UNIVERSITY OF WYOMING
College of Agriculture and Natural Resources

AGRICULTURAL EXPERIMENT STATION

2011 Field Days Bulletin

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

B.W. Hess[1]

[1]Director, Wyoming Agricultural Experiment Station.

Project funded by the Wyoming Agricultural Experiment Station.

Introduction

Since its beginning in 1891, the Wyoming Agricultural Experiment Station (WAES) has conducted applied and basic research to help solve problems that affect the agricultural sector of our state, region, and nation. Advances in agricultural science certainly will not lead to development of new technologies or farming practices without transfer of research-based knowledge to society. Thus, WAES has recognized the value of disseminating science-based information to its stakeholders.

WAES operates four branch stations within the state that are known as Research and Extension centers (R&E centers). R&E centers are located in Laramie, near Lingle (James C. Hageman Sustainable Agriculture R&E Center, or SAREC), near Powell, and near Sheridan. The R&E centers were placed in these locations to conduct research and educational programs that are connected to agriculture in their vicinity, albeit many of the projects are applicable throughout the state and beyond. The R&E centers host annual field days to provide the public with an update on the centers' activities and to discuss research projects at various stages of completion.

Objectives

The goal of the WAES Field Days Bulletin is to document and make publicly available the content of research and other activities being conducted at the R&E centers. A major objective is to document results of R&E center activities in a standardized, simple format that is reader-friendly.

Development of Field Days Bulletin Guidelines

WAES hosts an annual planning conference to discuss progress and coordinate activities for the upcoming year. The conference is organized by WAES and is attended by personnel from each of the R&E centers as well as personnel from the University of Wyoming campus. R&E center directors, in consultation with others from on and off campus, plan for the coming season and discuss ideas on how to improve communication of our activities to our colleagues and the general public. Among other items, better documentation of R&E center activities at each field day was suggested during the 2011 planning conference. Thus, R&E center directors along with the Laramie R&E Center's Research Greenhouse Complex manager were assigned the task of developing guidelines for the WAES Field Days Bulletin. The individuals charged with developing bulletin guidelines have since become the bulletin's Editorial and Review Board.

Results and Discussion

Members of the WAES Field Days Bulletin Editorial and Review Board have been undyingly devoted to producing a practical, high-quality publication. In addition to reviewing every single report submitted for its content, relevance, and formatting, each of these individuals contributed an introduction to their R&E center. All bulletin reports then underwent an additional editorial review before the bulletin was published. This process helped maintain consistency among the various reports. The end result has been the creation of a field days bulletin that is reader-friendly while also reflecting the high standards expected from an institution of higher education.

This edition of the field days bulletin is organized with reports from scientists conducting projects at Powell, the Sheridan R&E Center, SAREC, and Laramie. Arrangement of reports in this manner reflects the order in which field days were scheduled, and although a field day was not scheduled for the Sheridan R&E Center, reports of their projects were placed second to separate the centers into regions of north and south.

In conclusion, the first edition of the field days bulletin is an example of the WAES's commitment to documenting discoveries made as a result of agricultural research conducted by scientists using WAES resources. Reports within this bulletin illustrate the diversity and breadth of the research portfolio at the R&E centers. WAES wishes to continue its commitment to making new discoveries and researching problems relevant to agriculture in Wyoming with the goal of helping guarantee the sustainability of agricultural systems in our state. Transferring knowledge generated by conducting research at the R&E centers is the initial step toward achieving this goal. Therefore, WAES is proud to present the inaugural edition of the field days bulletin.

Acknowledgments

Thank you to all of the authors for their contributions to the first edition of the bulletin. Thanks also to Kathleen Bertoncelj for all of her efforts to ensure the bulletin was ready for distribution at the field days. The Editorial and Review Board deserves accolades for making the bulletin become a reality. Special thanks to the bulletin editor, Robert Waggener.

