for increased irrigation efficiency and energy savings, which will help determine how long it takes to pay the machine off and begin realizing greater profits.

**Impact:** Results should assist area farmers make more informed decisions whether VRI is something that would benefit their operations and whether the purchase of a VRI system for their pivot irrigation operations makes economic sense.

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

**Keywords**: variable-rate irrigation, economic evaluation, energy efficiency

**PARP:** IV:4, VII:4,7

# Evaluating Multi-Species Targeted Grazing for Cheatgrass Control

*C.E. Noseworthy[1], B.A. Mealor[1,2]*

Cheatgrass (*Bromus tectorum* L.), also known as downy brome, is an exotic winter annual grass present throughout much of North America, particularly the Intermountain West, including Wyoming. It is commonly problematic on Western rangelands, specifically in perennial shrublands such as the sagebrush steppe vegetation zone. This invasive species causes many problems, from displacing native plant communities to increasing fire frequency to reducing wildlife habitat and livestock forage. Herbicides are currently the most common method of cheatgrass control, but studies suggest targeted grazing may also be a viable control option.

Targeted grazing can be defined as the use of purposefully chosen livestock for a specific duration, intensity, and frequency of grazing to achieve goals for vegetation management. Although cattle grazing may be damaging to native perennial grasses, thereby increasing cheatgrass invasion, targeted grazing should not be ruled out as a tool for highly impacted systems where few native perennial grasses exist. Alternatively, protection from grazing does not guarantee a reduction in cheatgrass or the return of native perennial grasses. With appropriate conditions and implementation, grazing could be a tool for management rather than having damaging impacts.

## Objectives

The objectives were to: 1) determine the effectiveness of targeted grazing as a method for controlling cheatgrass, 2) evaluate the effects of livestock species (cattle, sheep, or both) and grazing timing (spring, fall, or spring + fall) on cheatgrass populations and associated vegetation, and 3) compare results to those of commonly used herbicide treatments.

## Materials and Methods

The study began in May 2013 at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Plots were arranged in a randomized complete block design. Grazing treatments included combinations of species (cattle, sheep, or both) and timings (spring, fall, or both spring and fall). Stocking density was constant across all treatments at approximately 100 au (animal units) per acre$^{-1}$ with a goal of 90% utilization. Treatments were applied in spring and fall 2013 and spring 2014. Herbicide treatments included imazapic (Plateau®) at 6 oz product per acre and rimsulfuron (Matrix®) at 3 oz product per ac applied early postemergent in fall 2013. Canopy cover, biomass, and cheatgrass seed production data were collected and analyzed using a one-way analysis of variance (ANOVA) with treatment as the factor.

## Results and Discussion

Results are based on two spring grazing events and one fall grazing event. Cheatgrass and other vegetation appeared to respond differently to season of grazing, but not to livestock species.

[1]Department of Plant Sciences; [2]Sheridan Research and Extension Center.

Figure 1. Mixed spring grazing (right) and untreated control (left). Photo taken October 2014. The control is mostly newly emerged cheatgrass and standing dead cheatgrass from spring. Kochia skeletons are visible in the grazed treatment.

All treatments reduced summer 2014 cheatgrass cover ($p<0.0001$). Spring, dual-season grazing, and herbicide treatments decreased cheatgrass biomass irrespective of livestock species ($p=0.0009$; Table 1). Cheatgrass seed production appeared to follow a pattern similar to cover and biomass with lower production in spring and lower production in dual-season grazing and rimsulfuron treatments, but there was no significant effect from any treatments ($p=0.0673$). Our results for fall grazing were based on one fall grazing treatment, so it may not be prudent to make a strong statement concerning the effectiveness of fall grazing on cheatgrass. Cover of the annual weed kochia (*Kochia scoparia L.)* increased where cheatgrass cover was reduced (Figure 1). Based on cheatgrass, perennial grass, and kochia responses, we conclude that springtime targeted grazing has potential as a management method for downy brome, especially in severely degraded sites.

**Acknowledgments:** We thank the SAREC staff , Rachel Mealor, Beth Fowers, Shayla Burnett, Travis Decker, Will Rose, Julia Workman, Amanda Jenkins, Kate Richardson, Amanda Lee, Kelsey Welter, and Jenna Meeks. The study is supported by the Wyoming Reclamation and Restoration Center and Wyoming Agricultural Experiment Station's Competitive Grants Program.

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**Keywords:** cheatgrass, targeted grazing, weed control

**PARP:** III:5, VI:4,5, XII:1

Table 1. Biomass (lb/ac) collected in summer 2014 for a targeted grazing study at SAREC. Treatments include fall, spring, and dual-season (S+F) grazing, rimsulfuron (Matrix) and imazapic (Plateau), and an untreated control.

| Treatment | Cheatgrass[1] | Perennial Grass[1] | Forbs[1] | Sedges | Other Annual Grass |
|---|---|---|---|---|---|
| Control | 1627a | 428b | 482bc | 0 | 63 |
| Fall | 1583a | 413b | 448c | 2 | 130 |
| Spring | 445b | 336b | 139c | 9 | 48 |
| S+F | 538b | 392b | 196c | 5 | 43 |
| Rimsulfuron | 211b | 1258a | 2096a | 261 | 45 |
| Imazapic | 921ab | 380b | 1553ab | 29 | 6 |

[1]Cheatgrass, perennial grass, and forb biomass between treatments followed by different letters ($p<0.05$).

# Effects of Drought on Cow-Calf Production at Two UW Research Stations from 2011–2014

*J.D. Scasta[1], J.L. Windh[1], T. Smith[2], and B. Baumgartner[3]*

Drought is a constant challenge to livestock production on Western rangelands. The early 2000s resembled the extreme droughts of the 1930s "Dust Bowl" and 1950s. The most common way that drought impacts livestock production is the reduction of forage quantity and the carrying capacity relative to animal demand, an effect that typically leads to herd reduction and even complete liquidation. While the reduction of forage quantity leading to reduced animal numbers is well understood and problematic, what may be less understood are the negative effects on forage quality and subsequent livestock performance. Even when ranches are stocked to handle the variation in precipitation and reduction in forage quantity, ranchers may not fully recognize and quantify the potential negative effects of low-quality forage relative to livestock nutrient requirements and potential reductions in growth potential.

## Objectives

Our primary objective was to correlate weaning weight losses with precipitation variability. These data should help ranchers predict production losses caused by drought, quantify and predict potential economic consequences of escalating drought events, and document these negative consequences.

## Materials and Methods

Our study was conducted at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) ranch northwest of

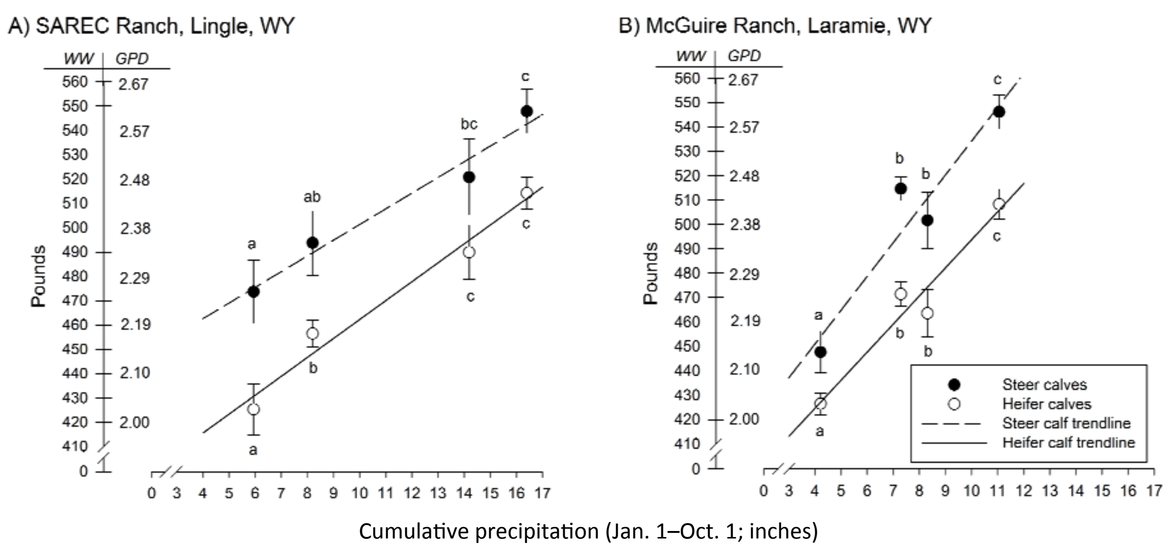


Figure 1. Weaning weight (WW) and gain per head per day (GPD) correlation with drought. Points on line with different letters differ significantly ($p<0.05$) .

[1]Department of Ecosystem Science and Management; [2]Laramie Research and Extension Center; [3]James C. Hageman Sustainable Agriculture Research and Extension Center.

Table 1. Linear regression of steer and heifer adjusted 210-day weaning weights (WW) and calf gain per day (GPD) at the SAREC ranch northwest of Lingle and McGuire Ranch northeast of Laramie from 2011 to 2014.

| Ranch | Calf sex | WW Slope* | WW Intercept | GPD Slope* | GPD Intercept | Adjusted $r^2$ | *p*-value |
|---|---|---|---|---|---|---|---|
| SAREC | Steers | 6.45x | 437 | 0.03x | 2.08 | 0.95 | < 0.02 |
| SAREC | Heifers | 7.77x | 385 | 0.04x | 1.83 | 0.96 | < 0.02 |
| McGuire | Steers | 13.85x | 396 | 0.07x | 1.88 | 0.87 | < 0.05 |
| McGuire | Heifers | 11.51x | 379 | 0.06x | 1.80 | 0.91 | 0.03 |

*x indicates cumulative precipitation from January 1 to October 1 in inches, and slope/intercept are in pounds for WW and GPD.

Lingle and the Laramie R&E Center's McGuire Ranch northeast of Laramie. The SAREC ranch is composed of 1,880 acres of native rangeland dominated by native cool-season species and some warm-season species. The McGuire Ranch is composed of 5,550 acres of native rangeland dominated by native cool-season species and a minor component of planted forages. From 2011 to 2014, a period with very dry and very wet years, we assessed an adjusted 210-day weaning weight (WW) and gain per day (GPD) for a total of 869 calves on both ranches. We compared WW and GPD to cumulative precipitation from January 1 to October 1 by year, calf sex, and ranch locations separately. We calculated the coefficient of determination (adjusted $r^2$) to understand how the trend line explained the variation and assessed *p*-values for significance. We assessed linear equation slopes for each scenario to predict pounds of adjusted total calf gain and gain per day that may be lost for each inch of precipitation reduction.

## Results and Discussion

WWs were up to 99 pounds lower and GPD was up to 0.47 pounds lower between the driest (2012) and wettest (2014) years. The range of WWs between the driest and wettest years ranged from 74 to 99 lbs for steer calves and 89 to 82 lbs for heifer calves at the SAREC and McGuire ranches, respectively (Figure 1). For each one-inch reduction in precipitation, WWs are predicted to be 7 to 8 pounds lower at SAREC and 12 to 14 pounds lower at the McGuire Ranch (Table 1). For each one-inch reduction in precipitation, pounds of gain per head per day are expected to be 0.03 to 0.04 pounds lower at SAREC and 0.06 to 0.07 pounds lower at McGuire (Table 1). Although we did not measure forage quality, other studies report a 2 to 3% reduction in forage crude protein for every one-inch reduction in monthly precipitation. If drought occurs, or continues to escalate, WW, GPD, and value-per-head reductions can be expected and documented for strategic planning and compensation programs. A manuscript from this study is under review at a scientific journal—when published it will provide additional information that should be useful to producers.

**Acknowledgments:** Appreciation is extended to Wyoming Agricultural Experiment Station staff members who managed the beef cattle herds from 2011 to 2014.

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**Keywords:** cattle, drought, rangeland

**PARP:** I:1, V:5,7, VI:3, X:1,2

# Forage Kochia in Seeding Mixtures with Perennial Grass to Improve Disturbed Areas

*P. Aryal*[1] *and M.A. Islam*[1]

Forage kochia (*Bassia prostrata*) is considered a valuable species for both reclamation and forage. It has been found to successfully grow in areas that are disturbed, degraded, and dominated by annual invasive weeds such as cheatgrass (*Bromus tectorum*) and halogeton (*Halogeton glomeratus*). It provides high-quality forage for livestock and wildlife even during fall and winter months when most forage grasses become dormant. Although forage kochia has the ability to persist in disturbed areas, its establishment is affected mainly by seed quality and planting time followed by subsequent environmental conditions. Planting recently harvested seeds at the right time can improve establishment of forage kochia. Additionally, mixing forage kochia with cool-season perennial grasses (e.g., thickspike wheatgrass, bluebunch wheatgrass, and tall fescue) may improve disturbed lands by providing improved stands and high-quality forage.

## Objectives

The objectives were to evaluate planting time and seeding mixtures on forage kochia establishment.

## Materials and Methods

The study was established in 2014 at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Species used were: 'Immigrant' forage kochia, four native perennial grasses (thickspike wheatgrass, bluebunch wheatgrass, basin wildrye, and western wheatgrass), and two introduced perennial grasses (crested wheatgrass and tall fescue). The experiment was laid out in a split-plot randomized complete block with two planting times as the main plot factor, eight seeding mixture treatments as the subplot factor, and four blocks. Eight seeding mixture treatments included: 1) forage kochia monoculture, 2) four native grasses, 3) forage kochia with four native grasses, 4) forage kochia w/crested wheatgrass, 5) forage kochia w/tall fescue, 6) forage kochia w/crested wheatgrass and tall fescue, 7) forage kochia w/four native and two introduced grasses, and 8) untreated control. Different forage kochia-grass mixture treatments were planted at two times: winter planting on the snow in March 2014, and early spring planting in April 2014.

Data were collected during summer and fall 2014. This included density and height of forage kochia and grasses, and weed coverage. Seeding success of forage kochia and grasses was calculated simply by dividing the number of plants observed per unit area by the estimated number of seeds planted per unit area and expressed as a percentage.

## Results and Discussion

During the establishment year, a dense stand of annual weeds—including green foxtail, annual kochia, Russian thistle, and cheatgrass—was present throughout the study site. Despite this,

[1]Department of Plant Sciences.

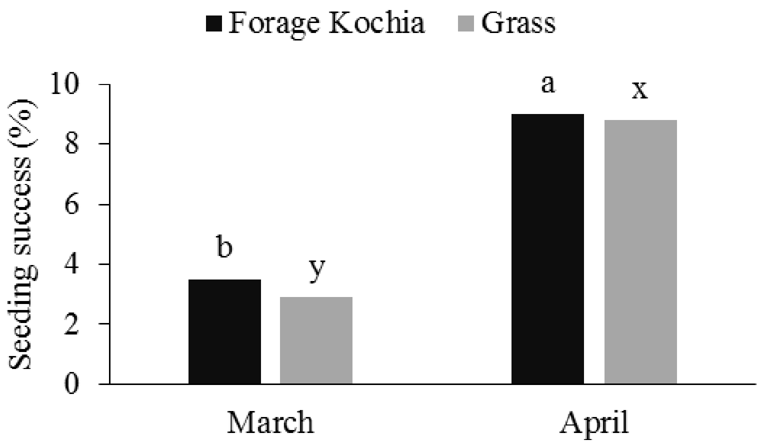


Figure 1. Effect of planting dates on seeding success of forage kochia and grass at SAREC. Values are means across treatments. Different lowercase letters indicate significant difference ($p<0.05$) between two planting dates. Comparison was not made between forage kochia and grass.

the study revealed that April planting resulted in overall higher seeding success (higher plant density) of forage kochia and grass than the March planting (Figure 1). This difference may stem from subsequent weather conditions after each planting. Considering April planting only (as it performed better than March planting), the forage kochia monoculture treatment produced a higher number of forage kochia seedlings than the rest of the seeding mixtures (data not shown). Other seeding mixtures also resulted in satisfactory forage kochia density (>1 seedlings per square foot). Additionally, all seeding mixture treatments containing grasses with or without forage kochia produced a similar number of grass seedlings (data not shown). Results from all seeding mixtures showed possibility of successful establishment of forage kochia either as a sole species or as mixture with perennial grass species in areas dominated by weeds, especially when planted in April. The current study (data collection) is continuing this year; however, future monitoring is needed to determine the persistence, competitive ability against weeds, and forage production of different seeding mixture treatments of forage kochia and other perennial grasses. Continuation of this research, which depends on funding, could provide valuable information regarding potential use of forage kochia in seeding mixtures containing native or nonnative perennial grasses in degraded and disturbed areas in Wyoming and beyond.

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

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**Keywords:** forage kochia, perennial grass, reclamation

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

# Use of Perennial and Annual Flowers to Attract Beneficial Insects to Alfalfa

*M. Benander*[1] *and R. Jabbour*[1]

Intensification of cropland has lowered habitat diversity in agricultural landscapes, leading to fewer alternative resources for natural enemies of agricultural pests. Natural enemies represent an important mechanism to reduce pest populations and improve crop yields. Alternative habitats near or bordering agricultural fields can provide overwintering habitat, refuge from management disturbances, and additional food sources important for many types of natural enemies. Alfalfa weevil and aphids are major pests of alfalfa hay in Wyoming. Beneficial insects that can kill 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.

## Objectives

We are testing whether planting strips of perennial and annual flowers in alfalfa fields attract beneficial insects. Specifically, we are comparing whether insect groups vary between habitats of annual flower mix, perennial flower mix, alfalfa, and a control of fescue grass.

## Materials and Methods

The field site for this experiment is located at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Plots (25 ft by 25 ft) of alfalfa were adjacent to either a perennial flower strip, an annual flower strip, or a control strip of fescue grass. The species used for each treatment from 2014 are listed in Tables 1 and 2. Perennial species were sourced regionally when possible. Plots and treatments were then vacuum sampled and the collected arthropods counted and sorted.

## Results and Discussion

Because this was an establishment year, not all flowers in the perennial treatment bloomed,

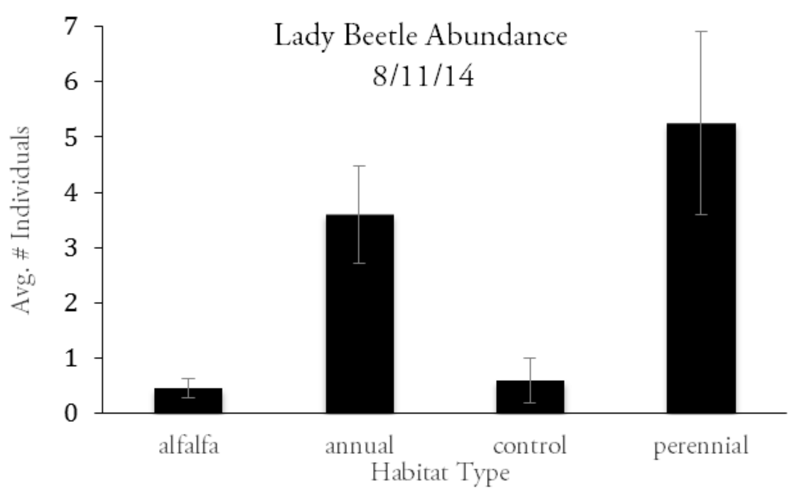


Figure 1. Relationships between average number of individual lady beetles and habitat types.

[1]Department of Plant Sciences.