Contact Information

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2011 Powell Research and Extension Center Field Day

A. Garcia y Garcia[1]

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Introduction

The Powell Research and Extension Center (PREC) lies one mile north of Powell on Highway 25 (latitude 44.776, longitude 108.766) at an elevation of 4,374 feet. The 30-year average annual precipitation is 6.67 inches. May and June are the only two months that exceed 1 inch in average monthly precipitation. Employees at PREC include faculty members, a research scientist, an assistant research scientist, a research associate, a research assistant, a farm manager, and an operation staff supporting studies conducted at the center. PREC personnel conduct research and provide services to benefit the northwestern Wyoming counties of Fremont, Hot Springs, Washakie, Big Horn, and Park, and other areas of Wyoming and beyond. Two hundred of the 220 acres at the PREC are irrigated cropland. Research foci include agronomic weed control, irrigation, cropping systems, high tunnel production system, variety performance testing, transgenic variety response to herbicide treatments, and alternative crops. The center participates in numerous regional research and education projects.

Background Information

The 2010 growing season was characterized as dry, with a total rainfall of 4.2 inches, and with a freeze-free period of 118 days (from 5-24 to 9-18). The wettest months were May (1.06 inches), June (0.75 inches), and August (0.85 inches); July, with 0.28 inches of rainfall, was dry (**Figure 1**).

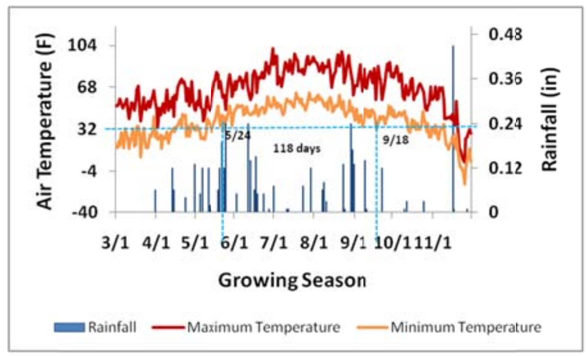

Figure 1. Weather conditions at PREC during the 2010 growing season.

Regarding the 2011 growing season, the spring weather was wet and cold, especially May. Soggy soil conditions challenged planting due to the above-normal rainfall received during April and May. Dry conditions returned in June (**Figure 2**).

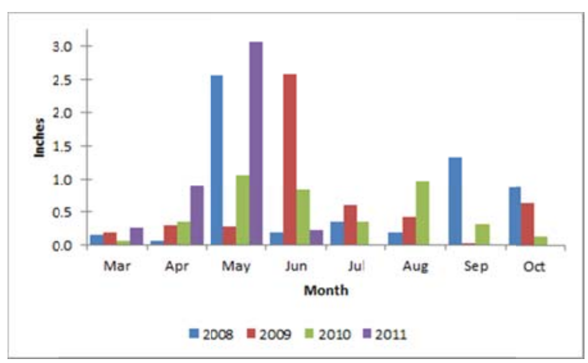

Figure 2. Comparison of the monthly rainfall recorded at PREC during the actual and the last three years.

Facility Improvements and Acquisitions

Improvements at PREC during 2010 included three high tunnels of three different shapes (**Figure 3**) constructed with grant funds from the Wyoming Department of Agriculture; a building to process foundation seed (**Figure 4**) constructed with grant funds from the Wyoming Agricultural Experiment Station (WAES) and the Wyoming Foundation Seed Program; and a sub-surface drip irrigation system (**Figure 5**), constructed with the support of the Department of Plant Sciences and the WAES.

Figure 4. Inside and outside views of the foundation seed building at PREC.

Acknowledgments

The dedication and effort of the PREC team is recognized.

Contact Information

For additional information, contact Axel Garcia y Garcia at 307-754-2223 or axel.garcia@uwyo.edu.

Figure 5. Sub-surface drip irrigation installation at PREC.

Figure 3. High tunnels installed at PREC in 2010.

Corn Response to Water Stress

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Project funded by AgroFresh Inc. and Dow Chemical Co.

Introduction

Water shortages are an important issue in agricultural production. Strategies for an efficient use of irrigation water, such as the ability of plants to overcome short periods of water stress, are in need of additional research.

Objectives

The goals of this project are to study corn response to short periods of water stress and to assess simple and reliable methods to determine the onset of the stress.

Figure 1. Deployment of infrared (IR) thermometers in the experiment conducted at the USDA-ARS research center in Maricopa, Arizona.

Materials and Methods

The experiment is being conducted at the Powell Research and Extension Center (PREC). Corn planted under a lateral move sprinkler irrigation system and under sub-surface drip irrigation will be used for the evaluation. To determine the impact of different environments, a similar study is being conducted at the U.S. Department of Agriculture-Agricultural Research Service (USDS-ARS) center in Maricopa, Arizona (**Figure 1**). Researchers from Washington State University provide modeling support to both sites.

At PREC, weather conditions will be monitored using a dedicated automated weather station deployed in the field. Soil moisture will be monitored using a neutron probe. Infrared thermometry will be used to monitor canopy temperature. Growth will be measured in the field using a photosynthesis analyzer.

Acknowledgments

Thanks to Mike Killen and his crew as well as Randy Violett, Joan Tromble, and our summer helpers at PREC for their support with this study.

Contact Information

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Effect of Different Irrigation Regimes on Growth, Development, and Yield of Sweet Corn

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Project funded by the Department of Plant Sciences.

Introduction

Sweet corn is one of the most important horticultural crops in in the U.S. and one of the few crops produced in all 50 states (Lucier and Jerardo, 2007). Normally, it is planted over an extended planting window period to provide a continuous supply for the fresh market; however, this planting window exposes the crop to various stresses and weather risks (Garcia y Garcia et al., 2009a).

Sweet corn is an attractive alternative income source to small producers in Wyoming and may be an option to entrepreneurs to diversify farming operations. It's well known that plant growth, development, and yield are influenced by weather conditions (Garcia y Garcia et al., 2009b); however, there is no known information related to sweet corn performance in Wyoming. Therefore, a study to determine the impact of environmental conditions on growth and water use of sweet corn was initiated in 2010 at the Powell Research and Extension Center (PREC).

Objectives

The main goal of this experiment is to determine the impact of different irrigation regimes on growth, development, and yield of sweet corn.

Materials and Methods

Three yellow type sweet corn hybrids, which correspond to three different maturity groups, were planted June 3, 2010, and May 16, 2011, under sub-surface drip irrigation at PREC. In 2010, the irrigation treatments consisted of four levels of soil water depletion (70, 60, 50, and 40 percent). In 2011, the irrigation treatments included full irrigated and irrigated at 40, 50, and 70 percent of full irrigated.

Results and Discussion

Preliminary results from 2010 showed that the higher the soil water depletion, the lower the yield. Sweet corn performed better at 40 percent (T1) than at 70 percent (T4) depletion of the available soil water (**Figure 1**).

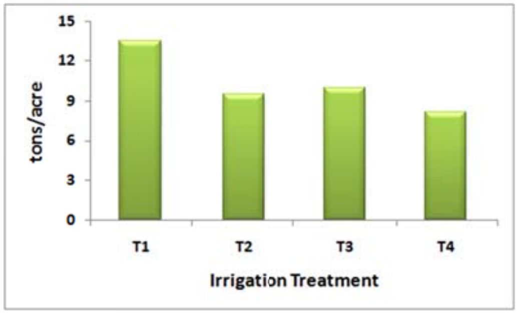

Figure 1. Yield response of sweet corn (Zeneca Horizon, 65 days to maturity) to different irrigation regimes during the 2010 growing season at PREC.

Similarly, the water use efficiency (WUE) of the sweet corn variety grown with a regime of 40 percent depletion of available water was slightly higher than the WUE estimated for the other treatments (**Figure 2**). It's worth mentioning that the WUE here presented corresponds to the ratio of growth (CO_2) to transpiration.

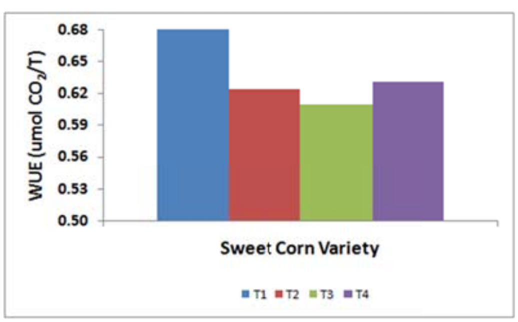

Figure 2. Water use efficiency of sweet corn (Zeneca Horizon, 65 days to maturity) grown under different irrigation regimes during the 2010 growing season at PREC.