Table 1. Annual species used in flowering strips.

| Common Name | *Species* |
|---|---|
| Lacy phacelia | *Phacelia tanacetifolia* |
| Common sunflower | *Helianthus annuus* |
| Cosmos | *Cosmos bipinnatus* |
| Bluebells | *Phacelia campanularia* |
| Rocky Mountain beeplant | *Cleome serrulata* |
| Plains coreopsis | *Coreopsis tinctoria* |
| Dill | *Anethum graveolens* |
| Pot marigold | *Calendula officinalis* |
| Cornflower | *Centaurea cyanus* |

Table 2. Perennial species used in flowering strips.

| Common Name | *Species* |
|---|---|
| Blanketflower | *Gaillardia aristata* |
| Sticky geranium | *Geranium viscosissimum* |
| Yellow penstemon | *Penstemon confertus* |
| Wild beebalm | *Monarda fistulosa* |
| Hairy false goldenaster | *Heterotheca villosa* |
| Harebells | *Campanula rotundifolia* |
| Showy fleabane | *Erigeron speciosus* |
| Prairie sunflower | *Helianthus maximiliani* |
| Sainfoin | *Onobrychis viciifolia* |

and vacuum sampling only occurred toward the end of the season. We present data from the sampling data of August 11, 2014. Following our initial sort, we determined that lady beetles were attracted to both annual and perennial flowering strips (Figure 1). We are repeating our sampling over the entire growing season this year, rather than just one sampling date, to determine whether this pattern occurs more broadly.

**Acknowledgments:** We are grateful to Bob Baumgartner and the SAREC field crew, Jackson Bassett, Matthew Cozzens, Bill Stump, David Leitz, and Seth Gill for assistance in establishing and maintaining field experiment plots. Casey Delphia and Brett Blauww advised on experimental design.

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**Keywords:** alfalfa, biological pest control, flowering strips

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

# Forage Grass-Legume Mixtures for Maximizing Profit

*D. Dhakal[1] and M.A. Islam[1]*

Forage grown for hay production in Wyoming is the state's most important crop in terms of value (the total value in 2013 was $390, according to *Wyoming 2014 Agricultural Statistics*). The area of grass hay production in Wyoming is also large. In 2013, for example, nearly 55% of the 990,000 acres planted in hay was cultivated with grass (the remaining was in alfalfa). Grass hay growers in the state use a substantial amount of nitrogen (N) fertilizers to increase productivity. Chemical fertilizers, however, increase production costs and can degrade the soil and environment if not used appropriately. Moreover, grass hays can be low in nutritive quality and are often supplemented with protein to feed cattle, which increases the cost of cattle production. Since legumes fix free atmospheric N, grass-legume mixtures may be a better option to reduce production costs, improve net economic return by boosting productivity and quality of hay, and lessen environmental impacts. However, information comparing the economics of grass and legume mixtures and monocultures is sparse for Wyoming.

## Objectives

The objective was to compare the net economic return of N-fertilized monoculture grass, monoculture legume, and 50-50% grass-legume mixture in hay production systems.

## Materials and Methods

The study was conducted at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle from 2011 to 2014. Five treatments were used with varying seeding ratios of two grasses (meadow bromegrass and orchardgrass) and one legume (alfalfa). Treatments included N-fertilized monoculture meadow bromegrass, N-fertilized monoculture orchardgrass, monoculture alfalfa, 50-50% alfalfa-meadow bromegrass, and 50-50% alfalfa-orchardgrass. Nitrogen fertilizer at 134 pounds N per acre as urea was applied to only monoculture grass plots. The experimental design was a randomized complete block with three replicates. Plots were harvested three to four times each year from 2012 to 2014. Forage dry matter yield was recorded at each harvest.

The economic analysis was performed by using a net present value (NPV) approach with a 3% discount rate to identify the most profitable treatment (discount rate refers to the interest rate used to determine the present value of future cash flows). The budget for production costs, inputs, and revenues for each treatment and year was calculated based on actual operations at the study site. The prices for alfalfa, alfalfa-grass mixture, and grass hay were obtained from the U.S. Department of Agriculture's National Agricultural Statistics Service database. The unit price of hay was based on crude protein content.

## Results and Discussion

Variations were observed among the treatments for the total NPV during the four-year study period. The 50-50% mixture of alfalfa-meadow bromegrass (Figure 1) provided the highest total NPV at $1,512 per acre, followed by the 50-

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Figure 1. Plot with 50-50% mixture of alfalfa -meadow bromegrass.

50% mixture of alfalfa-orchardgrass at $1,306 per acre over the four years (Table 1). The 50-50% mixture of alfalfa-meadow bromegrass provided 44 and 211% more net economic return than alfalfa and meadow bromegrass, respectively. Similarly, the 50-50% mixture of alfalfa-orchardgrass provided 25 and 292% more net economic return than alfalfa and orchardgrass, respectively. The higher net economic return from grass-legume mixtures was due to increased hay productivity (Table 1), even accounting for a decreased value of hay on a per-unit basis when compared to the monoculture alfalfa system. Another reason for increased economic return was due to reduction in fertilizer costs (compared to N-fertilized grass) and seed costs (compared to alfalfa). This could help hay producers reduce production costs and maximize profits.

**Acknowledgments:** We thank SAREC crews and University of Wyoming forage agronomy laboratory members for assistance.

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**Keywords:** grass-legume mixture, forage productivity, net economic return

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

Table 1. Effects of different combinations of grass-legume mixtures on total net present value (NPV) at SAREC from 2011 to 2014.

| Treatments (ALF-MB-OG*) | Dry matter yield (ton/acre/4-year) | Total NPV ($/acre/4-year) | % Increased net economic return† |
|---|---|---|---|
| 100-0-0 | 10 | 1047 | - |
| 50-50-0 | 15 | 1512 | 211 |
| 50-0-50 | 13 | 1306 | 292 |
| 0-100-0+N** | 11 | 486 | - |
| 0-0-100+N | 9 | 333 | - |

*ALF=alfalfa; MB=meadow bromegrass; OG=orchardgrass.
**N=nitrogen applied at the rate of 134 pounds per acre as urea.
†Based on N-fertilized 100% grass.

# Management of Rhizoctonia Diseases of Sugarbeet Under a Replant Scenario with Various Fungicide Application Methods

*W. Stump[1], A. Burkhardt[1], and W. Cecil[1]*

*Rhizoctonia solani*—the soil-borne fungus that causes seedling disease and Rhizoctonia root and crown rot diseases—is a major problem facing sugarbeet growers in Wyoming and around the country. One of the management strategies is to plant early when soil temperatures are not optimal for Rhizoctonia activity and thereby giving the crop a head start. When growers are faced with a replant scenario, soils are typically warmer and, hence, have an increased Rhizoctonia infection risk. A study was designed to determine which single fungicide application method would provide the best season-long management of beet diseases caused by Rhizoctonia.

## Objectives

The objective is to determine which single fungicide application method would provide the best season-long management of sugarbeet diseases caused by Rhizoctonia.

## Materials and Methods

Research plots were established in 2014 at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. In a split-split plot design, two sugarbeet cultivars were planted at three dates into soil inoculated with Rhizoctonia. Each treatment plot was 25-foot long and four rows wide with four replicates. The field plot area received fertility, weed control, and irrigation appropriate for sugarbeet production. A seed treatment alone was compared to four in-furrow fungicide treatments and a foliar fungicide band application. All fungicide applications were at normal field rates and compared to a non-inoculated and inoculated check. Parameters measured were plant stands as an indirect measure of seedling disease, canopy decline due to root and crown disease, and root yield.

## Results and Discussion

The impact of beet cultivar was not significant; therefore, data were combined over the two cultivars (Table 1). Overall, final stands were 5% less in the final planting date than the first two planting dates (data not shown). Averaging over all planting dates, in-furrow treatments improved final stands 22% and the seed treatment 12.4% compared to the inoculated check. The foliar band treatment had stands similar to the inoculated check, presumably due to lack of or early seedling disease management. For all subsequent comparisons, data were combined over planting dates. Late-season canopy decline was 29.5% in the inoculated check, and the Kabina® seed treatment was similar at 25%. All in-furrow and foliar band fungicide treatments resulted in canopy declines similar to that of the non-inoculated check (3.5–8%). The Priaxor® in-furrow treatment and the Quadris® foliar

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Table 1. Fungicide treatment means combined over planting date and cultivar.

| Treatment, rate (product/ac) and timing* | Final stand counts (25 row ft) | % canopy decline** | Root yield T/ac |
|---|---|---|---|
| | Ca. 28 days after planting | Aug 26 | Oct 3 |
| Inoculated check | 52.8 e*** | 29.5 a | 8.1 d |
| Non-inoculated check | 60.8 bc | 4.5 bc | 19.1 b |
| Quadris® (0.6 fl oz/1000 ft) in-furrow | 61.4 bc | 3.5 c | 18.3 bc |
| Priaxor® (0.46 fl oz/1000 ft) in-furrow | 64.0 ab | 4.5 bc | 20.8 a |
| Proline® (0.33 fl oz/1000 ft) in-furrow | 67.4 a | 5.5 bc | 18.1 bc |
| Vertisan® (0.46 fl oz/1000 ft) in-furrow | 64.6 ab | 8.5 b | 16.6 c |
| Quadris (0.6 fl oz/1000 ft) foliar band | 55.2 de | 7.0 b | 20.1 ab |
| Kabina® (1.1 fl oz/100000 seed) seed treatment | 59.3 cd | 25.0 | 8.2 d |

*Plots were inoculated with barley seed infested with Rhizoctonia solani on May 19. Seeding dates were May 23, June 3, and 10, and in-furrow treatments made at planting. The foliar fungicide treatment was made at the 8–12 leaf beet stage at each planting date.

**Foliar necrosis was estimated using the Horsfall-Barratt scale (0–11) and converted to percentage. Necrosis resulted from the combined effects of seedling blight and root and crown rot.

***Treatment means followed by different letters differ significantly (Fisher's protected least significant difference, $p \leq 0.05$).

band treatment resulted in root yields equivalent to that of the non-inoculated check. The Kabina seed treatment sugar yield was equivalent to that of the inoculated check. For other in-furrow treatments, total sucrose yields were greater than the inoculated check, but not greater than the non-inoculated check. Results indicate a single fungicide applied in-furrow or as a single foliar band can provide season-long—albeit shortened season—management of diseases caused by Rhizoctonia under moderate disease pressure. The Kabina seed treatment provided only about 30 days protection from Rhizoctonia.

**Acknowledgments:** We thank SAREC field crews for assistance in plot establishment, maintenance, and harvesting, and Western Sugar Cooperative for quality analysis. The study was supported by a Western Sugar research grant.

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**Keywords**: Rhizoctonia management, in-furrow fungicide, sugarbeet

**PARP**: not applicable

# In-Furrow Fungicide Treatments to Manage Rhizoctonia Diseases in Sugarbeet

*W. Stump*[1]

New biological-based fungicides are coming to market and require testing with conventional fungicides for efficacy of management of sugarbeet diseases caused by *Rhizoctonia solani*. Efficacy data gleaned from studies such as this will be used in federal pesticide labeling efforts.

## Objectives

Objectives were to determine the efficacy of in-furrow fungicide treatments for the management of seedling decay and root and crown rot diseases caused by Rhizoctonia.

## Materials and Methods

Research plots were located at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle in 2014. Seven in-furrow fungicide programs were compared to inoculated and non-inoculated checks. A randomized complete block design with four replicates was established. Each treatment plot was 20-foot long and four rows wide with a five-foot, non-treated, in-row buffer between plots. On May 27, the plots were planted and in-furrow applications and inoculations were made. After the applications, the furrows were sealed with foot pressure. The sugarbeet variety used had moderate resistance to Rhizoctonia. The field plot area received fertility, weed control, and irrigation appropriate for sugarbeet production. The foliar fungicide treatment was applied July 1. Parameters measured were beet stand counts (as an indication of seedling decay), Rhizoctonia root and crown rot severity (as measured by canopy decline), and beet root yield.

## Results and Discussion

On June 30, only the Proline® alone in-furrow treatment had greater stands than the inoculated check and equivalent to the non-inoculated check. For reasons unknown, the Serenade® Soil (32 fl oz) treatment actually had significantly less stands than the inoculated check (Table 1). This effect was also seen in the measurement of the cumulative disease (AUDPC) for canopy decline with both Serenade Soil treatments (treatments 3 and 4), which had greater canopy decline than even the inoculated check. For all other in-furrow treatments, with the exception of Propulse® on September 2, canopy decline and AUDPC values were similar to the non-inoculated check.

As expected, Serenade Soil-only treatments had poor yields and were statistically similar to the inoculated check. Treatments of Proline alone, Propulse alone, and Serenade Soil tank-mixed with Quadris® had yields greater than the inoculated check and equivalent to the non-inoculated check ($p \leq 0.05$).

This experiment demonstrates that under conditions of beet production in the High Plains, most of the in-furrow fungicides tested can provide reasonable protection against seedling decay due to Rhizoctonia; however, Serenade Soil applied in-furrow by itself or in

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Table 1. Managing Rhizoctonia disease with in-furrow fungicides effects on disease and beet crop.

| Treatment, rate and timing* | Stand count per 20 row-ft 6/30/2014 | % canopy decline** 9/2/2014 | AUDPC*** | Root yield lbs per 40 row-ft 10/6/2014 |
|---|---|---|---|---|
| Non-inoculated check | 40.3 a† | 0.0 c | 0.0 c | 114.8 ab |
| Inoculated check | 29.5 cde | 32.0 a | 131.3 b | 79.3 bc |
| Serenade Soil (32 fl oz/ac) in-furrow | 22.0 f | 50.0 a | 175.0 a | 69.5 c |
| Serenade Soil (64 fl oz/ac) in-furrow | 25.6 ef | 45.3 a | 171.9 a | 76.8 bc |
| Serenade Soil (32 fl oz/ac) in-furrow<br>Proline (0.33 fl oz/1000 row-ft) in-furrow | 34.3 bc | 0.5 c | 9.4 c | 101.8 abc |
| Proline (0.33 fl oz/1000 row-ft) in-furrow | 36.4 ab | 1.0 bc | 6.3 c | 120.0 a |
| Propulse (13 fl oz/ac) in-furrow | 27.9 de | 7.4 b | 25.0 c | 130.5 a |
| Serenade Soil (32 fl oz/ac) in-furrow<br>Quadris (0.6 fl oz/1000 row-ft) in-furrow | 31.3 bcd | 1.5 bc | 34.4 c | 119.0 a |
| Serenade Soil (32 fl oz/ac) in-furrow<br>Quadris (0.6 fl oz/1000 row-ft) in-furrow<br>Proline (0.33 fl oz/1000 row-ft) foliar band | 34.5 bc | 0.0 c | 0.0 c | 113.8 ab |

*Plots planted May 27; furrows inoculated and in-furrow treatments made. Foliar band treatment was made July 1.
**Canopy decline due to the combined effects of seedling, root, and crown rot diseases.
***AUDPC= area under the disease progress curve (a measure of overall disease).
†Treatment means followed by different letters differ significantly (Fisher's protected least significant difference, $p \leq 0.05$).

combination had little to no effect or additional effect on preventing seedling decay and root and crown rot disease caused by Rhizoctonia. Disease pressure was moderate, presumably because of moderate host resistance, so a foliar band following the in-furrow treatment had no additional benefit.

**Acknowledgments:** We thank SAREC field crews for assistance in plot establishment, maintenance, and harvesting. The study was supported by the agriculture chemical industry and Western Sugar Cooperative.

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**Keywords:** sugarbeet seedling disease, in-furrow fungicide, Rhizoctonia

**PARP:** not applicable

# Early Blight Management in Potato with Luna Tranquility® Fungicide Combinations

*W. Stump*[1]

Luna Tranquility® is a relatively new systemic fungicide (fungicide taken up by plant and distributed throughout plant) and is highly effective against certain fungal organisms at low use rates and has low environmental impact. Because highly effective fungicides are at risk of resistance development, it is important to rotate compatible and effective fungicide chemistries to reduce this risk.

## Objectives

The objective is to determine Luna Tranquility's efficacy for potato early blight control alone and in combination with varying fungicides.

## Materials and Methods

Research plots were established in 2014 at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Six fungicide programs were evaluated for the management of early blight and compared to a non-treated check. On May 28, seed-pieces were planted in 12-inch spacing with 30-inch row centers. After plant emergence, a randomized complete block design with four replicates was established. Each treatment plot was 20-ft long and four rows wide with a 5-ft non-treated, in-row buffer between plots. The field plot area received fertility, weed control, and irrigation appropriate for potato tuber production. On July 18, early blight (*Alternaria solani*) inoculum (spores) was directly applied to all rows of each plot to ensure disease pressure.

Foliar fungicide treatments were applied at approximate seven-day intervals, with treatment applications made July 15, 22, and 29, and August 4. Parameters measured were early blight disease severity consisting of: average number of lesions per leaflet, % necrosis (due to the combined effects of foliar disease and natural senescence), overall disease (AUDPC), and tuber yield. (AUDPC is a season-long measure of disease taking into account the amount and duration of disease in the crop.)

## Results and Discussion

Early blight disease progressed slowly and then advanced noticeably in late August, resulting in moderate disease development (Table 1). No phytotoxicity due to treatments was observed on the potato crop. All treatments had significantly reduced early blight compared to the non-treated check by July 29 (data not shown, $p \leq 0.05$). By August 19, treatment differentiation was apparent. When considering AUDPC, all treatments with the exception of the single application of Echo® ZN reduced overall disease 69 to 97% compared to the non-treated check ($p \leq 0.05$). Despite the wide range of overall disease reductions, there were no significant differences between these treatments in terms of AUDPC. Interestingly, a single application of Luna Tranquility at the onset of disease provided statistically equivalent AUDPC reductions as the other fungicide programs with four applications. All fungicide treatment programs reduced

[1]Department of Plant Sciences.

Table 1. Effects of fungicide treatments for early blight management in potato.

| Treatment, rate (product/ac) and timing* | Average # of early blight lesions per leaflet | | AUDPC** | % Necrosis*** |
|---|---|---|---|---|
| | Aug 12 | Aug 19 | | Sept 2 |
| Non-treated check | 17.8 a† | 23.4 a | 261.2 a | 99.0 a |
| Luna Tranquility (11.2 fl oz) + Induce® (0.125% v:v) A | 7.5 ab | 2.1 de | 65.2 b | 82.6 bc |
| Echo Zn (32 fl oz) A | 19.7 a | 17.8 b | 216.3 a | 98.5 a |
| Luna Tranquility (11.2 fl oz) + Induce (0.125% v:v) A, B<br>Scala (7 fl oz) + Echo Zn (24 fl oz)<br>Echo Zn (32 fl oz) D | 2.6 b | 0.6 e | 22.1 b | 74.1 c |
| Luna Tranquility (11.2 fl oz) + Induce (0.125% v:v) A, C<br>Scala® 60SC (7 fl oz) + Echo Zn 4.17SC (24 fl oz) B, D. | 0.5 b | 1.0 de | 7.6 b | 78.8 bc |
| Echo Zn (32 fl oz) A<br>Endura (2.5 oz) B, D<br>Headline® (9 fl oz) C | 1.2 b | 3.1 d | 24.1 b | 88.4 b |
| Echo Zn (32 fl oz) A, C<br>Dithane Rainshield (32 oz wt) B, D | 3.1 b | 15.1 c | 80.7 b | 98.5 a |

*Plots were planted May 28, 2014, with 'FL2053' and inoculated with *Alternaria solani* on July 18. Tubers were harvested September 18. Fungicide application dates (A–D, respectively) were: July 15, 22, 29 and August 4.

**AUDPC=area under the disease progress curve for data collected from July 29 through August 19.

***Foliar necrosis was estimated using the Horsfall-Barratt scale (0–11) and converted to percentage. Necrosis resulted from the combined effects of early blight and senescence.

†Treatment means followed by different letters differ significantly (Fisher's protected least significant difference, $p \leq 0.05$).

foliar necrosis, except for the single application of Echo ZN and the Echo Zn/Dithane Rainshield® program, compared to the non-treated check ($p \leq 0.05$). Due to late onset of disease, fungicide programs had no significant effect on yield (data not shown).

**Acknowledgments:** We thank SAREC field crews for assistance in plot establishment, maintenance, harvesting, and Western Potato Company for seed. The study was supported by the agriculture chemical industry.

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

**Keywords:** early blight management, fungicide

**PARP:** not applicable

# Management of Potato Diseases with In-Furrow Fungicide Applications

*W. Stump*[1]

The control of later-developing diseases like early blight and black dot with an in-furrow treatment at planting is a novel approach for the management of these diseases in potato. Most at-planting treatments target early season soilborne diseases, but lack the staying power to be effective on later-developing diseases. Efficacy data gleaned from studies such as this will be used in federal pesticide labeling efforts.

## Objectives

The objectives were to determine the efficacy of in-furrow fungicide treatments in the control of early blight (*Alternaria solani*) and black dot (*Colletotrichum coccodes*) in potato.

## Materials and Methods

Research plots were established in 2014 at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC). Six in-furrow fungicide programs were compared to a foliar fungicide program and an insecticide-only (Poncho®) check for the management of early blight and black dot. A randomized complete block design with four replicates was established. Each treatment plot was 20-ft long and four rows wide with a 5-ft non-treated, in-row buffer between plots. On May 28, seed-pieces were planted in 12-inch spacing with 30-inch row centers in an open furrow. After seed placement, fungicide treatments were applied in-furrow in a 5- to 7-inch band over the seed. Rates listed for the in-furrow applications were concentrated in the furrows. After applications, a cultivator was used to cover the furrows. The field plot area received fertility, weed control, and irrigation appropriate for potato tuber production. On July 18, early blight inoculum (spores) was directly applied to the buffer rows of each field plot to ensure disease pressure. Plots were not directly inoculated with the black dot pathogen, but rather relied on natural populations. The foliar fungicide treatment was made on July 15, 22, and 29, and August 4. Parameters measured were early blight disease severity (average number of lesions per leaflet and overall disease), black dot disease severity (based on stem assay), and tuber yield.

## Results and Discussion

No phytotoxicity due to in-furrow or foliar treatments was observed in the potato crop. Early blight disease was first confirmed in the study area on July 17. Disease development was initially slow to develop, but then advanced noticeably by early September. Although early blight disease was light to moderate, this test revealed that BCS-AR83685 applied in-furrow at planting provided season-long early blight control. With the addition of other fungicides (Serenade® Soil, Quadris®, Evito®, or Gem® RC), yields were significantly increased over the insecticide-only check (Poncho). There were no treatment effects on black dot disease. Although results are preliminary, the manufacturer is cautious about further development due to the potential for resistance development.

[1]Department of Plant Sciences.

Table 1. Effects of in-furrow fungicides for potato disease management .

| Treatment, rate (product/ac) and timing* | Average # of early blight lesions per leaflet | | AUDPC** | Black dot severity assay*** | Total yield cwt/ac |
|---|---|---|---|---|---|
| | Aug 12 | Aug 19 | | Sept 11 | |
| Poncho (5 fl oz)- check A | 2.0 a† | 7.7 a | 43.7 a | 2.1 a | 150.5 c |
| Poncho (5 fl oz) A<br>Echo ZN (32 fl oz) B, D<br>Endura® (2.5 fl oz) C<br>Headline® (9 fl oz) E | 0.2 b | 1.8 b | 8.0 b | 2.2 a | 190.7 bc |
| Poncho (5 fl oz) + BCS-AR83685 (8.55 fl oz) A | 0.0 b | 0.1 b | 0.2 b | 1.9 a | 213.0 abc |
| Poncho (5 fl oz) + BCS-AR83685 (8.55 fl oz) + Serenade Soil (64 fl oz) A | 0.0 b | 0.1 b | 0.7 b | 2.0 a | 236.8 ab |
| Poncho (5 fl oz) + BCS-AR83685 (8.55 fl oz) + Quadris (6 fl oz) A | 0.0 b | 0.1 b | 0.4 b | 2.2 a | 296.5 a |
| Poncho (5 fl oz) + BCS-AR83685 (8.55 fl oz) + Quadris (12 fl oz) A | 0.0 b | 0.1 b | 0.8 b | 1.8 a | 271.1 ab |
| Poncho (5 fl oz) + BCS-AR83685 (8.55 fl oz) + Evito (3.8 fl oz) A | 0.0 b | 0.1 b | 0.7 b | 2.0 a | 200.7 bc |
| Poncho (5 fl oz) + BCS-AR83685 (8.55 fl oz) + Gem RC (3.8 fl oz) A | 0.0 b | 0.1 b | 0.2 b | 1.7 a | 257.8 ab |

*Plots were planted May 28, 2014, with variety FL2053; border rows were inoculated with the early blight pathogen July 18. Fungicide applications dates (A–E, respectively) were: May 28, July 15, 22, and 29, and August 4. Per-acre rates listed for application A were concentrated in-furrow. Tubers were harvested September 18.

**AUDPC=area under the disease progress curve for data collected from July 29 through August 19.

***Black dot incidence based on the maximum of 15 stem disks assayed. Severity was rated on a scale of 0–3: 0=no signs of disease; 1=<10% stem surface area affected; 2=10–50% surface area affected; 3=>50% surface area affected.

†Treatment means followed by different letters differ significantly (Fisher's protected least significant difference, $p \leq 0.05$).

**Acknowledgments:** We thank SAREC field crews for assistance in plot establishment and harvesting and Western Potato Company for seed. The study was supported by the agriculture chemical industry.

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**Keywords:** early blight, black dot disease, in-furrow fungicide

**PARP:** not applicable

# Potato Early Blight Management in Wyoming with GWN-10126 Combinations

*W. Stump*[1]

Potato early blight is a common foliar disease problem that is predominantly managed with foliar fungicides in conventional potato production. Fungicides are typically developed with different formulations to improve efficacy, ease, and safety of use. New formulations require testing under field conditions prior to labeling.

## Objectives

The objective was to determine the efficacy of GWN-10126 for potato early blight control.

## Materials and Methods

Research plots were established in 2014 at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle (SAREC). Five fungicide programs were evaluated for the management of early blight disease and compared to a non-treated check. On May 28, seed-pieces were planted in 12-inch spacing with 30-inch row centers. After plant emergence, a randomized complete block design with four replicates was established. Each treatment plot was 20-ft long and four rows wide with a 5-ft non-treated, in-row buffer between plots. The field plot area received fertility, weed control, and irrigation appropriate for potato tuber production. On July 18, early blight (*Alternaria solani*) inoculum (spores) was directly applied to the rows of each field plot to ensure disease pressure. Foliar fungicide treatments were applied July 15, 22, and 29, and August 4. Parameters measured were early blight severity consisting of: average number of lesions per leaflet, % necrosis (due to the combined effects of foliar disease and natural senescence), overall disease (AUDPC), and tuber yield. (AUDPC is a season-long measure of disease taking into account the amount and duration of disease in the crop.)

## Results and Discussion

Following inoculation on July 18, disease initially progressed slowly then advanced noticeably in late August resulting in moderate disease development (Table 1). No phytotoxicity due to treatment was observed in the potato crop. All treatments significantly reduced early blight compared to the non-treated check by July 29 and on subsequent ratings ($p \leq 0.05$). All treatments reduced overall disease (as measured by AUDPC) 92–99.9% compared to the non-treated check ($p \leq 0.05$). For all observation dates and for the AUDPC, there were no significant differences between fungicide treatments. All fungicide treatment programs reduced foliar necrosis compared to the non-treated check ($p \leq 0.05$). The fungicide program with two applications of Luna Tranquility® and two applications of Gavel® had less foliar necrosis than the treatment programs with a single application of Luna Tranquility ($p \leq 0.05$). Due to late disease onset, fungicide programs had no significant effect on total tuber or quality yields (data not shown).

[1]Department of Plant Sciences.

Table 1. Effects of fungicide treatments for early blight management in potato.

| Treatment, rate (product/ac) and timing* | Average # of early blight lesions per leaflet | | AUDPC** | % Foliar necrosis*** |
|---|---|---|---|---|
| | Aug 12 | Aug 19 | | Sept 2 |
| Non-treated check | 19.6 a† | 26.2 a | 305.1 a | 99.0 a |
| Luna Tranquility (11 fl oz) + Induce® (0.125% v:v) A, B<br>GWN-10126 (32 fl oz) C<br>Gavel (2 lb/ac) D | 0.0 b | 0.3 b | 1.2 b | 54.8 bc |
| Luna Tranquility (11 fl oz) + Induce (0.125% v:v) A, B<br>GWN-10126 (32 fl oz) C, D | 2.4 b | 0.1 b | 25.6 b | 63.4 bc |
| Luna Tranquility (11 fl oz) + Induce (0.125% v:v) A, B<br>Gavel (2 lb/ac) C, D | 0.0 b | 0.1 b | 0.4 b | 45.3 c |
| Luna Tranquility (11 fl oz) + Induce (0.125% v:v) A<br>GWN-10126 (32 fl oz) B, C<br>Gavel (2 lb/ac) D | 0.7 b | 1.2 b | 11.6 b | 66.4 b |
| Luna Tranquility (11 fl oz) + Induce (0.125% v:v) A<br>GWN-10126 (32 fl oz) B<br>Gavel (2 lb/ac) C, D | 0.0 b | 1.9 b | 7.1 b | 69.4 b |

*Plots were planted May 28, 2014, with variety FL2053 and inoculated with early blight (*Alternaria solani*) on July 17. Tubers were harvested September 18. Fungicide applications dates (A–D, respectively) were: July 15, 22, and 29 and August 4.

**AUDPC=area under the disease progress curve for data collected from July 29 through August 19.

***Foliar necrosis was estimated using the Horsfall-Barratt scale (0–11) and converted to percentage using the appropriate conversion table. Necrosis resulted from the combined effects of early blight disease and senescence.

†Treatment means followed by different letters differ significantly (Fisher's protected least significant difference, $p \leq 0.05$).

**Acknowledgments:** We thank SAREC field crews for assistance in plot establishment, maintenance, and harvesting and Western Potato Company for seed. The study was supported by the agriculture chemical industry.

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**Keywords:** potato, early blight, disease management

**PARP:** not applicable

# Planting Date Effect on Winter Forage Crops for Supplemental Cornstalk Grazing

*J. Meeks[1], A.R. Kniss[1], B.A. Mealor[1,2], and S.I. Paisley[3,4]*

Agricultural producers commonly place livestock to graze on cornstalk residue during winter months. While the cost of this feed is low, forage quality may not provide adequate protein for cattle in the last trimester of pregnancy. Forage crops can provide additional protein in livestock diets already utilizing corn residue.

## Objectives

The objective of this study was to determine planting date effect on forage crop biomass production for winter grazing by cattle.

## Materials and Methods

A field study was conducted at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle in 2013 and 2014. A species mixture of annual ryegrass (42%), crimson clover (25%), rapeseed (17%), turnip (8%), and radish (8%) was aerially seeded at 12 pounds/acre into a standing corn crop between September 2 and October 30, 2013, and between July 14 and October 13, 2014. Plots were 15 by 50 feet. Aboveground biomass was collected from two quadrats from each plot during the winter both years. Green biomass was clipped at soil surface, separated by species, and dried. Digital images were acquired monthly using a nadir-oriented digital camera approximately 4 feet above ground level. SamplePoint software was used to quantify ground cover. Experimental design was a randomized complete block with four replicates. Biomass and ground cover data were analyzed using four-parameter log-logistic model.

## Results and Discussion

Image analysis highly correlated with biomass ($r=0.86$, $p<0.01$), indicating it provides a non-destructive method for quantifying forage pro-

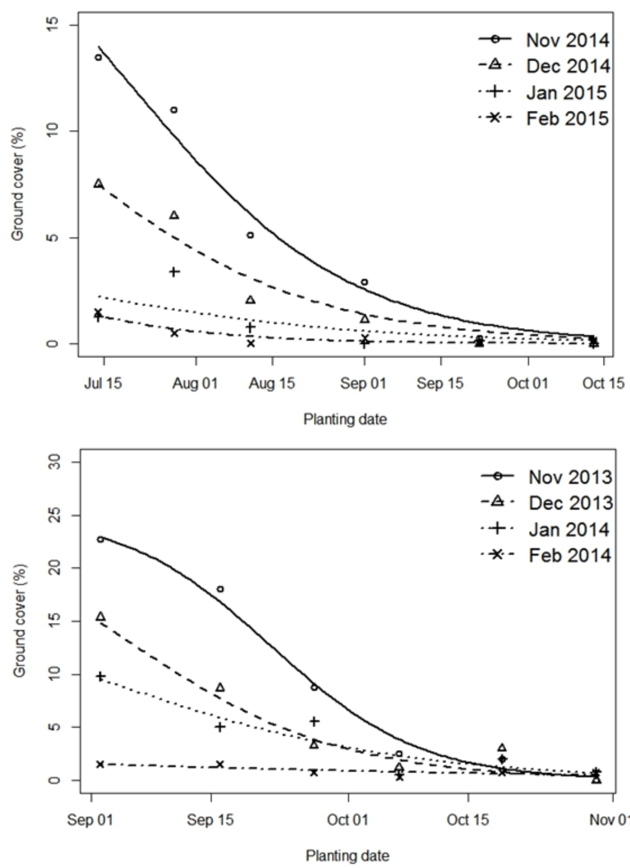


Figure 1. Ground cover by sample month: 2014 (top) and 2013 (bottom).

[1]Department of Plant Sciences; [2]Sheridan Research and Extension Center; [3]Department of Animal Science; [4]James C. Hageman Sustainable Agriculture Research and Extension Center.

duction. As expected, later planting dates reduced biomass available for grazing. Biomass production from the earliest planting date was not significantly different between 2013 (72 lb/ac) and 2014 (78 lb/ac) when collected on similar dates in December. When sampled in November 2014 (144 lb/ac), the earliest planting date produced twice as much biomass as either December sampling date. Green forage crop biomass declined nearly 50% between November and December, and cover continued to decline throughout winter (Figure 1). Mid- to late-summer planting dates are necessary to obtain adequate production for livestock grazing. Grazing early in the season may provide a greater benefit as more forage is available for grazing.

**Acknowledgments:** The study was funded by a grant from the Wyoming Agricultural Experiment Station.

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**Keywords:** cattle grazing, cornstalk forage

**PARP:** I:2,4,6, II:5, V:7, VI:1,3, VII:2,6

# Residual Corn Herbicide Effects on Fall Cover Crop Establishment

*J. Meeks[1] and A.R. Kniss[1]*

Due to a short growing season, cover crops in southeast Wyoming may need to be planted in mid- to late-summer to reach optimal growth potential. Producers are interested in planting cover crops into a standing corn crop to improve opportunities for winter cattle grazing; however, cover crops seeded into corn may be susceptible to residual herbicides used to control early season weeds.

## Objectives

The objective of this study was to determine if residual effects of eight corn herbicides reduced biomass of five cover crop species.

## Materials and Methods

A field study was conducted at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle in 2014. Corn herbicides were applied August 21 at six rates using a half-step logarithmic sprayer. Atrazine (AAtrex®), dicamba (Clarity®), dimethenamid-P (Outlook®), glyphosate (Roundup WeatherMAX®), pyroxasulfone (Zidua®), S-metolachlor (Duall II MAGNUM®), saflufenacil (Sharpen®), and 2,4-D (2,4-D amine) were applied at 1x, 0.5x, 0.25x, 0.125x, 0.06x, and 0.03x rates, which were based on each herbicide's respective label for medium-textured soils (Table 1). Decreasing application rates simulate herbicide degradation over time and served as a proxy to determine how much cover crop biomass would be reduced when the crop was planted immediately after herbicide application (1x rate) up to 120 days after herbicide application (0.03x rate). The five species mix contained annual ryegrass (42%), crimson

Table 1. Herbicide application rates.

| | Herbicide Application Rate (lb ai/ac)* | | | | | |
|---|---|---|---|---|---|---|
| Herbicide | 1x | 0.5x | 0.25x | 0.125x | 0.06x | 0.03x |
| Atrazine | 1 | 0.50 | 0.25 | 0.13 | 0.06 | 0.03 |
| Dicamba | 0.5 | 0.25 | 0.13 | 0.06 | 0.03 | 0.02 |
| Dimethenamid-P | 0.84 | 0.42 | 0.21 | 0.11 | 0.05 | 0.03 |
| Glyphosate** | 1.13 | 0.57 | 0.28 | 0.14 | 0.07 | 0.04 |
| Pyroxasulfone | 0.16 | 0.08 | 0.04 | 0.02 | 0.010 | 0.005 |
| S-Metolachlor | 1.59 | 0.80 | 0.40 | 0.20 | 0.10 | 0.05 |
| Saflufenacil | 0.067 | 0.03 | 0.02 | 0.01 | 0.004 | 0.002 |
| 2,4-D** | 0.475 | 0.24 | 0.12 | 0.06 | 0.03 | 0.01 |

*lb ai/ac = pounds of active ingredient per acre

**Glyphosate and 2,4-D rate units listed as pounds of acid equivalent per acre (lb ae/ac).

[1]Department of Plant Sciences.

clover (25%), rapeseed (17%), radish (8%), and turnip (8%*).* Plots measured 10 by 15 feet and were seeded at 12 lbs/acre on August 29. Aboveground green biomass was collected October 29, separated by species, and dried. Experimental design was a randomized complete block with four replicates. Biomass and ground cover data were analyzed using a four-parameter log-logistic model.

## Results and Discussion

Biomass of total cover crop was greatly reduced by atrazine and pyroxasulfone ($p$<0.01). Atrazine rates greater than 0.07 and 0.39 lb active ingredient (ai)/ac reduced biomass by more than 10% for annual ryegrass and turnip, respectively. Pyroxasulfone caused greater than 10% biomass reduction of annual ryegrass, rapeseed, and turnip at rates greater than 0.01, 0.03, and 0.02 lb ai/ac, respectively. S-metolachlor decreased biomass of annual ryegrass by greater than 10% at rates greater than 0.21 lb ai/ac. Results suggest rotation intervals could be shortened (i.e., from nine months to six months) for herbicides that did not cause a significant decrease in biomass production of these cover crops. This could assist producers in deciding which cover crops to consider planting in the fall after a spring/summer herbicide application.

**Acknowledgments:** We thank the graduate students for help collecting biomass.

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**Keywords:** herbicide residual, cover crop, corn

**PARP:** I, III, VI

# 2014 National Winter Canola Variety Trial

*J. Nachtman*[1]

Variety performance evaluations conducted by the Wyoming Agricultural Experiment Station (WAES) are a continuous and ongoing program. WAES evaluates many varieties/lines of winter canola each year in cooperation with Kansas State University. This trial was distributed to 41 cooperators in 21states, including Wyoming.