Preliminary results are encouraging since we observed that sweet corn can be successfully planted in some areas of Wyoming if irrigation is triggered when 40 percent of soil available water is depleted.

Further analyses include total water use and WUE as related to marketable yield.

References

Garcia y Garcia, A., L.C. Guerra, and G. Hoogenboom. 2009a. Impact of planting date and hybrid on early growth of sweet corn. Agron. J., 101:193-200.

Garcia y Garcia, A., L.C. Guerra, and G. Hoogenboom. 2009b. Water use and water use efficiency of sweet corn under different weather conditions and soil moisture regimes. Agric. Water Manage., 96:1369-1376.

Lucier, G. and A. Jerardo. 2007. Vegetables and Melons Outlook. VGS-320, 1-49. USDA-ERS. 4-19-2007.

Acknowledgments

Thanks to Joan Tromble, Brad May, and Keith Schaefer for their field support with this study.

Contact Information

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Impact of the Spatial Variability of Soil Characteristics on Yield and Water Use of Crops Grown Under Different Cropping Systems

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Project funded by the Big Horn and Wind River Basin Applied Research Fund.

Introduction

A sustainable irrigation practice requires proper irrigation water management. In turn, proper irrigation water management is a function of several factors, including cropping system, crop type, soils characteristics, and weather information. The amount of water and time of application are keys for the success of crops under irrigation. This is possible if precise information on soil characteristics, weather conditions, and appropriate devices to monitor soil moisture are available.

Objectives

The goals of this study are to determine how different cropping systems affect yield and use irrigation water. Specific objectives are: a) to determine spatial relations of water use and yield and b) to evaluate the performance of soil moisture devices.

Materials and Methods

The experiment is being conducted at the Powell Research and Extension Center (PREC) and was initiated during the 2010 growing season. A 50-acre field planted with barley and sugar beets was irrigated with a lateral move sprinkler system. A detailed soil sampling was conducted, and results were spatially analyzed. Final yield of both crops was obtained at different locations in the field for spatial analysis. For 2011, sugar beets were planted under four cropping systems: till, no till, strip till, and disk ripper in a 13-acre portion of the field that was planted in 2010. Irrigation treatments of full irrigated, 70 percent of full irrigated, and 50 percent of full irrigated were superimposed to each cropping system. The irrigation amounts are calculated using the FAO56 (Allen et al., 1998) procedure for water balance. Soil moisture is monitored at different depths on a weekly basis using previously calibrated probes.

Results and Discussion

Our results from the 2010 growing season show that soil texture was even at 6 inches deep but highly variable beyond that depth (**Figure 1**). This may impact irrigation water management since texture is tightly related to the soil's water holding capacity. The assessment of the moisture probes showed that TDRs performed better than PR2s when compared to neutron probe readings (**Figure 2**), evidencing the need for a calibration before their use. Sugar beet yielded as high as 32 tons/acre and as low as 18 tons/acre (**Figure 3**), and barley yielded as high as 123 bushels/acre and as low as 99 bushels/acre (data not shown). Further analysis will help determining the relation of those yields to soil characteristics such as texture and moisture content.

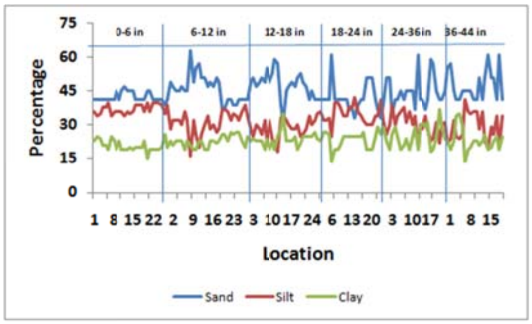

Figure 1. Texture variation at the 50-acre field.

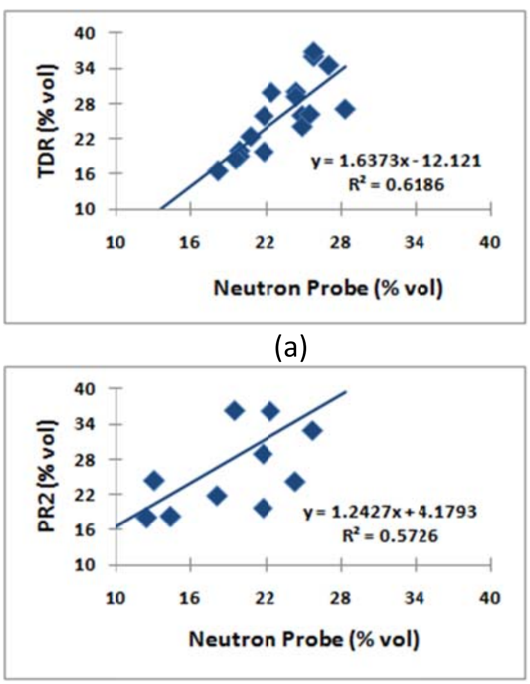

Figure 2. Calibration of a) TDR and b) PR2 moisture probes.

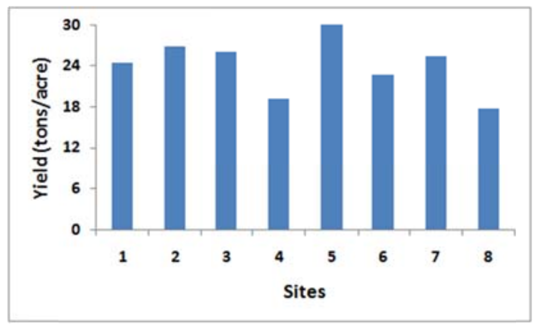

Figure 3. Variation on sugar beet at the experimental field.

References

Allen, R.G., L.S. Pereira, D. Raes, M. Smith. 1998. Crop evapotranspiration: Guidelines for computing crop water requirements. FAO Irrigation and Drainage Paper 56.

Acknowledgments

Thanks to Joan Tromble, Brad May, and Keith Schaefer for their field support with this research.

Contact Information

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Response of Sunflower to Different Levels of Drought Stress

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[2] Research Associate, PREC; [3] Farm Manager, PREC.

Project funded by the Department of Plant Sciences.

Introduction

Sunflower plants can grow well in a wide range of soils and climates, can produce acceptable yield, and respond well to irrigation water. Sunflower is one of the world's largest oilseed crops and is also grown for human and animal food. Its versatility makes commercial production an attractive alternative income source to Wyoming growers and gives them a chance to further diversify farming operations.

Sunflowers are drought and heat tolerant plants that are well adapted to many areas of Wyoming. These characteristics make sunflower an attractive crop for some growers in the state. Although sunflower production in the state has been increasing during recent years, little research has been conducted regarding the crop's performance for the state's conditions.

Objectives

The main goal of this experiment is to study sunflower's response to drought.

Materials and Methods

A sunflower variety has been under test since 2010 in a surface irrigated field at the Powell Research and Extension Center (PREC). The crop is being submitted to water stress at different growth stages, including full irrigated (FI), start irrigation when a miniature floral head is visible (R1), start irrigation when the flowers start to open (R4), and rainfed (RF). Irrigation is applied as usually scheduled by area farmers.

Detailed information on soil moisture characteristics, such as field capacity and wilting point, as well as texture, were obtained at the beginning of the 2010 growing season. Photosynthesis is monitored at the different irrigation treatments. Soil moisture is monitored at different depths on a weekly basis using a neutron probe. Plant growth and development information, including samples for dry matter, leaf area index, and canopy height, are being recorded and observed regularly.

Results and Discussion

Preliminary results from the 2010 growing season showed no yield differences between the full irrigated and the R1 and the R4 irrigation treatments; the rainfed treatment, however, produced approximately 40 percent less than the irrigated treatments (**Figure 1**).

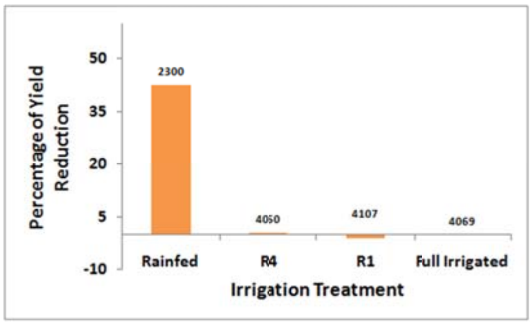

Figure 1. Effect of drought on yield of sunflower planted at the PREC in 2010.