## Objectives

Discover new and existing winter canola varieties to help growers select ones adapted to the area.

## Materials and Methods

The experiment was located on an irrigated site at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. The experimental design consisted of three replications in a randomized complete block. Measurements taken were fall stand and vigor, winter survival, protein and oil content, and grain yield. Thirty-eight winter canola varieties were seeded September 4, 2013, in plots 5 by 20 feet using a hoe drill with a row spacing of 14 inches. Seeding depth was 1 inch, and the seeding rate was 5 pounds per acre. Fertilizer was applied at 50 pounds of nitrogen (N) per acre, 50 pounds of phosphorus (P), and 20 pounds of sulfur (S) before planting, and an additional 50 pounds of N were applied in spring. Treflan™ was incorporated before planting at1.5 pt/acre. Plots were harvested July 23, 2014, using an ALMACO plot combine.

## Results and Discussion

Results are presented in Table 1 (next page). The highest yielding entry was Safran at 2,344 lbs/acre. The second highest yielding entry, Mercedes, had significantly higher oil content and would actually produce 95 lbs/acre more oil. 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 SAREC crew members for great plot care.

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**Keywords**: winter canola, variety trial

**PARP:** VIII

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

Table 1. National winter canola variety trial at SAREC.

| Name | Yield (lb/acre) | Yield (% of test avg.) | Winter survival (%) | Fall Stand (0–10) | Plant vigor* (1–5) | Protein (%) | Oil (%) |
|---|---|---|---|---|---|---|---|
| *CROPLAN® by WinField®* | | | | | | | |
| HYCLASS 115W | 1301 | 78 | 99.3 | 8.5 | 4.5 | 30.6 | 36.1 |
| HYCLASS 125W | 1266 | 76 | 99.3 | 8.8 | 4.1 | 29.4 | 36.8 |
| *DL Seeds Inc.* | | | | | | | |
| Argos | **2224** | 134 | 100 | 9.2 | 4.7 | 26.1 | **38.7** |
| Garou | **1781** | 107 | 100 | 8.8 | 4.7 | 27.8 | 37.1 |
| *DuPont® Pioneer®* | | | | | | | |
| 46W94 | 1611 | 97 | 98.7 | 8.7 | 4.5 | 26.1 | 37.3 |
| 46W99 | **1811** | 109 | 98.7 | 8.3 | 4.1 | 28.9 | 35.4 |
| Exp 1301 | **1852** | 112 | 99.3 | 8.5 | 4.4 | 27.1 | **41.1** |
| Pioneer Exp1 | **1986** | 120 | 98.0 | 8.7 | 4.3 | 28.1 | **40.0** |
| PX112 | **1912** | 115 | 100 | 9.0 | 4.5 | 28.2 | **38.8** |
| PX117 | **2251** | 136 | 100 | 8.8 | 4.1 | 30.6 | 37.5 |
| *High Plains Crop Development* | | | | | | | |
| Claremore | 1522 | 92 | 100 | 9.5 | 4.3 | 29.7 | 35.8 |
| *Kansas State University* | | | | | | | |
| KSR07363 | 1627 | 98 | 100 | 9.2 | 4.4 | 30.4 | 35.2 |
| KSUR21 | **2004** | 121 | 100 | 8.2 | 4.1 | 28.0 | 38.6 |
| Riley | **1785** | 108 | 100 | 8.3 | 4.2 | 28.7 | 36.5 |
| Sumner | 1231 | 74 | 100 | 8.8 | 4.1 | 28.8 | 36.0 |
| Wichita | **1857** | 112 | 99.3 | 9.2 | 4.2 | 29.1 | 35.9 |
| *Momont, France* | | | | | | | |
| CHH2311 | **1936** | 117 | 96.0 | 9.5 | 4.9 | 25.6 | **39.3** |
| Chrome | **1906** | 115 | 98.0 | 9.2 | 4.6 | 26.3 | 37.7 |
| Hekip | 1390 | 84 | 98.0 | 8.5 | 4.4 | 28.8 | 34.6 |
| MH10G11 | **1787** | 108 | 91.7 | 9.3 | 4.9 | 26.8 | **39.2** |
| MH10L23 | 1732 | 104 | 98.0 | 9.0 | 4.7 | 26.6 | 38.4 |
| DKW41-10 | 1255 | 76 | 98.0 | 8.7 | 4.3 | 30.2 | 33.6 |
| *Monsanto®/DEKALB®* | | | | | | | |
| DKW44-10 | 1154 | 70 | 96.0 | 9.3 | 4.2 | 29.3 | 35.7 |
| DKW45-25 | 1506 | 91 | 100 | 9.0 | 4.4 | 28.5 | 34.9 |
| DKW46-15 | 1314 | 79 | 100 | 8.8 | 4.1 | 29.3 | 36.5 |
| DKW47-15 | 1515 | 91 | 99.3 | 8.8 | 4.4 | 29.8 | 35.1 |
| *Rubisco Seeds LLC* | | | | | | | |
| Dimension | **2028** | 122 | 98.0 | 8.7 | 4.6 | 28.1 | 36.5 |
| Edimax CL | **1919** | 116 | 100 | 8.7 | 4.8 | 28.5 | 36.6 |
| Hornet | **1998** | 120 | 99.3 | 8.8 | 4.7 | 26.8 | 36.4 |
| Inspiration | **2060** | 124 | 98.0 | 9.2 | 4.8 | 28.7 | 35.8 |
| Mercedes | **2259** | 136 | 100 | 9.0 | 4.9 | 25.9 | **40.3** |
| Safran | **2344** | 141 | 98.7 | 8.5 | 4.7 | 28.2 | 34.8 |
| Sitro | 1652 | 100 | 99.3 | 8.8 | 4.5 | 26.7 | **38.6** |
| Visby | 1663 | 100 | 98.7 | 8.5 | 4.7 | 26.8 | 37.8 |
| *Syngenta®* | | | | | | | |
| NK Petrol | **1864** | 112 | 98.7 | 9.0 | 4.7 | 28.3 | 36.3 |
| NK Technic | **1966** | 119 | 100 | 8.7 | 4.6 | 27.9 | 34.2 |
| *Virginia State University* | | | | | | | |
| Virginia | 1096 | 66 | 100 | 8.8 | 4.2 | 29.5 | 34.7 |
| VSX-3 | 1706 | 103 | 100 | 9.5 | 4.7 | 29.0 | 35.3 |
| Average | 1739 | --- | 98.9 | 8.9 | 4.5 | 28.2 | 36.8 |
| CV | 17 | --- | 0.9 | 3.4 | 4.1 | 4.3 | 3.3 |
| LSD (0.05) | 607 | --- | 1.4 | 0.5 | 0.3 | 2.6 | 2.5 |

**Bold**: Superior LSD (least significant difference) group. Unless two entries differ by more than the LSD, little confidence can be placed in one being superior to the other. *Plant vigor rated on a scale of 1=poor to 5=excellent.

# 2014 Proso Millet Variety Trial Nursery: Dryland

*J. Nachtman*[1]

Variety performance evaluations conducted by the Wyoming Agricultural Experiment Station (WAES) are a continuous and ongoing program. WAES evaluates many varieties/lines of proso millet each year in cooperation with the University of Nebraska.

## Objectives

Our objective is to test new and existing proso millet varieties to help growers select ones adapted to the area.

## Materials and Methods

The experiment was located on a dryland site at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. The experimental design consisted of four replications in a randomized complete block. Measurements taken were grain yield. Thirty-two proso millet varieties were seeded June 30, 2014, in plots 5 by 25 feet using a disc drill with a row spacing of 7.5 inches. Seeding depth was 1 inch, and the seeding rate was 20 pounds per acre. Conventional herbicide applications were used. Plots were harvested October 28, 2014, using an ALMACO plot combine.

## Results and Discussion

Results are presented in Table 1 (see next page). Yields were in line with trials in adjoining states. The highest yielding entry was Huntsman at 1,943 lbs/acre. Results for this trial and many others are available at: www.uwyo.edu/plantsciences/uwplant/trials.html

**Acknowledgments:** Appreciation is extended to SAREC crew members for great plot care.

**Contact:** Jerry Nachtman at nachtman@uwyo.edu or 307-837-2000.

**Keywords:** proso millet, variety trial

**PARP:** VIII

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

Table 1. 2014 (SAREC) Wyoming dryland proso millet variety test.

| Variety | Yield (lbs/acre) |
|---|---|
| Huntsman | 1943 |
| Earlybird | 1639 |
| Horizon | 1622 |
| NE1 | 1564 |
| Sunrise | 1551 |
| 5059wx | 1506 |
| Sunup | 1444 |
| 177-9-13 | 1440 |
| Plateau | 1427 |
| Abarr | 1387 |
| 5100 | 1382 |
| 5061wx | 1338 |
| Cope | 1273 |
| 5002wx | 1260 |
| 5016 | 1250 |
| Minco | 1200 |
| 177-3-13 | 1197 |
| 177-8 | 1155 |
| 5106wx | 1127 |
| Panhandle | 1123 |
| Snowbird | 1103 |
| Rise | 1094 |
| 5034wx | 1088 |
| 174-7-13 | 1019 |
| 5087wx | 1015 |
| 5104wx | 965 |
| 182-4-24 | 950 |
| 182-5-18 | 907 |
| 5014 | 903 |
| 172-2-B | 844 |
| Minsum | 716 |
| Dawn | 551 |
| Average | 1218 |
| LSD 0.05% | 500 |

LSD=least significant difference

# 2014 Winter Wheat Variety Trial Nurseries: Eastern Wyoming Dryland

*J. Nachtman*[1]

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–Lincoln, Colorado State University, Montana State University, and private seed companies.

## Objectives

Our objective is to test new and existing winter wheat varieties to help growers select ones adapted to the area.

## Materials and Methods

The experiments were located in Crook, Laramie, and Platte counties in eastern Wyoming. The experimental design consisted of six replications in a randomized complete block. Measurements taken included: heading date, plant height, grain yield, test weight, protein content, and moisture. Fertilizer was applied to three reps at 86 pounds nitrogen, 20 lbs phosphorus, and 40 lbs sulfur per acre. The other three remained unfertilized. Twenty-seven winter wheat varieties were seeded September 17, 20, and 28, 2013, 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 50 lb/ac. Herbicides were applied by the cooperators. Plots were harvested July 24 and 25, and August 13, 2014, using an ALMACO plot combine.

## Results and Discussion

Only fertilized vs. unfertilized yield results are presented in Table 1. The highest yielding entries were: Platte County, SY Wolf hard red winter wheat, 76 bushels/ac; Laramie County, MTS 1024, a solid stem hard red winter wheat, 75 bu/ac; and Crook County, MTS 1024 and MT 1078, both at 90 bu/ac. With the addition of fertilizer, overall protein content was increased by 2–3.6%, and bushel weight was reduced by 3.5 lbs/bu in Platte County (data not shown). Complete results for these trials and many others are available on the web at: www.uwyo.edu/plantsciences/uwplant/trials.html

**Acknowledgments:** Appreciation is extended to the cooperators—Newton Russell-Platte, Herb Mattson-Laramie, and Whalen Farms-Crook—who allowed us to place trials on their land.

**Contact:** Jerry Nachtman at nachtman@uwyo.edu or 307-837-2000.

**Keywords**: winter wheat, variety trial

**PARP:** VIII

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

Table 1. Eastern Wyoming, dryland winter wheat variety test – 2014.

| Entry | Platte County Fertilized Grain Yield (bu/acre) | Platte County Unfertilized Grain Yield (bu/acre) | Laramie County Fertilized Grain Yield (bu/acre) | Laramie County Unfertilized Grain Yield (bu/acre) | Crook County Fertilized Grain Yield (bu/acre) | Crook County Unfertilized Grain Yield (bu/acre) |
|---|---|---|---|---|---|---|
| SY Wolf | **76** | 50 | 69 | 54 | 86 | 75 |
| CO09W040-F1 (W) | 74 | 61 | 69 | 48 | 67 | 62 |
| Hatcher | 74 | 58 | 59 | **62** | 77 | 69 |
| CO09W009 (W) | 74 | 51 | 64 | 44 | 81 | 75 |
| Robidoux | 73 | 56 | 74 | 50 | 74 | 63 |
| CO011D446 | 72 | 47 | 66 | 57 | 78 | 67 |
| MT 1138 | 71 | 57 | 73 | 50 | 86 | 69 |
| Antero (W) | 71 | 54 | 64 | 54 | 85 | 74 |
| Byrd | 71 | 56 | 65 | 54 | 76 | 71 |
| NE10589 | 70 | 55 | 72 | 51 | 78 | 63 |
| Brawl Cl Plus | 70 | 52 | 67 | 54 | 61 | 55 |
| Cowboy | 69 | 64 | 67 | 50 | 83 | 68 |
| CO011D174 | 68 | 61 | 64 | 48 | 77 | 69 |
| MT 1078 | 68 | 58 | 72 | 52 | **90** | 72 |
| MT 1113 | 68 | 58 | 65 | 49 | 80 | 72 |
| Settler CL | 68 | 43 | 54 | 41 | 77 | 64 |
| MTS 1024 (SS) | 67 | 53 | **75** | 49 | **90** | 77 |
| Denali | 66 | 53 | 60 | 50 | 83 | 66 |
| CO011D346 | 65 | **65** | 64 | 47 | 83 | **78** |
| Panhandle (NE05548) | 61 | 44 | 53 | 43 | 68 | 63 |
| Judee (SS) | 60 | 46 | 57 | 42 | 75 | 64 |
| Warhorse (SS) | 60 | 42 | 53 | 42 | 72 | 66 |
| Goodstreak | 59 | 45 | 51 | 43 | 65 | 60 |
| Snowmass (W) | 56 | 47 | 58 | 36 | 78 | 64 |
| Bearpaw (SS) | 55 | 38 | 49 | 46 | 72 | 63 |
| Buckskin | 51 | 43 | 53 | 37 | 66 | 60 |
| Centurk 78 | -- | -- | -- | -- | 60 | 58 |
| Average | 67 | 52 | 63 | 48 | 77 | 67 |
| LSD 0.05% | 7 | 13 | 12 | 11 | 9 | 9 |

(W) hard white winter wheat; (SS) solid stem for sawfly resistance; (LSD) least significant difference

# 2014 Winter Wheat Variety Trial Nursery: Goshen County Dryland

*J. Nachtman*[1]

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 (CRFW), University of Nebraska–Lincoln, Colorado State University, Montana State University, and private seed companies.

## Objectives

Our objective is to test new and existing winter wheat varieties to help growers select ones adapted to the region.

## Materials and Methods

The experiment was located on the Lou and Marti Hubbs farm in southeast Wyoming near Hawk Springs. The experimental design consisted of five replications in a randomized complete block. Measurements taken included: heading date (not shown), plant height, grain yield, test weight, and moisture. Fertilizer was applied to three reps at 86 pounds nitrogen, 20 pounds phosphorus, and 40 pounds sulfur per acre. The other two remained unfertilized. Data for fertilized and unfertilized were combined for the table. Forty-three winter wheat varieties were seeded September 18, 2013, in plots 5 by 25 feet using a hoe drill with a row spacing of 14 inches. Seeding depth was 1.5 inches, and the seeding rate was 50 pounds per acre. Herbicides were applied by the cooperator. Plots were harvested July 22, 2014, using an ALMACO plot combine.

## Results and Discussion

Results are presented in Table 1. The highest yielding entries were Cowboy and Denali hard red winter wheat at 58 bushels/acre. Wheat yields were above average with excellent moisture during the growing season. Results for this trial and many others are available at: www.uwyo.edu/plantsciences/uwplant/trials.html

**Acknowledgments:** Appreciation is extended to the cooperators who allowed us to place trials on their land.

**Contact:** Jerry Nachtman at nachtman@uwyo.edu or 307-837-2000.

**Keywords:** winter wheat, variety trial

**PARP:** VIII

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

Table 1. 2014 Goshen County, Wyoming, dryland winter wheat variety test.

| Brand | Variety | Grain Yield (bu/acre) | Moisture (%) | Bushel Wt. (lb/bu) | Plant Height (in) |
|---|---|---|---|---|---|
| CRFW | Cowboy | 58 | 11 | 61 | 20 |
| PlainsGold™ | Denali | 58 | 11 | 62 | 22 |
| PlainsGold | Hatcher | 52 | 10 | 62 | 18 |
| Husker Genetics™ | Overland | 52 | 11 | 61 | 20 |
| ----- | Warhorse (SS) | 52 | 11 | 61 | 20 |
| Limagrain Cereal Seeds | LCS Wizard | 51 | 11 | 61 | 20 |
| Husker Genetics | Panhandle (NE05548) | 49 | 10 | 61 | 21 |
| Limagrain Cereal Seeds | LCS Mint | 47 | 11 | 62 | 19 |
| ----- | Judee (SS) | 47 | 11 | 60 | 18 |
| ----- | NHH11569 | 47 | 10 | 60 | 19 |
| Husker Genetics | Robidoux | 45 | 11 | 61 | 18 |
| ----- | NE10589 | 45 | 10 | 61 | 19 |
| ----- | NW03666 (W) | 44 | 11 | 61 | 20 |
| PlainsGold | Antero (W) | 44 | 11 | 61 | 18 |
| ----- | Bearpaw (SS) | 44 | 10 | 60 | 17 |
| WestBred® | Winterhawk | 43 | 11 | 61 | 18 |
| ----- | Mattern | 43 | 11 | 59 | 19 |
| ----- | Freeman | 42 | 10 | 60 | 18 |
| AGSECO Inc. | TAM 113 | 42 | 10 | 60 | 19 |
| PlainsGold | Byrd | 41 | 10 | 60 | 19 |
| ----- | Alliance | 41 | 10 | 60 | 18 |
| ----- | NW09627 (W) | 41 | 11 | 59 | 17 |
| ----- | NE09521 | 40 | 11 | 60 | 18 |
| ----- | NW07505 (W) | 39 | 11 | 60 | 19 |
| ----- | Goodstreak | 39 | 11 | 61 | 19 |
| ----- | NE09517 | 39 | 12 | 60 | 19 |
| ----- | NE07531 | 38 | 10 | 60 | 18 |
| Husker Genetics | Settler CL | 38 | 11 | 60 | 19 |
| WestBred | WB-Grainfield | 38 | 10 | 61 | 19 |
| ----- | NX04Y2107 (W) | 38 | 11 | 59 | 17 |
| PlainsGold | Brawl Cl Plus | 37 | 11 | 61 | 18 |
| Limagrain Cereal Seeds | T158 | 37 | 10 | 61 | 17 |
| Limagrain Cereal Seeds | T163 | 37 | 10 | 61 | 18 |
| NuPride Genetics | Camelot | 37 | 11 | 60 | 18 |
| ----- | Buckskin | 35 | 11 | 60 | 19 |
| WestBred | WB4458 | 35 | 11 | 60 | 18 |
| ----- | Pronghorn | 35 | 10 | 61 | 18 |
| ----- | Turkey | 34 | 10 | 60 | 21 |
| ----- | NI09710H | 34 | 10 | 57 | 18 |
| Limagrain Cereal Seeds | LCH10-13 | 34 | 11 | 60 | 17 |
| ----- | Scout 66 | 30 | 11 | 58 | 19 |
| ----- | Wesley | 30 | 11 | 57 | 17 |
| ----- | NE10478 | 30 | 11 | 59 | 18 |
| Average of all entries | | 41 | 11 | 60 | 19 |
| LSD 0.05% | | 7 | 1 | 2 | 2 |

(W) hard white winter wheat; (SS) solid stem for sawfly resistance; LSD (least significant difference)

# An Experiment to Re-Establish Ponderosa Pine after Fire at the Rogers Research Site

*S.E. Williams*[1]

The Triple R Ranch was bequeathed to the University of Wyoming as set forth in the living trust of Col. Williams Rogers (1998 and amended in 2002). This parcel of about 320 acres is now a component of the Wyoming Agricultural Experiment Station (WAES) administered through the UW College of Agriculture and Natural Resources. The area—renamed the Rogers Research Site—is being developed to address forestry-related issues, notably fire.