Canopy height, a characteristic directly related to sunflower's water stress, was slightly higher for the full irrigated treatment; however, no differences were observed between treatments (**Figure 2**).

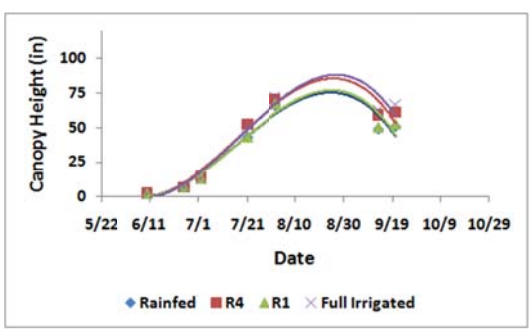

Figure 2. Effect of drought stress on canopy height of sunflower planted at PREC in 2010.

Photosynthesis of sunflower from all three irrigation treatments followed a similar tendency while the sunflower grown under rainfed conditions showed a persistent photosynthesis decline evidencing the severity of drought on growth (**Figure 3**).

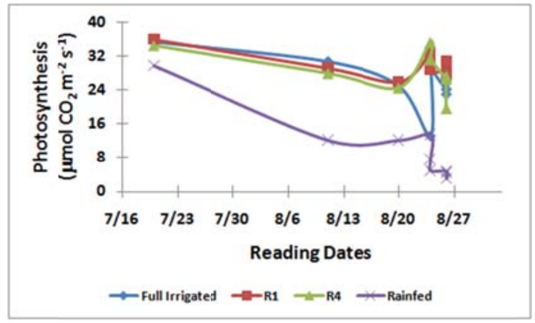

Figure 3. Effect of drought on photosynthesis of sunflower planted at PREC in 2010.

Preliminary results show that irrigation is necessary to grow a successful sunflower crop in the Bighorn Basin; however, irrigation may not be strictly necessary during the first weeks of the growing season. As a result, producers may be able to save one to two irrigation applications with a direct benefit on their income.

Acknowledgments

Thanks to Joan Tromble, Brad May, and Keith Schaefer for their field support with this study.

Contact Information

For additional information, contact the principal investigator, Axel Garcia y Garcia, at 307-754-2223 or axel.garcia@uwyo.edu.

Toward the Recommendation of Scientifically-Based Irrigation Scheduling Strategies in Wyoming: A Case Study for Forage Alfalfa Crop Production

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Project funded by the Agricultural Experiment Station Competitive Grants Program (WYO-462-11).

Introduction

Alfalfa, the number one cash generating crop in Wyoming, is produced under both irrigated and rainfed conditions with higher yield in irrigated lands compared to dryland. Over the years, irrigation practices of alfalfa for hay have changed little in Wyoming even though yield has increased. The increase may be primarily due to plant breeding but could also be management practices. Therefore, understanding alfalfa plant response to water and use efficiency is essential to identify possibilities of yield increases through proper on-farm irrigation water management.

Objectives

The main goal of this project is to determine the impact of irrigation water on alfalfa growth, development, and yield. Specific objectives are to 1) *s*tudy the physiological response of alfalfa to water stress and 2) determine water use and water use efficiency (WUE) of alfalfa for conditions in Wyoming.

Materials and Methods

The study started during the 2011 growing season. Three alfalfa varieties were planted under subsurface drip irrigation (SDI) on June 7. Irrigation treatments for each of the varieties are full irrigated and 75, 50, and 25 percent of full irrigated.

Variables to be measured include water use and use efficiency, growth, and soil moisture. Soil moisture is being monitored weekly using water marks that transmit data to a data logger via radio communication devices (**Figure 1**).

Environmental conditions are monitored using an automated station as part of the Wyoming Agricultural Weather Network [www.WAWN.net] system near the experimental area.

Results and Discussion

Plant growth and development information, including samples for dry matter, leaf area index, and canopy height, will be recorded and observed regularly for growth analysis.

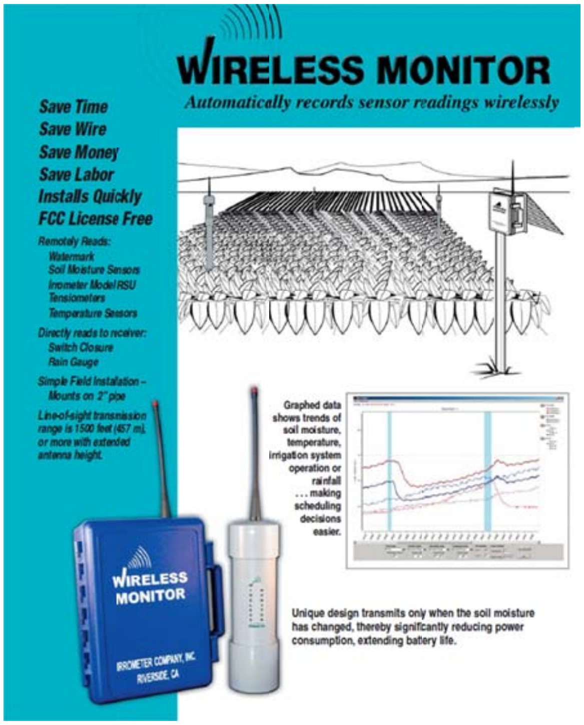

Figure 1. System to be used to monitor soil moisture at the experimental field.

Acknowledgments

Thanks to Mike Killen and his crew as well as Randy Violett, Kyrre Stroh, and Joan Tromble for their support with this study.

Contact Information

For additional information, contact the principal investigator, Axel Garcia y Garcia, at 307-754-2223 or axel.garcia@uwyo.edu.

Vegetable Crop Production and Variety Selection Inside and Outside High Tunnels: Research, Demonstration, Education, and Training

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Project funded by the Wyoming Department of Agriculture.

Introduction

Demand for locally grown fresh vegetables is increasing, and the quality of those products is taking on greater significance. Many urban and small-acre owners would like to take advantage of this situation, but the short, cool growing season that characterizes the state makes it difficult to overcome these obstacles and make vegetable production more profitable. Knowledge about "what to grow" and "how to grow it" needs to be further developed.

Objectives

The objectives of this study are to evaluate and compare yield and quality of several vegetable crops fertilized with organic and inorganic fertilizers grown inside and outside high tunnels.

Materials and Methods

Vegetable crops are being planted during three growing seasons each year in three high tunnels of three different shapes (**Figure 1**) at the Powell Research and Extension Center (PREC). The seasons include early greens (mid-March through the beginning of May); main crop (mid-May through mid-August both inside and outside the high tunnels); and late greens (end of August through November). The crops are under drip irrigation.

Figure 1. View of the high tunnels at PREC.

Data including plant height, date of maturity, date of harvest, fresh and dry weights, and harvest yield are being collected. Soil temperature, light intensity, and humidity are monitored inside the high tunnels with HOBO® sensors, and soil moisture is monitored using tensiometers (**Figure 2**).

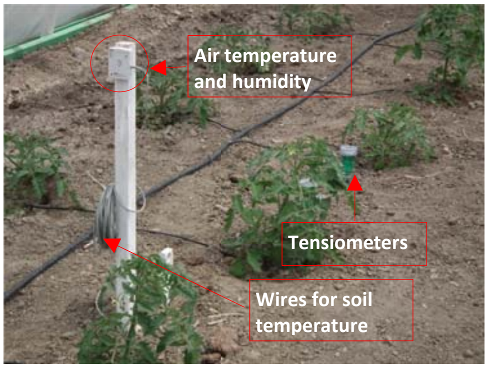


Figure 2. Environmental conditions and soil moisture are monitored in the high tunnels.

Two workshops each year will be organized to show the crops, train people interested in high tunnel production systems, and discuss high tunnel production systems.

Results and Discussion

The early greens were planted on March 23 and harvested May 13, 2011. The season was cold (**Figure 3**) with an average maximum temperature of 54^{o}F and an average minimum temperature of 32^{o}F.