The Rogers Research Site (RRS) lies in the Laramie Mountains eight miles southeast of Laramie Peak at an average elevation of 7,000 feet. The vegetation type is largely ponderosa pine forest with a few stands of aspen. The area is habitat for a wide diversity of game and non-game wildlife, and is also grazed by domestic animals from adjacent grazing allotments and private holdings. The site is surrounded by Medicine Bow National Forest lands on three sides. South are private and State of Wyoming lands.

Early in summer 2012, a forest fire that burned nearly 100,000 acres in the Laramie Mountains also burned through RRS. The blaze torched nearly 95% of the ponderosa pine on the site as well as the one cabin. Since the fire, efforts at RRS have been toward restoration of the pine.

## Objectives

The study being established at RRS is aimed at ponderosa pine restoration. It should provide information on the effectiveness of using a mix of post-fire erosion control grasses on the restoration effort. It should also provide information on natural regeneration of ponderosa as well as survival of seed-planted and seedling-planted pine. Another goal is to share details on pine regeneration under three cutting treatments: areas that have had dead ponderosa pine cut and all wood and slash removed, areas where the wood only has been removed and slash left behind, and areas that have not had any dead pine cut.

Lastly, this paper presents an outline of a larger, comprehensive report on RRS; work on the report has begun, and we hope to have it complete next year. The regeneration experiment described herein is viewed as a long-term study that is anticipated to last for decades.

## Materials and Methods

Over especially the last year, the study to test various methods of ponderosa pine regeneration has been partially established. The expectation is that the study will be fully established by the beginning of July 2015.

RRS is composed of several small watersheds. A complete set of all treatments is being established in each of four watersheds. They include three cutting treatments (no cut, cut and leave slash, cut and remove slash), three planting treatments (no planting, plant with ponderosa seed, plant with ponderosa seedlings), and two erosion control treatments (no

[1]Department of Ecosystem Science and Management.

erosion control and planting with an erosion control seed mixture). This is a three by three by two factorial experiment. This means that each treatment will include interaction possibilities with all other treatments. Consequently, each replicate contains 18 plots or experimental units (3x3x2). The treatments are replicated four times, each in a separate watershed. Each plot is 0.62 acres in size, and at this writing, the cutting treatments are being completed by a company contracted to perform the work. This year, erosion control seed was planted first; ponderosa seed was then distributed; finally, ponderosa seedlings were planted by hand.

Establishment and survival of particularly the ponderosa pine will be monitored in the future, likely at one-year intervals for five years and two-year intervals thereafter.

## Results and Discussion

Previous brief reports on the RRS are available in the 2011, 2012, 2013, and 2014 Wyoming Agricultural Experiment Station (WAES) *Field Days Bulletins*. They are available at www.uwyo.edu/uwexpstn (click on the Publications link on the left side of the page). These describe the potential of this site as well as some of the consequences of the 2012 fire and results from work performed by Claire Wilkin at the site for her master's thesis.

It is anticipated that the comprehensive report on RRS will contain sections on the area's natural and human history, the Arapaho Fire of 2012, completed research (mostly Wilkin's thesis work, *Soil Amendments and Microbial Community Recovery Following High Intensity Forest Fire*), results from the ponderosa pine restoration study (e.g., pine bark beetle invasion, root pathogen survey, and soil characterization pre- and post-fire), and a full description of the ponderosa restoration study. It is our goal to also include sections on the outreach potential of this site as well as its potential for instructional opportunities through classes from UW and other institutions. Lastly will be a section on future potential of RRS.

**Acknowledgments:** We appreciate support from McIntire-Stennis Cooperative Forestry Research Program funds through WAES. Thanks is extended to Jim Freeburn (former director of the James C. Hageman Sustainable Agriculture Research and Extension Center) for efforts to establish this unit.

**Contact:** Steve Williams at sewms@uwyo.edu or 307-766-2683.

**Keywords:** forestry, ponderosa pine, forest fire

**PARP:** X:1,2; XI:1,2

# Understanding the Market for Wyoming Unadulterated Honey

*L. Thunström[1], C. Jones Ritten[2], M. Emhke[2], and C. Emhke[2]*

Due to the persistence of drastic losses in honeybees, the supply of U.S. honey is continuing to follow a sharp decline while the demand for honey is reaching all-time highs. This shortage in demand is being met by ever-increasing imports of foreign honey. Although the U.S. has banned honey produced in China because of apparent high levels of pesticides and antibiotics, Chinese honey makes it into imported honey through alleged fraudulent activities. Imported honey, therefore, may pose risks to consumer health, and, thus, consumers may be willing to pay a premium for honey guaranteed to be produced in Wyoming.

## Objectives

This project aims at analyzing how consumers evaluate health and ethical risks of consuming internationally produced honey and how these risks influence consumer willingness to pay for honey produced in Wyoming. The objective is to answer the following: 1) Are consumers willing to pay a premium for Wyoming honey? 2) Do consumers feel a sense of guilt when consuming non-local honey? 3) Will consumers avoid information about the origin of honey to avoid feelings of guilt?

This report concerns phase one of the project, which consisted of focus group discussions about honey. Focus group results, in turn, were used to design an economic experiment aimed at answering the above objectives.

## Materials and Methods

Focus groups were conducted in spring 2014 at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle and at the University of Wyoming in Laramie. Focus group participants were recruited from the general public in Lingle and Laramie. During focus group sessions, participants were asked about their usage of honey, their value of different honey attributes, the meaning to them of 'healthy', 'ethical' and 'local' honey, the attributes they read into local honey, the kind of information they would like about honey, their knowledge of the retail price of honey, and their trust of information on honey provided through labels. Each focus group session lasted for about an hour. Participants were endowed with both local and non-local honey and paid $30 in our effort to get a more representative sample of Wyoming consumers.

## Results and Discussion

*Usage of honey*: Focus group participants generally used honey as a sweetener (e.g., in tea, when baking, when cooking, etc.), but some also used honey for medicinal purposes.

*Local honey is highly valued*: Focus group participants stated that they wanted to pay the most for locally produced honey. Many participants thought of locally produced honey as generally healthier and more environmentally friendly than non-locally produced honey.

[1]Department of Economics and Finance; [2]Department of Agricultural and Applied Economics.

Some stated that they made an effort to buy local honey, motivated primarily by a desire to support the local community or to derive health benefits associated with locally produced honey. Local honey was stated as especially important to participants interested in honey's medicinal properties; however, participants had different ideas of the meaning of 'local' honey. To some, 'local' meant knowing the farmer, while to others it meant that the honey had been produced in a specific county or in the state of Wyoming.

*Knowledge of honey prices*: Retail prices stated by participants for honey were in the general range of $2.50–$7 per pound, with many participants stating that the price depends on the type of honey and where it is sold. Some participants, however, used honey without ever buying it themselves, e.g., receiving honey as gifts from relatives; therefore, they lacked knowledge of the retail price.

*Honey attributes and information*: The desire to take information on honey varied over participants and honey attributes. Some participants stated that they always want information on where the honey is produced and the nectar source; others said they do not care for the attributes of the honey and would not take the information if it was offered to them. At the same time, when faced with a specific health or ethical message on honey (domestically produced versus honey of unknown origin), all participants stated that they would like that particular information. Participants stated that they generally trust the labels in the store. Typically, darker honey was preferred to honey lighter in color.

*General discussion*: The main message from the focus groups to honey bee farmers was that local honey is highly valued to consumers, although there was some confusion as to what 'local' really means. The importance of the health attribute of honey provides an opportunity for farmers producing local honey to increase market shares by emphasizing health properties of local honey in their communication to consumers. Information on whether honey is locally produced and healthy was also generally considered to be important to participants.

The knowledge extracted from the focus groups was used for phase two of the project: the design of surveys and an economic experiment on honey. The project group is currently analyzing data from the surveys and experiment.

**Acknowledgments:** This study is supported by the Wyoming Agricultural Experiment Station's Competitive Grants Program.

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**Keywords:** honey, market demand, locally produced

**PARP:** VII:5 (although the project concerns honey, not meat)

## Introduction to the
# Sheridan Research and Extension Center

*B.A. Mealor*[1,2]

The Sheridan Research and Extension Center (ShREC) has active research and educational programs ongoing at its two locations: the historic station at Wyarno (east of Sheridan) and the Adams Ranch immediately south of the UW Watt Agriculture Center on the Sheridan College campus. With access to nearly 700 acres between the two locations, and improved research infrastructure, scientific activity at ShREC continues on an upward trajectory. Nearly 12,000 square feet of working space within the newly constructed greenhouse complex supports research and extension projects requiring a controlled growing environment.

ShREC continues to be driven by cooperative efforts of numerous regional partners to focus on our three emphasis areas—horticulture, forage management, and rangeland reclamation—as outlined in our strategic plan. We hope to provide an excellent learning experience for researchers, students, and clientele in the region.

### Changes

In 2015, ShREC welcomed a new director, Brian Mealor, and a new assistant farm manager, Mike Albrecht. Mike brings a wealth of local knowledge and experience that will strengthen

Figure 1. ShREC employees, from left, Mike Albrecht, Rochelle Koltiska, Brian Mealor, Dan Smith, and Sadanand Dhekney.

[1]Sheridan Research and Extension Center; [2]Department of Plant Sciences.

ShREC's ability to facilitate research and maintain the productivity of fields not currently supporting a research project. Brian has been the University of Wyoming Extension weed specialist with statewide duties since 2009, and his background in rangeland restoration and weed management will complement current faculty expertise in the center's three focus areas.

### Research and Education

Although the total volume of research outputs is somewhat less than recent years, the quality of projects remains high. One of the growing strengths of ShREC is research into advanced plant breeding and biotechnology. The initial focus, and still the main emphasis, is on developing grape varieties suitable for Wyoming's harsh climate; however, additional plant biotechnology projects, such as insect pest resistance in alfalfa and DNA sequencing of historic apple cultivars, are currently under way. Ongoing forage-research projects are evaluating the suitability of grass-legume mixtures for a diverse hay crop and the establishment of various perennial grasses under different planting regimes. A four-year study investigating how weed-management strategies impact reclamation success was recently completed at Wyarno.

ShREC has continued to serve as a location for hands-on learning. The center practically buzzes with activity during the field season, when undergraduate interns (including many Sheridan College students) gain experience in a number of different areas, and graduate students collect detailed field data for their research. ShREC has also served as the host venue for a number of extension and outreach activities, where the fruit tree pruning workshop has continued to gain momentum. At the suggestion of the ShREC Advisory Board, much of the produce to be served at the 2015 Field Day will be grown on the center and skillfully prepared by UW Extension's Kentz Willis.

**Acknowledgments:** The research and educational efforts at ShREC are made possible by a number of cooperators, not the least of which includes the members of the ShREC Advisory Board. Their participation in establishing a vision for the center will have long-term impacts on the nature of information and programming in the ShREC service area. Special thanks to our employees, Dan Smith, Mike Albrecht, Rochelle Koltiska, and Sadanand Dhekney (Figure 1), along with University of Wyoming Extension educator Jeremiah Vardiman and cooperating researchers and educators for their continued commitment to the success of ShREC.

**Contact:** Brian Mealor at bamealor@uwyo.edu or 307-673-2647.

**Keywords:** horticulture, forage, reclamation

# Short Reports—ShREC

## 1. Alleviating grapevine cold damage in Wyoming vineyards

**Investigators:** Sadanand Dhekney, Raju Kandel, Jeremiah Vardiman, Daniel Bergey, and Michael Baldwin

**Issue:** Grapevine production in Wyoming evinces strong interest from some producers seeking viable alternatives to traditional crops and 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:** Evaluate the incidence of cold damage affecting grapevines in Wyoming vineyards and develop canopy management practices for alleviating low-temperature stress, resulting in improved vine growth, health, and productivity.

**Objectives:** 1) Analyze cold injury to grapevine cordons, canes, and compound buds in vineyards at various locations statewide, 2) correlate observed cold injury with existing canopy management practices, and 3) study the influence of grapevine training and pruning systems on mitigating cold injury and maximizing productivity in wine-grape cultivars 'Elvira', 'Frontenac', 'Lacrosse', and 'Marquette'.

**Impact:** Results from freeze-induced injury in grapevine cultivars statewide could provide information on the cultivar/location interaction with respect to cold-induced damage of compound buds and, ultimately, provide recommendations on the type and extent of pruning to adopt following a damaging freeze event.

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

**Keywords:** grapes, cold-hardy grapes, vineyards

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

## 2. Engineering alfalfa weevil resistance in commercial alfalfa cultivars: A valuable tool for integrated pest management

**Investigators:** Sadanand Dhekney, Randa Jabbour, Anowar Islam, and Blaine Horn

**Issue:** Alfalfa weevil is the most destructive insect pest of alfalfa in the United States. Severe infestations of alfalfa weevil can result in high loss of forage yield and a significant reduction in quality attributes.

**Goal:** Incorporate alfalfa weevil resistance in commercial alfalfa cultivars using genetic engineering technology, thus generating new germplasm not currently available and overcoming a major limiting factor in alfalfa production.

**Objectives:** Specific objectives include 1) inserting genes that will confer insect resistance in commercial alfalfa cultivars, 2) screening engineered plants for insect resistance, and 3) determining yield and quality of new plant lines.

**Impact:** A reduction in pest damage on transgenic cultivars combined with other cultural practices could significantly decrease losses attributed to alfalfa weevil and help producers in Wyoming and other states increase yield and forage quality.

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

**Keywords:** alfalfa, insect resistance, weevil

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

## 3. Study of heirloom, historic, and novel apple cultivars in century-old Wyoming orchards

**Investigators:** Steven Miller, Gayle Volk, and Brent Sarchet

**Issue:** The last remnants of 19th and early 20th century apple plantings struggle to survive in isolated, nearly forgotten, or abandoned orchards, and the identity of most of these varieties has been lost. Next-generation sequencing and other molecular techniques offer powerful methodologies for the identification of heirloom, historic, and novel apple cultivars in century-old orchards in Wyoming.

**Goal:** Investigate the use of next-generation and other molecular genotyping techniques to identify heirloom, historic, and novel apple varieties in 100-year-old orchards in Wyoming. (Heirloom plants are old, open-pollinated varieties passed from generation to generation, while novel plants are those with unique genetic makeups that have not yet been documented or discovered.)

**Impact:** Results could assist growers in selecting suitable apple cultivars for growing in many areas of Wyoming. Molecular data could also serve as a mechanism for selecting valuable traits for potential breeding of apple cultivars specifically suited to different regions of the Rocky Mountains.

**Contact:** Steve Miller at 307-766-2834 or fungi@uwyo.edu.

**Keywords:** Wyoming heirloom apples, genotyping, identification of varieties or cultivars

**PARP:** not applicable

## 4. Effects of nitrogen application rates on sunflower seed size and oil quality

**Investigators:** Austen Samet, Axel Garcia y Garcia, and Gustavo Sbatella

**Issue:** The effects of nitrogen (N) application on grain crops are well documented, but the impacts on oil and confection sunflowers are less known. Both crops are viable alternatives in some areas of Wyoming; for that reason, the impacts of agricultural practices such as N fertilization need to be further investigated.

**Goal:** Effectively use N application to improve quality in oil and confection sunflowers.

**Objectives:** Evaluate the impact of N applications on sunflower seed size and oil quality.

**Impact:** Results should provide growers with information concerning best N applications to improve quality of oil and confection sunflowers.

**Contact:** Gustavo Sbatella at gustavo@uwyo.edu or 307-754-2223.

**Keywords:** nitrogen, fertilization, sunflower

**PARP:** I:2, II:2,4

# Screening Grapevine Cultivars for Adaptability to Soil and Climatic Conditions in Wyoming

*S.A. Dhekney[1], R. Kandel[1], D.R. Bergey[2], D. Smith[2], and J. Vardiman[3]*

Grapevine production is traditionally confined to subtropical regions of the United States. The development of new cold-hardy grape cultivars has led to the possibility of sustainable grape production in colder regions of the United States, including Wyoming. The Wyoming grape industry, although small, continues to grow and generate interest among producers seeking to diversify crop production. Grape production and quality is governed by the complex interaction of cultivars with prevailing soil and climatic conditions. Thus, choice of cultivar is a critical factor for successful vineyard establishment.

## Objectives

The goal is to identify promising grapevine cultivars for Wyoming, thus helping to overcome obstacles to initial vineyard establishment. This could result in increased production and earlier financial returns.

## Materials and Methods

A grape germplasm comprising 52 cultivars and rootstocks was obtained from the U.S. Department of Agriculture's (USDA) cold-hardy grape germplasm repository in Geneva, New York. Stock vines were vegetatively propagated in a mist chamber to produce plants for the field trials. A one-acre vineyard site was established at the Sheridan Research and Extension Center (Figure 1). A five-feet-tall wire cordon trellis system was constructed using wooden posts (8 feet tall) at 20 feet distance within rows and two wires at 3 and 5 feet (12.5 gauge aluminum wire). End posts were securely anchored in the ground using 40-inch earth anchors. Wire tension on rows was adjusted using a wire vise tensioning tool. All supplies for vineyard establishment were purchased from Orchard Valley Supply Inc., North Carolina. A smaller test site (120 by 40 feet) was established at the Powell

Figures 1 and 2. Test plots in Sheridan (left) and Powell (right).

[1]Department of Plant Sciences; [2]Sheridan Research and Extension Center; [3]University of Wyoming Extension.

Figure 3. 'Frontenac' vine growth following dormancy: Sheridan (left) and Powell (right).

Research and Extension Center (Figure 2). Vines were planted at 10 feet by 5 feet spacing in 11.8-inch deep holes filled with compost and supplemented with 1.8 ounces 19:6:12 slow-release fertilizer. A drip irrigation system was installed at both locations to provide irrigation during periods of extreme drought. A total of 350 vines were planted at Sheridan and 100 at Powell. Vineyard irrigation was terminated at the end of September to initiate grapevine acclimation for winter conditions. Bud break and vine survival rates were recorded in spring 2014 to estimate vine winter damage and cold-hardiness of various cultivars. Fruiting in vines was discouraged by removing any inflorescences to ensure vine establishment and enhance cold hardiness in the subsequent winter season.

## Results and Discussion

Preliminary results indicated significant variations among grapevine cultivars in timing of bud break and vine survival rates at the two locations (Figures 3). Bud break following dormancy among cultivars ranged from early (May 14) to late (June 9). A higher vine survival rate following winter damage was recorded in Sheridan (73%) compared to Powell (40%). Among the various cultivars studied, 100% survival was recorded in several, including 'Frontenac', 'Marechal Foch', and 'Osceola Muscat', at Sheridan, while 60% survival and regrowth was recorded in 'Frontenac Gris' and 'Elvira' at Powell. Grapevine cultivars exhibit a wide variation in growth and developmental response to varying soils and climate. Vine establishment following planting, growth and development, flowering, berry development, and ripening also varies regionally. Such variation in survival rates may be attributed to differences in soil, climate, and topography of the two test sites.

Based on preliminary results, grapevine cultivars 'Elvira' and 'Frontenac Gris' exhibited higher vine survival rates following winter damage in Powell whereas 'Frontenac', 'Marechal Foch', and 'Osceola Muscat' performed well in Sheridan. We will continue to screen grapevine cultivars at the two locations for several years before any recommendations on cultivars suitable for this region can be made.

**Acknowledgments:** The project is supported by the Wyoming Department of Agriculture and USDA's Specialty Crop Block Grant Program.

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**Keywords:** grapes, wine, cold-hardy

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

# Productivity and Profitability of Irrigated Grass-Legume Mixtures

*A.T. Adjesiwor[1], M.A. Islam[1], V. Jeliazkov[2,3], J.P. Ritten[4], and A. Garcia y Garcia[5,6]*

Forages are among the most important crops in Wyoming; however, average state yields are generally below national average. Although alfalfa is the most widely grown forage legume in Wyoming, bird's-foot trefoil and sainfoin are potential alternatives due to their high nutritive value and non-bloating characteristics. One approach to increase forage yield and reduce reliance on nitrogen (N) fertilizers is to plant legumes in mixtures with grasses. Mixing alfalfa with grasses also reduces the risk of bloating problems associated with feeding alfalfa hay to cattle. To obtain high yield of good quality forage, species selection is essential. Also, seed cost is a major component in the establishment of grass and legumes stands. Thus, it is important to evaluate how modifying seeding rates in grass-legume mixtures affects farm profits.

## Objectives

The objective was to evaluate yield and economic implications of replacing N fertilizers with different ratios of grass-legume mixtures.

## Materials and Methods

The study was established in 2013 at the Adams Ranch of the Sheridan Research and Extension Center (ShREC). Fifteen treatments and four replicates were arranged in a randomized complete block. Treatments comprised a sole stand each of alfalfa (cultivar 'WL 363 HQ), sainfoin ('Shoshone'), and bird's-foot trefoil ('Norcen'). Also, there were three 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 (Table 1). Nitrogen was applied in two splits—April 25 and October 21, 2014. Data collected included: forage growth, yield, and nutritive value. Profitability was calculated as a difference between total revenue (hay prices obtained from U.S. Department of Agriculture hay market report) and total production costs (cost of operations obtained from Nebraska custom farm budgets). Total revenue calculation took into account yield and nutritive value of forage.

## Results and Discussion

Results showed yield was not influenced by treatments at first cut. This could be due to the high weed pressure at the time of first cut; however, second and third cut yields as well as total annual yields were influenced by treatments. Nitrogen application only influenced yield at third cut. This might be the result of high soil residual N at the beginning of the study. At the time of the third cut, soil residual N could have been exhausted, resulting in significant effect of N application on forage yield. Applying half the recommended rate of N (grass100-N50) produced similar total annual yield as the treatment receiving the full rate (grass100-N100). Alfalfa, bird's-foot trefoil, and sainfoin monocultures produced similar total annual yields (Table 1). Legume monocultures produced similar yields as meadow bromegrass monocultures receiving

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Table 1. Forage dry matter and profitability of different ratios of grass-legumes mixtures in 2014.

| Mixture ratio treatment* (% of seeding rate) | Dry matter yield (ton/acre) June 12 | August 12 | October 15 | Total | Profit/Loss ($/acre) |
|---|---|---|---|---|---|
| A100 | 0.54 | 1.51 | 0.54 | 2.59 | 73 |
| A50:G50 | 0.51 | 1.17 | 0.60 | 2.28 | -18 |
| A30:G70 | 0.52 | 1.21 | 0.63 | 2.36 | 19 |
| G50:A25:S25 | 0.57 | 0.94 | 0.45 | 1.96 | -82 |
| S100 | 0.56 | 1.53 | 0.37 | 2.46 | 6 |
| S50:G50 | 0.54 | 0.92 | 0.48 | 1.93 | -147 |
| S30:G70 | 0.53 | 1.25 | 0.50 | 2.28 | -76 |
| G:50:A25:B25 | 0.48 | 0.85 | 0.62 | 1.95 | -60 |
| B100 | 0.56 | 1.70 | 0.64 | 2.90 | 125 |
| B50:G50 | 0.41 | 0.94 | 0.59 | 1.94 | -167 |
| B30:G70 | 0.58 | 1.29 | 0.59 | 2.47 | -150 |
| G50:A16.7:S16.7:B16.7 | 0.54 | 0.95 | 0.49 | 1.98 | -67 |
| G100-N0 | 0.53 | 1.17 | 0.47 | 2.18 | -98 |
| G100-N50 | 0.57 | 1.29 | 0.82 | 2.69 | -57 |
| G100-N100 | 0.52 | 1.21 | 1.12 | 2.85 | -53 |
| *p*-value (0.05) | 0.87 | 0.03 | <0.0001 | 0.002 | - |
| LSD | 0.16 | 0.49 | 0.15 | 0.54 | - |

half and full recommended N rate. Overall, dry matter yield in grass-legume mixture treatments were marginally lower than legume monocultures as well as N treatments. All legume monocultures were profitable just one year after establishment. Among the grass-legume mixture treatments, only 30% alfalfa+70% meadow bromegrass (alfalfa30:grass70) was profitable (Table 1). Although none of the meadow bromegrass monocultures was profitable, application of N reduced uncovered costs. The high legume seed cost, especially alfalfa and sainfoin together, combined with lower yields in mixtures might have resulted in higher uncovered costs. Because establishment cost is the main cost element, the systems are still expected to be profitable if stands persist and remain productive for several more years. Bird's-foot trefoil is a promising legume that could be an alternative, high-yielding, and profitable crop in Wyoming where alfalfa is not suitable.

**Acknowledgments:** We thank ShREC Competitive Graduate Assistantships Program for funding and also thank ShREC staff members for assistance.

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**Keywords:** forage productivity, profitability, grass-legume mixtures

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

# Developing Strategies to Improve Reclamation Success of Drastically Disturbed Lands

*B. Fowers[1], B.A. Mealor[1,2], A.R. Kniss[1]*

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 such negative impacts, but establishment of desirable plant communities on disturbed areas—particularly in Wyoming's more arid and semi-arid environments—is typically difficult.

Non-native and undesirable weed species often invade disturbed areas with bare soils. Widespread growth of invasive and noxious 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 effectiveness of herbicides and season of application on weed control in reclamation programs.

## Objectives

This research addresses the following: 1) How do various herbicide treatments affect weed control in reclamation settings? 2) Does season of seeding improve or diminish the establishment of desirable plant species? 3) Which desirable species are able to successfully establish in reclamation settings?

## Materials and Methods

Three field trials were established at the Sheridan Research and Extension Center (ShREC), Laramie Research and Extension Center (LREC), 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 (Table 1). Six pre-emergence herbicide treatments were applied in fall 2011, and eight postemergent treatments were applied in spring 2012 (Table 2). Herbicides were applied for weed control, but effects on seeded species were also evaluated. To determine the outcome of each treatment, canopy cover of all species and biomass of seeded species were collected in summer 2014.

## Results and Discussion

Three years after treatment, weed control was impacted by both herbicide and seeding treatments at all sites ($p<0.05$). Season of treatment application was important, but varied depending on weed type. The most abundant weed spe-

Table 1. Perennial grass species showing seeding rate.

| Common name | Seeding rate |
|---|---|
| 'Arriba' western wheatgrass | 12 PLS lbs/ac |
| 'Sherman' big bluegrass | 4 PLS lbs/ac |
| 'Trailhead' basin wildrye | 12 PLS lbs/ac |
| 'Anatone' bluebunch wheatgrass | 14 PLS lbs/ac |
| 'Sodar' streambank wheatgrass | 12 PLS lbs/ac |
| alkali sacaton | 2 PLS lbs/ac |
| 'Hycrest' crested wheatgrass | 9 PLS lbs/ac |
| 'Bozoisky' Russian wildrye | 12 PLS lbs/ac |

PLS = 'pure live seed'

[1]Department of Plant Sciences; [2]Sheridan Research and Extension Center.

Table 2. Herbicides used for weed control. All spring treatments included a 0.25% volume volume$^{-1}$ rate of non-ionic surfactant (NIS).

| Chemical Name | Rate |
|---|---|
| Aminocyclopyrachlor plus chlorsulfuron | 2.2 oz ai/acre<br>0.9 oz ai/acre |
| Aminocyclopyrachlor plus chlorsulfuron | 1.1 oz ai/acre<br>0.4 oz ai/acre |
| Aminocyclopyrachlor | 2.2 oz ai/acre |
| Aminocyclopyrachlor | 1.1 oz ai/acre |
| Aminopyralid | 1.3 oz ai/acre |
| Chlorsulfuron | 0.8 oz ai/acre |
| Imazapic* | 3.7 oz ai/acre |
| Rimsulfuron* | 1.9 oz ai/acre |
| 2,4-D Amine** | 24 oz ai/acre |
| Saflufenacil** | 0.4 oz ai/acre |

ai = active ingredient
*herbicides only applied in spring at ShREC.
**herbicides only applied in spring at other sites.

cies were kochia, mustards, and cheatgrass. Fall-seedings had lower annual forb cover. Herbicides most greatly reducing annual forb cover included aminocyclopyrachlor+chlorsulfuron and aminocyclopyrachlor. Lower forb cover also occurred where crested wheatgrass, Russian wildrye, or basin wildrye were seeded (varying by site). Annual grass cover was only dominant at the ShREC site and was negatively impacted by specific seeded species including crested and streambank wheatgrasses and other wheatgrasses based on the season they were seeded (fall) (seed mix*season of seeding $p<0.0001$). Annual grass cover was lower in spring-seeded areas, as an unplanned byproduct of site preparation (disking) before spring seeding occurred.

Three years after treatment, seeded species cover was low at the LREC and Ucross sites (typically less than 5% cover, at most 35%). At all three sites, the response of seeded species cover depended on the herbicide applied (herbicide*seeded species $p<0.05$). The top two species at all sites were crested wheatgrass and Russian wildrye, followed by western wheatgrass, basin wildrye, and streambank wheatgrass as the third best species at individual sites. Some herbicide plots with higher seeded species cover included aminocyclopyrachlor products and aminopyralid. The ShREC site exhibited more variation in responses to herbicides where some species had both higher and lower cover compared to plots with no herbicide, depending on the herbicide applied. Biomass of seeded species showed similar results to cover in terms of species response. Season of seeding and seed mix were important at all sites ($p<0.05$); however, the season with increased biomass varied by site (ShREC had higher biomass in spring). Aminopyralid, chlorsulfuron, and aminocyclopyrachlor increased biomass; other herbicides were observed to decrease biomass depending on species. When recommending treatments for reclamation, it is extremely important to take into account variations at each site. Herbicides were found to be useful in areas where weed management is needed and could include aminopyralid and aminocyclopyrachlor products. Overall observations from this study indicate that use of wheatgrasses and wildrye species often will exhibit good establishment and weed control even with herbicides; however, establishment of desirable species in arid conditions is difficult.

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

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**Keywords**: desirable grasses, reclamation, seeding

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

# Short Reports—Off-Station

## 1. Genomic research and prediction technologies for beef cattle: Where's the economics?

**Investigators:** Nicole Ballenger, Matt Andersen, Chris Bastian, Kristi Cammack, and Bridger Feuz

**Issue:** The beef industry adds value to its product through health and nutrition programs, genetic choices, and addressing temperament of the cattle. Commercially available genomic prediction technologies—stemming from public investments in beef genomics research—may have potential to increase the economic returns from these value-adding production strategies.

**Goal:** Study benefits and distribution of benefits in the beef cattle industry stemming from public investments in beef genomic research.

**Objectives:** The primary initial objective is to 1) understand advances in beef genomic prediction technologies and 2) develop an economic framework for evaluating their potential benefits and the distribution of their benefits within the vertically segmented beef cattle industry.

**Impact:** Results should improve understanding and communication of potential economic effects of genomic prediction technologies resulting from investments and discoveries in beef genomic research. Better understanding of potential benefits and costs can help direct future research investments toward the highest potential return, and can assist cow-calf operators in determining if and when using genomic prediction technologies can improve competitiveness.

**Contact:** Nicole Ballenger at nicoleb@uwyo.edu or 307-766-5128.

**Keywords:** beef cattle, genomics research, genomic prediction technologies

**PARP:** V, VII, VIII

## 2. Quantifying production of ecosystem services by Western ranchers

**Investigators:** Philip Lavallee Jr., John Tanaka, and Kristie Maczko

**Issue:** Beef production is one of the largest market-based uses of rangelands in the West, but it is certainly not the only product or use coming from these lands. Ranchers may also engage in practices that enhance or conserve such ecosystem services as clean water, biodiversity, or recreational activities that benefit society and which may be converted into alternative income streams.

**Goal:** Study the impacts and attitudes of Western ranchers on ecosystem services and quantify the ecosystem services produced by their operations.

**Objectives:** Quantify the ecosystem services produced by ranchers in the central Rocky Mountains, Colorado Plateau, Great Basin, and Desert Southwest regions and determine if ranchers are adjusting management practices to produce more or less of the services.

**Impact:** Results should assist marketing efforts in terms of what else ranchers produce beyond red meat. Knowledge of the amount of the ecosystem services produced could assist decision-makers as they make resource allocation decisions.

**Contact:** John Tanaka at jtanaka@uwyo.edu or 307-766-5130, or Philip Lavallee Jr. at plavall1@uwyo.edu or 307-351-4040.

**Keywords:** ecosystem services, ranching

**PARP:** VI:1,3,5, VII:2,4

## 3. Development of a new test for diagnosis of livestock brucellosis

**Investigators:** Brant Schumaker, Gerard Andrews, Jason Gigley, Myrna Miller, William Laegreid, William Edwards, and Noah Hull

**Issue:** Recurrent cases of livestock brucellosis in the Greater Yellowstone Area (GYA) can cause severe economic losses to producers in the form of lower calving rates and decreased ability to market and sell their animals; however, current diagnostic tests for brucellosis are costly, time consuming, and inefficient.

**Goal:** Develop and validate a new test to diagnose livestock brucellosis.

**Objectives:** Using tissue samples from an affected producer's herd in the GYA, we are designing the new test to more quickly and accurately diagnose brucellosis infections.

**Impact:** Our new test should have earlier detection of infections and better accuracy. This should greatly assist with control and eradication efforts for this devastating livestock disease.

**Contact:** Brant Schumaker at bschumak@uwyo.edu or 307-766-9970.

**Keywords:** brucellosis, diagnostic test, livestock

**PARP:** not applicable

## 4. Prevalence of *Brucella ovis* in Wyoming domestic sheep

**Investigators:** Kerry Sondgeroth and Molly Elderbrook

**Issue:** *Brucella ovis* has direct negative effects on lamb production and is of major concern for Wyoming sheep producers. Infection into a flock is introduced by an infected ram; however, less than half of rams show clinical signs of infection.

**Goal:** Determine if *Brucella ovis* is present in Wyoming sheep flocks.

**Objectives:** Collect and test blood samples from apparent healthy rams and ewes across Wyoming and determine how many, if any, have been exposed to *Brucella ovis*.

**Impact:** Results should give a better understanding if any Wyoming sheep have been exposed to *Brucella ovis*, and if so how many. The outcome should help producers identify infected animals, decrease infection rates through blood testing during breeding soundness exams, and, ultimately, increase lamb production rates.

**Contact:** Kerry Sondgeroth at ksondger@uwyo.edu or 307-766-9932.

**Keywords:** sheep, lamb production, *Brucella ovis*

**PARP:** not applicable

# Reducing Direct Harvest Losses in Conservation Tillage Dry Bean Production

*C. Beiermann[1], D. Claypool[1], Tim Anderson[2], Ty Anderson[2], and A.R. Kniss[1]*

Dry bean production in Wyoming is relatively expensive compared to other crops due to high labor, equipment, and fuel costs. A typical dry bean grower may use five to nine field operations over each acre of dry beans. Planting dry bean directly into previous crop stubble reduces input costs and has the added benefit of reducing soil erosion and protecting the crop from wind damage early in the growing season. Another way to reduce input costs is to direct-harvest the dry bean crop instead of undercutting and windrowing.

In this project, we are investigating practices that could reduce harvest loss associated with direct harvest of dry beans grown in conservation tillage systems. Adoption of this practice could result in reduced soil erosion due to wind and substantial savings in the cost of dry bean production through reduced fuel and labor requirements. Direct-harvest of the dry bean crop will eliminate at least one—and in some cases two—field harvest operations while also reducing the risk of weather damage to seed during the critical time the crop is in the windrow.

## Objectives

Our objective is to determine the impact of previous crop residue on dry bean growth habit and harvest loss.

## Materials and Methods

A large-scale study was conducted on the Anderson farm in southeast Wyoming near Albin in 2014. During the 2013 wheat harvest, wheat was cut at three different heights. Each wheat stubble height was replicated three times in a randomized complete block design. Stubble heights measured in spring 2014 were 7.5 inches (low residue), 10 (medium residue), and 14 (high residue).

The study included three plots for each treatment, and each plot measured 35 feet wide (width of the combine header) by the length of the field (approximately 1,000 feet), for a total trial area of nearly 10 acres. Pinto beans were drilled into the standing wheat stubble treatments on May 22, 2014, in 10-inch row spacing. Crop stand was measured by counting the number of beans in 20 feet of row (30 counts per strip). Total plant height and height from soil to the first and second bean pod were measured (30 bean plants per strip).

The strips were then harvested with a flex header with air reel (owned and operated by the Andersons). The entire strip was harvested and placed into a weigh wagon. Strip lengths were measured using a global positioning system to determine bean yield per acre. Harvest loss was then determined by counting the number of beans on the ground within a 2.7 $ft^2$ quadrat (10 per plot). Data was analyzed by analysis of variance (ANOVA). Treatment means were separated where appropriate using Fisher's protected LSD (least significant difference).

## Results and Discussion

Pinto bean populations averaged approximately 73,000 plants per acre and did not differ be-

[1]Department of Plant Sciences; [2]Prairie Farms Ltd., Albin, Wyoming.

Table 1. Pinto bean response to low, medium, and high wheat stubble heights at planting.

| Treatment | Stubble height (inches) May 22 | Bean height (inches) July 16 | Pod height (inches) Sept. 17 | Bean yield (lbs/A) Sept. 18 | Harvest loss (%) Sept. 18 |
|---|---|---|---|---|---|
| Low residue | 7.5 | 14.0 | 1.6 | 3,490 | 2.5 |
| Medium residue | 10.0 | 15.0 | 2.0 | 3,220 | 4.0 |
| High residue | 14.0 | 15.5 | 2.2 | 2,960 | 3.5 |
| LSD (0.05) | 1.7 | 0.4 | NS | 129 | 1.3 |

tween wheat residue treatments. Bean height increased as wheat stubble height increased, from 14 inches in the low residue treatment to 15.5 inches in the high residue treatment. Although not statistically significant, there was a trend for increased pod height as wheat residue amount increased (Table 1). Pinto bean yield was reduced as wheat stubble height increased. Yield ranged from 3,490 lbs/ac in the low residue treatment to 2,960 in the high residue treatment. Although some yield reduction was expected from the increased stubble amount, the 15% reduction in bean yield was greater than expected. Additionally, the lowest harvest loss was observed in the low residue treatment. These combined results suggest that leaving increased winter wheat stubble height should not be a recommended practice.

Although results are not promising, the study is being repeated in 2015. The 2014 growing season was nearly ideal for reducing harvest losses, and, therefore, the results may be overly optimistic for the low residue treatment. Results from 2015 should provide greater insight into whether this may be a viable practice to reduce harvest losses. The results from 2014, although contrary to what we expected, may actually provide some good news for growers considering dry bean production in winter wheat stubble. Our results suggest that lower wheat stubble heights produced greater bean yields and did not negatively impact harvest losses. Therefore, the additional wheat straw could be baled and sold when straw prices are high.

**Acknowledgments:** The work was funded by a contribution from Stateline Producers Cooperative and grants from the Wyoming Department of Agriculture's Agriculture Producer Research Grant Program and the Wyoming Agricultural Experiment Station.

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**Keywords:** conservation tillage, direct harvest, dry bean

**PARP:** I:3,4,7,8,9, II:6, IV:4, IX:2,4, X:1,2

# Understanding Epigenetic Mechanisms of Lactation Failure

*B. Cherrington*[1]

In Wyoming, 27.8% of adults and 10.7% of children are obese. By 2018, medical expenditures for obesity-related health issues in the state are predicted to cost $607 million per year. These statistics illustrate a growing obesity epidemic that will increase healthcare costs in Wyoming and the entire nation. To combat the growing epidemic, the Centers for Disease Control and Prevention recommends increasing the initiation and duration of breastfeeding.

Breastfeeding decreases obesity rates and the onset of Type 2 diabetes in the mother and infant. Unfortunately, mothers who are obese or overweight are more likely to terminate breastfeeding prematurely due to inadequate breast milk production. This problem is directly related to the hormone prolactin, which normally stimulates milk production in breast cells. Obese mothers, however, have a blunted prolactin response early postpartum, which delays the onset of copious breast milk production. Scientific understanding of how prolactin controls lactation is improving, but we do not currently understand how obesity alters prolactin production by lactotrope cells in the anterior pituitary gland.

## Objectives

The goal is to determine how maternal obesity effects prolactin production and lactation.

## Materials and Methods

Experiments are being conducted in the University of Wyoming Biological Sciences Building. One group of mice is receiving a control diet (10% calories from fat), while the second group receives a high fat diet (60% calories from fat). Blood and pituitary and mammary glands from both groups were collected during lactation to examine changes in prolactin and milk production. All animals are housed and cared for following approved UW Institutional Animal Care and Use Committee guidelines.

## Results and Discussion

Normally, prolactin levels rise dramatically at the end of pregnancy to initiate lactation. Prolactin is critical to activate expression of lactation-related genes, which produce breast milk proteins and enzymes. Obese mothers have a blunted prolactin response early postpartum, which delays milk production. To investigate

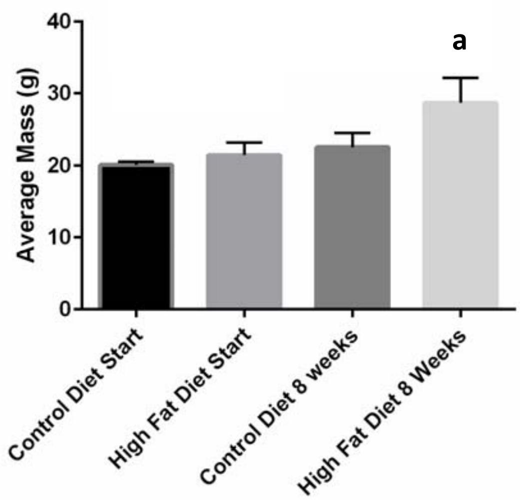


Figure 1. A high fat diet induces obesity. Mice were fed a control or high fat diet for eight weeks and weighed weekly. Means were separated by one way ANOVA ($p$<0.05).

[1]Department of Zoology and Physiology.

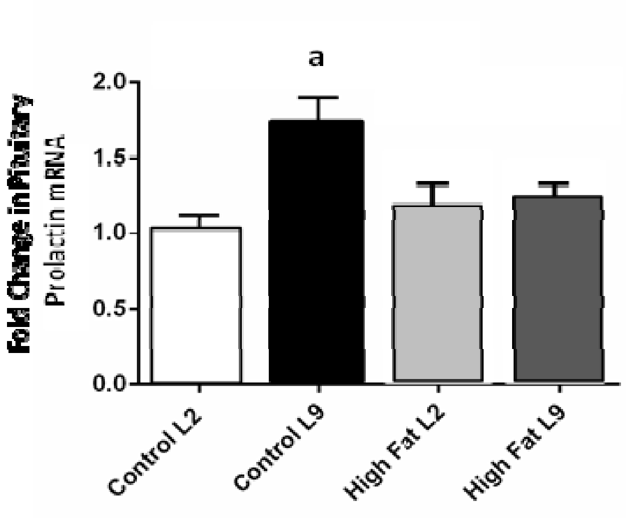


Figure 2. Obese lactating mice have decreased prolactin mRNA levels at L9 compared to normal-weight mice. Following eight weeks of control or high fat diet, mice were bred and pituitaries collected on L2 or 9. RNA was purified, reverse transcribed, and subject to qPCR with primers specific for prolactin and gapdh as the reference control gene. Means were separated by one way ANOVA ($p<0.05$) and n=3.

this problem at the cellular level, we have generated obese mice. Mice fed a high fat diet for eight weeks have approximately a 20% increase in body weight compared to mice fed the control diet (Figure 1). Next, obese and normal-weight female mice were bred. On lactation day two (L2) and nine (L9), we collected blood and pituitary and mammary glands from obese and normal-weight mothers. Our results indicate that normal-weight mice have an increase in pituitary prolactin mRNA production from L2 to L9, which facilitates normal milk production. In contrast, obese mice do not have an increase in pituitary prolactin mRNA production from L2 to L9, which may negatively affect milk production (Figure 2). Important studies are currently underway to corroborate mRNA data with prolactin protein levels in pituitaries and blood from control and high fat diet mothers. Our preliminary data suggest a correlation between obesity and the synthesis of prolactin, which warrants further investigation.

It is well established that a major complication of obesity is insulin resistance in metabolic tissues, which results in elevated circulating insulin, termed hyperinsulinemia. Our upcoming studies will investigate if obesity-induced hyperinsulinemia causes the decrease in prolactin production by the anterior pituitary gland lactotrope cells. We are using a weigh-suckle-weigh paradigm to examine if maternal obesity affects fetal weight. Lastly, changes in milk protein and fat levels will be examined in obese versus non-obese mothers. Our overall goal is to examine how obesity induces changes in the initiation of lactation and milk composition. We believe that our results will provide a scientific rational to promote breastfeeding to combat obesity.

**Acknowledgments:** Thanks to Amy Navratil and Guangyuan Li for technical support.

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**Keywords:** lactation, obesity, epigenetics

**PARP:** VII:1,2

# Regulation of Nuclear Size in Cancer Cells

*D.L. Levy[1], P. Jevtic[1], K. White[1]*

The nucleus is the compartment within each cell that contains the genetic information directing how the cell grows and behaves. Although pathologists use an enlarged nucleus to diagnose cancer and determine what stage it has reached, we know very little about what causes large nuclear size or what the consequences are for the cancer patient. My lab studies the model organism *Xenopus* (African clawed frog). Similar systems regulate cell growth in humans and frogs. In fact, proteins from human cells often work in frog cells. *Xenopus* research has been important in studying cancer, as well as congenital heart disease, progeria, and Fanconi anemia, to name a few. We anticipate that discoveries about nuclear size control in *Xenopus* will translate to humans, producing important information for the cancer community.

We are using *Xenopus* embryos to understand how nuclear size is controlled during embryo development. In many ways, the uncontrolled growth of cancer is similar to rapid cell growth in developing embryos. In fact, cancer may arise from reactivation of embryonic growth programs in otherwise normal cells. Understanding nuclear size regulation in embryos will therefore inform cancer. To translate our findings in *Xenopus* to humans, we propose to directly alter nuclear size in cancer cells. To our knowledge for the first time, we will directly test if reducing the size of the nucleus slows cancer cell growth and metastatic potential. Our studies should shed light on how nuclear size contributes to cancer development and progression. Novel approaches to cancer diagnosis and treatment that target nuclear size will be suggested, and new cancer susceptibility factors associated with altered nuclear size could be identified to aid in prevention.

## Objectives

The objective of this study is to use information we have gained from the *Xenopus* system about mechanisms of nuclear size control to test if reducing nuclear size in human cancer cells affects their growth properties. Importantly, these basic studies in cell biology should provide the necessary information to develop novel methods to control cancer.

## Material and Methods

We previously identified a protein, Ntf2, which regulates nuclear size in *Xenopus*. Ntf2 plays a role in regulating nucleocytoplasmic transport. To test the effect of Ntf2 expression on nuclear size and cell growth in human cancer cells, we are using a well-established human prostate cancer cell line called LNCaP. We transfected an Ntf2 expression plasmid into LNCaP cells and used antibiotic selection (geneticin) to isolate several stable cell lines that overexpress Ntf2. The ectopically expressed Ntf2 was tagged with an mCherry fluorescent marker, allowing us to visualize Ntf2 expression in cells. We imaged nuclei in these stable cell lines using a DNA stain (Hoechst) to assess effects on nuclear size. We also measured the proliferation rates of these cell lines using a cell counter (Countess® from Life Technologies).

[1]Department of Molecular Biology.

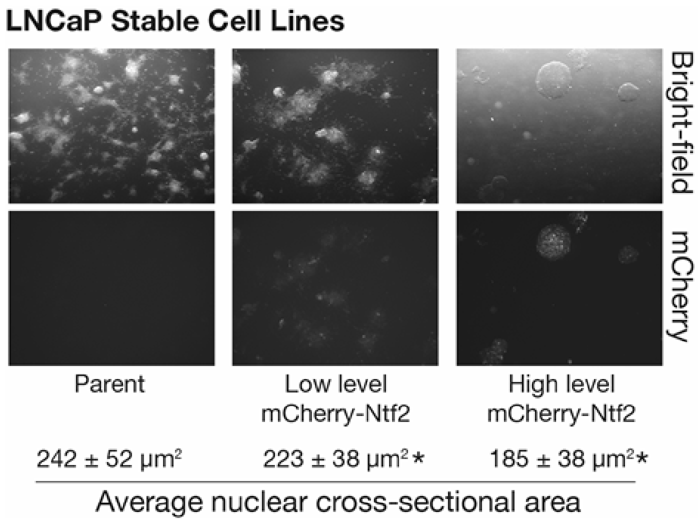


Figure 1. Stable LNCaP cell lines expressing varying levels of mCherry-Ntf2 were generated by geneticin selection. High level Ntf2 expression is associated with reduced nuclear size and altered colony morphology that is suggestive of reduced cell spreading, **p*<0.001, ±SD.

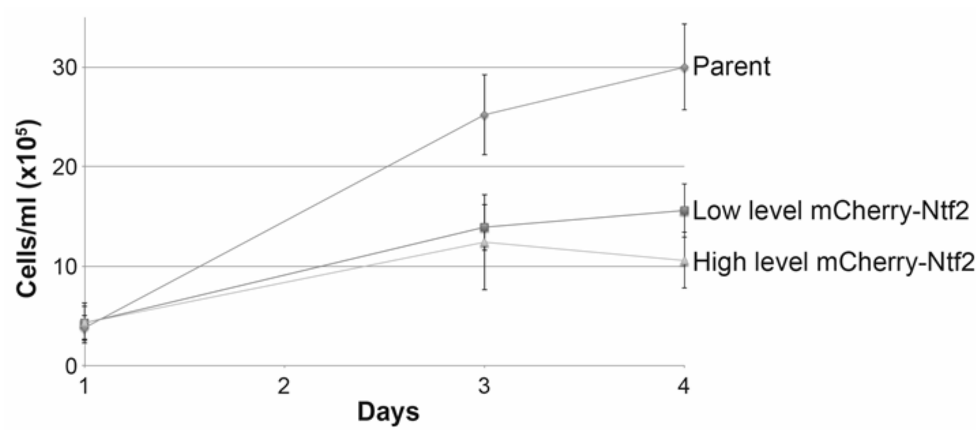


Figure 2. Cell proliferation rates were measured for the cell lines shown in Figure 1. Error bars represent SD.

## Results and Discussion

We found that stable overexpression of Ntf2 in LNCaP cells led to a reduction in nuclear size (Figure 1). This is consistent with how Ntf2 regulates nuclear size in *Xenopus*. Strikingly, these cell lines with reduced nuclear sizes exhibited reduced cell proliferation rates (Figure 2). We also observed that cells overexpressing Ntf2 exhibited altered colony morphology suggestive of reduced cell spreading (Figure 1). These data indicate that reducing nuclear size in cancer cells may be sufficient to slow the growth rate of these cells. Future studies will address whether reducing nuclear size impacts other cancer characteristics, such as apoptosis (programmed cell death) and cell migration, and we will test if these stable cell lines have reduced tumorigenic potential in mice.

**Acknowledgments:** We thank members of the Levy lab for helpful advice. This study is supported by the Wyoming Agricultural Experiment Station Competitive Grants Program.

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**Keywords:** nuclear size, cancer cell biology, health

**PARP:** not applicable

# Statewide Distribution of Cheatgrass Infestations in Wyoming

*C.E. Noseworthy[1], B.A. Mealor[1,2], and A. Pocewicz[3]*

Cheatgrass—also known as downy brome (*Bromus tectorum* L.)—poses a large problem for land managers across the arid and semiarid western United States, including Wyoming. It is an exotic winter annual, meaning it primarily germinates in the fall. Although climate appears to influence where cheatgrass is capable of invading, disturbance is a chief means by which it invades. Cheatgrass can displace native perennial grasses, reduce forage for livestock, increase wildfire frequency, and threaten wildlife habitat. Cheatgrass may provide good forage in early spring, but it is considered unreliable and sometimes substandard compared to native perennial grasses. There are a number of control methods available for treating cheatgrass, including chemical, mechanical, and biological means. This research focuses instead on how to strategically approach cheatgrass management on a larger scale in Wyoming.

Distribution prediction models can be a useful tool for managing invasive plant species. More specifically, they are useful for determining the probability of invasive species occurrence on a large landscape scale and for determining severity of impacts on the system. Developing distribution prediction models using abundance data may be more useful for management by determining probability of impact rather than probability of establishment. We can determine "establishment niche" for a species using presence/absence data and "impact niche" using abundance data. Some researchers recommend a large-scale approach and coordinating efforts to increase success of invasive species management. Understanding the impact niche of a species would be especially useful in developing a strategy for managing an invasive plant species on a large scale.

## Objectives

Objectives of this study were to: 1) develop a dataset that provides a better picture of the distribution of cheatgrass in Wyoming beyond presence/absence and 2) develop distribution prediction models for the state to determine both the establishment niche and impact niche for cheatgrass in Wyoming.

## Materials and Methods

The study area is the state of Wyoming. Data collection began in 2012 and included gathering information from land management agencies around Wyoming and conducting field surveys. Distribution prediction models were developed using Random Forests™, a machine-learning algorithm, in R statistical program. Inputs included cheatgrass distribution data and 37 predictor variables representing different aspects of climate, topography, disturbance, and soils/productivity. We developed one presence/absence model and three abundance models: absence vs. trace (presence=cheatgrass cover of 1–5%), absence vs. moderate (6–50%), and absence vs. dominance (>50%).

[1]Department of Plant Sciences; [2]Sheridan Research and Extension Center; [3]The Nature Conservancy.

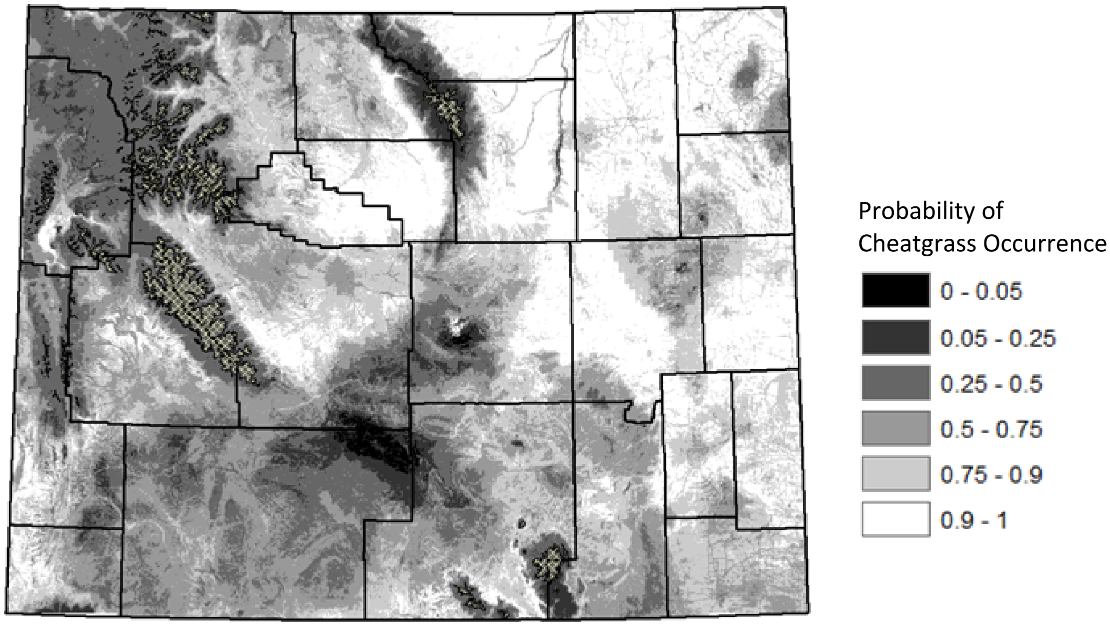


Figure 1. Presence/absence model ("establishment niche") for cheatgrass in Wyoming. Hatch marks represent areas above 10,000 feet. We recommend disregarding these areas as we had no data above this elevation.

## Results and Discussion

We achieved our objectives by producing a dataset of known cheatgrass locations for Wyoming as well as four distribution prediction models for cheatgrass in the state. All models were more than 80% accurate based on internal model validation statistics. Top predictors for the presence/absence model were elevation and eight different climate variables (Figure 1). The dominance model will help guide land managers on where to focus cheatgrass management in the near future, while the trace and moderate models will likely provide a conservative approach to long-term plans for cheatgrass management. The current models identify regions of the state where cheatgrass is currently presenting management challenges and will likely remain an issue. The establishment niche for Wyoming is fairly large, with close to 50% of the state above 75% probability of cheatgrass establishment. Specific landscape-scale management decisions for cheatgrass will require input from stakeholder groups and land managers with experience working in the state

**Acknowledgments:** We thank all who shared and collected data. The study is supported by the Wyoming Reclamation and Restoration Center, Wyoming Agricultural Experiment Station's Competitive Grants Program, Wyoming Weed and Pest Council, Wyoming governor's office, and Wyoming office of the U.S. Bureau of Land Management.

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**Keywords:** downy brome, cheatgrass distribution, weed management

**PARP:** III:5, X:1, XII:1

# Analysis for Reclamation Costs in Wyoming's Powder River Basin

*A. Perry[1], K. Hansen[2], R. Coupal[2], and B.A. Mealor[3,4]*

Wyoming's economy is highly dependent on the production of natural gas, oil, coal, and other energy and mineral resources, but extraction of these resources degrades rangelands. Federal and state laws and policies govern reclamation of disturbed lands; however, establishing sagebrush plant communities is difficult, and defining successful reclamation can be challenging. We found that revegetation costs represent approximately 2.5% of overall reclamation costs. Although the percentage is small, many of the cost variations fall within the revegetation category.

## Objectives

The objective is to understand costs and cost variability associated with reclamation activities in northeastern Wyoming's Powder River Basin (PRB). In turn, this should help incorporate economics into decision-making for successful reclamation.

## Materials and Methods

We collected data on reclamation costs for all coal companies operating in the PRB of Wyoming during 2010 to 2013. We compiled the data by recording all reclamation-related costs reported by the companies. We then condensed the costs into categories that were consistently reported by all the companies. Coal companies in Wyoming are required to file annual reports with the Wyoming Department of Environmental Quality's (WDEQ) Land Quality Division. The reclamation costs reported in annual reports are an account of reclamation activity that would have to take place for reclamation to be completed by WDEQ, in the event that a coal company defaulted on its bond. Information from PRB's 13 mines was utilized in the annual report analysis. We used the reformatted data to construct an enterprise budget to identify current reclamation activities and associated costs in the coal industry. The enterprise budget

Table 1. Sample budget for a representative 2,000-acre coal reclamation site in the PRB. Calculations based on a haul distance of 2,000 feet.

| Reclamation Activity | Total Cost | Cost Per Acre |
|---|---|---|
| Area bond | $26,000,000 | $13,000 |
| Dirt work and demolition | $13,554,602 | $6,777 |
| Topsoil replacement and revegetation | $8,480,920 | $4,240 |
| Contingencies and monitoring | $13,930,301 | $6,965 |
| Total | $61,965,823 | $30,982 |

[1]University of Wyoming Extension; [2]Department of Agricultural and Applied Economics; [3]Department of Plant Sciences; [4]Sheridan Research and Extension Center.

Table 2. Economic impacts of coal mine reclamation in Campbell County.

| Impact Type | Employment | Labor Income |
|---|---|---|
| Direct Effect | 926 | $45,682,839 |
| Indirect Effect | 256 | $9,522,286 |
| Induced Effect | 412 | $16,890,842 |
| Total | 1,594 | $72,095,967 |

is based on a representative 2,000-acre PRB site. We analyze reclamation costs using coal company annual reclamation reports.

The majority of mines (74%) reported reclamation activities (e.g., cut and fill, gradation, demolition, groundwater monitoring, and drill seeding) and associated costs. Mines that were not actively performing reclamation or extraction, but still maintained a permit, had limited data in their annual reports. In addition, most mines reported precipitation and wildlife impacts. How mines reported activities, however, differed among companies.

## Results and Discussion

Per-acre costs were used to create a representative budget for a 2,000-acre reclamation site (Table 1). The budget was validated through interviews with PRB reclamation practitioners. These practitioners noted that two activity categories—topsoil removal and replacement and revegetation—were likely to be highly variable from site to site depending on local topography and the nature of the disturbance. Interviews also revealed discrepancies in what reclamation practitioners consider to be best practices. More consistent data collection by practitioners and additional research would lead to a better understanding of reclamation costs and facilitate more informed decision making. Based on practitioner feedback and what is available in the literature, we believe areas that need additional investigation are seed timing, dirt management, seeding techniques, seed selectivity, container plantings, site-specific innovations, and adaptive management. Interviewees also noted a lack of consistency in regulatory agency personnel (and their areas of interest/formal training) making site visits, which increases uncertainty for energy operations in receiving approval for successful reclamation. We performed the same kind of analysis (though less detailed due to reporting regulations) for reclamation on oil and gas sites.

The representative 2,000-acre coal reclamation site budget was used in an economic input-output model to calculate the economic impacts of reclamation in Campbell County, as measured through jobs and income (the model could be run for additional counties). Results are presented in Table 2. Gross expenditures on reclamation and total acres of reclamation activity were used to allocate reclamation activities to industries in the Campbell County economy. The dirt work and revegetation categories were assigned to the construction and agricultural industries, respectively.

**Acknowledgments:** This project was funded by the University of Wyoming School of Energy Resources' Matching Grant Fund, DuPont, Apache Foundation, UW Department of Plant Sciences, Wyoming Agricultural Experiment Station, and U.S. Bureau of Land Management. Thanks to the practitioners who were willing to offer insight and expertise on reclamation costs, along with Doug Emme at WDEQ.

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**Keywords:** reclamation costs, enterprise budget, coal mine reclamation

**PARP:** IX, XII:1

# Economic Impacts of Variable Precipitation on Wyoming Ranchers

*T. Hamilton[1], J. Ritten[1], C. Bastian[1], J. Derner[2], J. Tanaka[3], S. Lake[4], D. Mount[5], S. Paisley[4], D. Peck[1], and J. Reeves[2]*

Variation in precipitation is a threat facing the economic stability of the cattle industry. Current national climate change impacts include changes in temperature, precipitation, snowpack, evaporation, and weather variability and increased occurrences of extreme events, most notably drought. These climate changes affect cattle production through the health, well-being, and performance of crops, pastureland, rangeland, and cattle. Quantification of the nature and severity of these effects on cattle production could help producers implement management strategies to reduce potential negative economic impacts.

## Objectives

The major objectives of this research include: 1) develop relevant ranch-level economic models of cattle production systems specific to eastern Wyoming, 2) incorporate a range of changes to variation in growing season precipitation on cattle production through both impacts directly on calf performance and indirectly through forage production, and 3) analyze potential ranch-level outcomes of management alternatives using economic models and climate scenarios developed for the first two objectives.

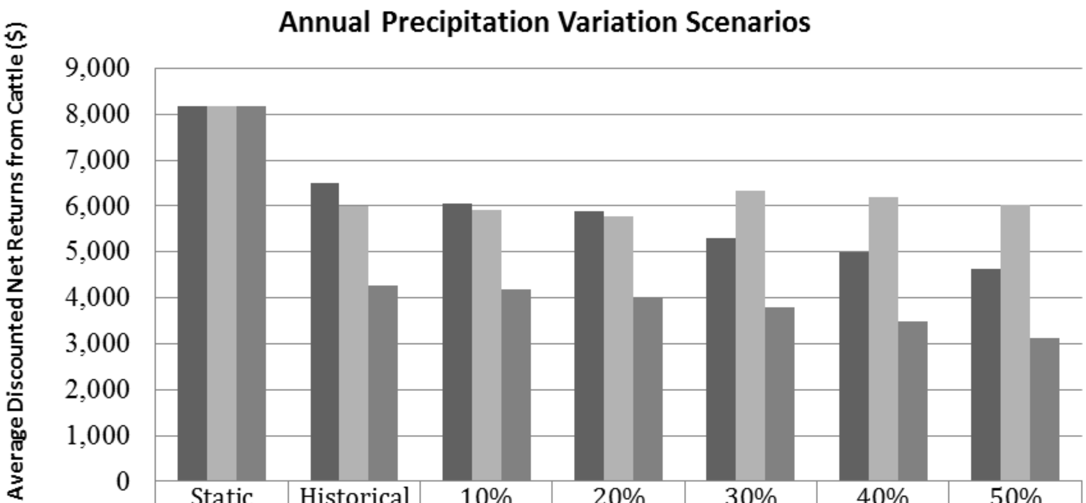
## Materials and Methods

A multi-period linear programming (MLP) model is used to quantify the impacts of climate change on cattle production in southeast Wyoming, as well as provide potential benefits and costs of alternative adaptations. The MLP model analyzes these impacts over a suite of climate forecasts to determine the potential impact of changes in growing season precipitation on the viability of cattle producers in the region. Information about the physical effects of climate variables were obtained from long-term research at the U.S. Department of Agriculture, Agricultural Research Service's (ARS) High Plains Grasslands Research Station near Cheyenne. To use the full climate data used in the ARS research, we utilize a 35-year planning horizon.

## Results and Discussion

Results indicate that precipitation variation negatively impacts profitability of cattle enterprises with dry years having larger negative impacts than positive impacts associated with wet years. Models based on static weather tend to overestimate profitability when compared to models that include historical precipitation variation. Further, impacts on forage production have larger negative consequences for producers than the direct impacts on calf performance, suggesting that producers can better prepare for increasing variation in annual precipitation by focusing on better forage management responses than investing in herd genetics. Results suggest that optimal herd numbers will decrease by 9% with a 10% increase in precipitation variation and up to 60% with a 50% increase in pre-

[1]Department of Agricultural and Applied Economics; [2]USDA ARS High Plains Grasslands Research Station; [3]Department of Ecosystem Science and Management; [4]Department of Animal Science; [5]UW Extension.




| | Static Precip | Historical Variation | 10% Increase | 20% Increase | 30% Increase | 40% Increase | 50% Increase |
|---|---|---|---|---|---|---|---|
| Forage Production | 8,160 | 6,494 | 6,061 | 5,871 | 5,292 | 5,000 | 4,620 |
| Calf Gain | 8,160 | 6,003 | 5,903 | 5,777 | 6,319 | 6,196 | 6,028 |
| Combined | 8,160 | 4,275 | 4,185 | 4,024 | 3,789 | 3,491 | 3,134 |

Figure 1. Average discounted net returns from cattle when considering precipitation variation separate and combined impacts on forage production and calf gain.

cipitation variation. Also, the negative impacts to discounted net returns when both forage and animal are impacted by weather variation are much larger than either of the individual impacts (Figure 1).

**Acknowledgments:** This work is partially funded by a Wyoming Agricultural Experiment Station competitive grant.

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**Keywords:** climate change, cattle production, ranching economics

**PARP:** VI:1, VII:6, X:1

# Valuation of Residual Feed Intake as a Selection Tool for Northeastern Wyoming Range Sheep Producers

*M.K. Harlan[1], J. Ritten[1], B. Rashford[1], and K. Cammack[2]*

One way for sheep producers to increase profitability is to lower costs associated with feed consumption of their flocks. To reduce feed consumption, producers may use feed efficiency as a selection tool when making replacement decisions for breeding stock. A practical tool for range sheep producers may be the selection of replacement ewes based on their residual feed intake (RFI) value. RFI is the difference between actual feed intake and feed intake predicted for maintenance and production by linear regression. Using enterprise budgets, we examine how increases in a flock's feed efficiency impact a sheep producer's profits over time. There has been previous research on sheep RFI and the economics of feed efficiency; however, most of the previous data collected and analyzed have been on males or on sheep fed a concentrate diet. Our study focuses on RFI for females fed a forage-based diet, which may be more realistic for Wyoming producers.

## Objectives

The objective is to determine if selecting replacement ewes with a desirable RFI value is a profitable sheep production strategy for Wyoming range-flock producers.

## Materials and Methods

We developed range sheep production enterprise budgets to assess the ranch-level economic impacts of selecting for feed-efficient replacement breeding ewes. Using these budgets, we examine how increases in the flock's feed efficiency impacts a sheep producer's profits over time.

In the model, we assume producers select for, and replace, ewes with low RFI values over a seven-year transition period. This strategy simply adds RFI as an additional selection criterion at normal herd replacement rates. Selecting for RFI may allow producers the option of either: 1) using feed sources longer and using less additional feed to maintain their flocks, or 2) choosing to stock additional ewes on current available feed.

Three different flock sizes are modeled to determine differences in potential profit from using RFI as a selection trait. Flock sizes are broken into large (1,500 bred ewes), medium (500 bred ewes), and small (250 bred ewes). The different flock sizes were analyzed to gauge if selecting for RFI is more profitable for producers with different numbers of breeding stock.

The profitability of using RFI as a selection tool is analyzed using a Monte Carlo simulation. The simulation randomly chooses (over 10,000 iterations) input prices (e.g., hay) and output prices (e.g., lamb, cull ewe, and cull ram [Figure 1]) based on historical datasets to capture a wide range of economic situations. By utilizing this approach, results are valid over a range of net returns, rather than on a simple average of historical prices.

[1]Department of Agricultural and Applied Economics; [2]Department of Animal Science.

## Results and Discussion

Preliminary results suggest a minor benefit to producers by using RFI as a selection tool when making female replacement decisions. The benefit is due mainly to reduced costs in feed expenses over time, as a flock's total feed needs decline as more efficient ewes are introduced to the flock. The potential benefit is greater for producers with larger flocks.

Once results are finalized, the per-head benefit will be calculated for each flock size. The -head benefit represents the producer's maximum willingness to pay for a genetic test that could be used to identify low RFI ewes.

**Acknowledgments:** The authors acknowledge the Wyoming Agricultural Experiment Station Competitive Grants Program for funding, which enabled us to compile data for this study.

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**Keywords:** sheep production, feed efficiency, replacement ewes

**PARP:** V:1,7, VI:3, VII:6

# Improving Restoration of True Mountain Mahogany Habitat

*T. Crow*[1] *and K. Hufford*[1]

The distributions of many plant species span a large geographic range, and populations within those ranges are often adapted to local soils and climate conditions. Plants from southern latitudes, for example, may be better adapted to drought than plants of the same species from northern latitudes. Local adaptation represents a challenge in ecological restoration because little is known about the distance that native plant seeds can be transferred with reasonable assurance of planting success. Seed transfer zones represent one tool to determine regions where seed sources may be transferred with no negative effects on restoration outcomes. Few seed transfer zones, however, have been developed for target species because of the costly, long-term field monitoring required.

We are testing seed transfer zones for true mountain mahogany (*Cercocarpus montanus*), an important reclamation species in Wyoming and other Rocky Mountain states. This widespread shrub grows in rocky, shallow soils, is a key winter browse species for elk and mule deer, and hosts a nitrogen-fixing actinobacteria similar to a legume, which facilitates growth in nutrient-poor soils.

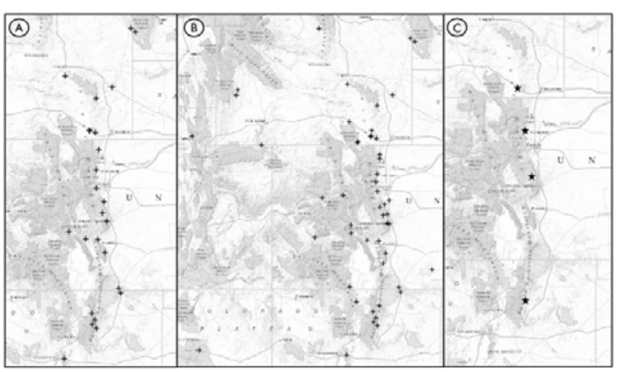

Figure 1. A) Seed collection, B) germplasm, and C) common garden locations.

## Objectives

Our objectives are to: 1) determine if populations of true mountain mahogany (also known as alderleaf mountain mahogany) are adapted to local environmental conditions, and 2) evaluate the effectiveness of three different methods for delineation of seed zones in this species: common garden, molecular markers, and distribution modeling.

## Materials and Methods

We collected seeds and leaf tissue of true mountain mahogany from Wyoming through New Mexico to represent a "latitudinal cline" and installed four common gardens in the field to test for local adaptation among populations (Figure 1). Common gardens enable researchers to measure heritable variation among different seed sources by growing plants from a wide geographic area in a common environment. We also sequenced molecular markers from all populations to measure genetic differentiation and diversity along the north–south transect.

## Results and Discussion

We found significant differences among populations of mountain mahogany in common garden studies, which suggests that seeds are more likely to germinate and survive in local environ-

[1]Department of Ecosystem Science and Management.

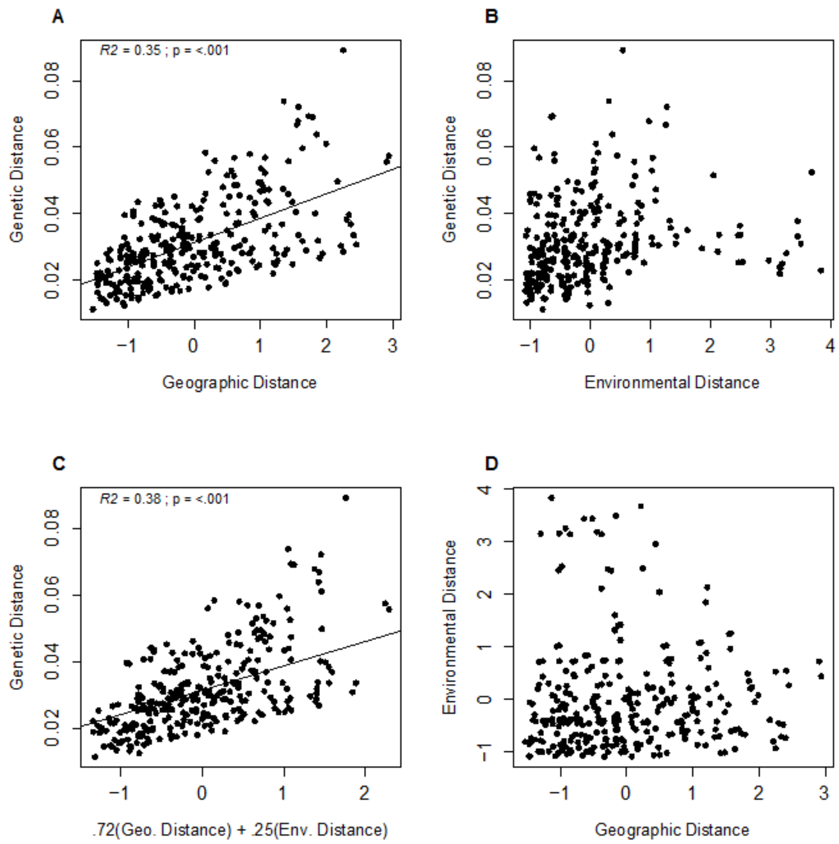


Figure 2. Relationship between geographic, environmental, and genetic distance metrics among populations of true mountain mahogany. The larger the environmental or genetic distance, the lower the similarity among populations.

mental conditions when compared to non-local sites. In addition, we discovered a strong correlation between genetic distance and geographic distance, suggesting that molecular markers may be an appropriate substitute for long-term field studies to develop seed transfer zones (Figure 2). We also found evidence of greater genetic diversity in northern populations, suggesting that the species' distribution in Wyoming may represent unique resources for reclamation and restoration.

Our results provide evidence of adaptation to local environments among populations of true mountain mahogany that warrant the delineation of seed zones. Overall, seeds were more likely to germinate and survive in local environmental conditions, and genetic distances reflected common garden results. Additional field testing and molecular marker analysis are underway. Our next step is to compare results for field and laboratory studies with data generated by species distribution models to map similar zones for environmental variables within the species' range. If the three methods are interchangeable, we can use molecular markers, distribution modeling, or both to create inexpensive seed transfer zones for understudied restoration target species.

**Acknowledgments:** We thank C. Alex Buerkle, Liz Mandeville, Cody Starosta, Mary Poelman, Jeff Brasher, and Andy MacClugage for field and laboratory assistance. This research is funded with generous support from the U.S. Department of Agriculture's Agriculture and Food Research Initiative and Boulder County (Colorado) Parks & Open Space.

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**Keywords:** true mountain mahogany, ecological restoration, seed zones

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

## Appendix

# Wyoming Production Agriculture Research Priorities (PARP)

[version 3/12/14]

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.

III. Weed Control Objectives

1) Develop control methods for weeds resistant to Roundup® or other herbicides.

*Continued on next page*

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.
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.

*Continued on next page*

### 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.

### 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.*

# INDEX

**Notes:**