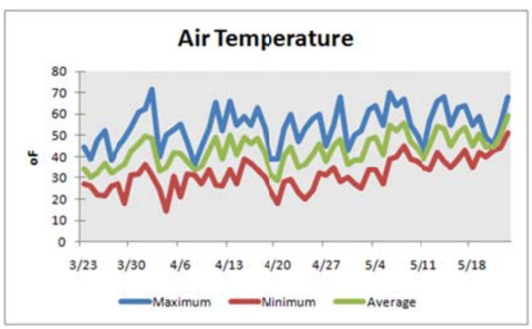
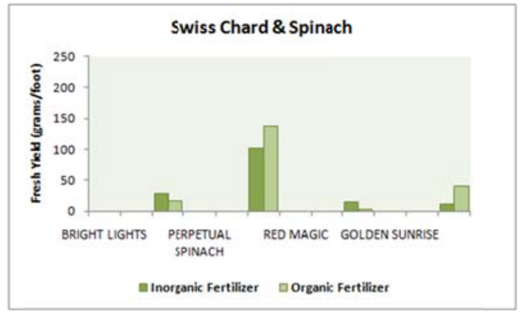
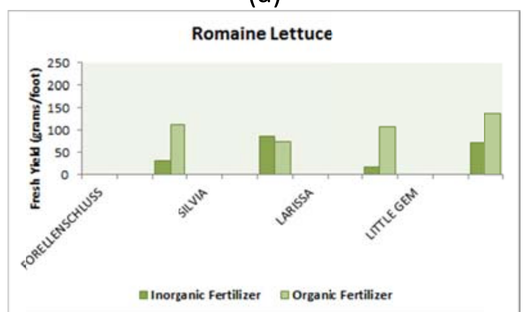


Figure 3. Outside air temperature during the early greens growing season of 2011.

Preliminary results showed a slightly better performance of the greens produced with organic fertilizer (**Figure 4**) at all three high tunnels. Those differences may be due to soil moisture and/or soil temperature in the inorganic and organic plots. Soil moisture was not monitored; the soil temperature data is being analyzed. The main crop was planted mid-May; both soil moisture and soil temperature are being monitored. This is the first of three years of study.



(a)



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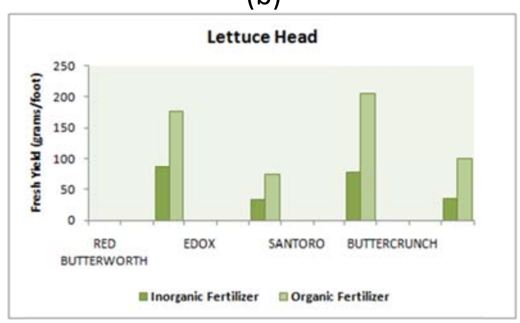

(c)

Figure 4. Performance of early greens grown inside high tunnels.

Contact Information

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Wyoming Agricultural Weather Network (www.WAWN.net)

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Project funded by the Washakie County Conservation District and supported by the Wyoming Sugar Company LLC and the Heart Mountain Irrigation District.

Introduction

Weather is typically the most important factor affecting agricultural production. Weather information is a key component for research and an important input in decision making of the ag and natural resources sectors. Decisions such as irrigation, pest and disease control, and land use and management, among others, should not be made without analysis of weather information. To support those decision making activities, the Powell Research and Extension Center (PREC) initiated the **W**yoming **A**gricultural **W**eather **N**etwork (www.WAWN.net) in 2010.

Objectives

The objective of the WAWN is to monitor weather conditions for agricultural and environmental applications in Wyoming.

Materials and Methods

The WAWN uses data collected from automated weather stations (AWS) at the PREC, Sheridan Research and Extension Center, Heart Mountain Irrigation District in Powell, and Wyoming Sugar Company LLC in Worland (**Figure 1**). All four AWSs are integrated in a unique Web-based platform at PREC.

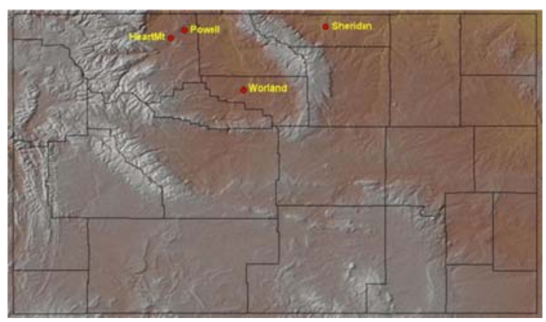


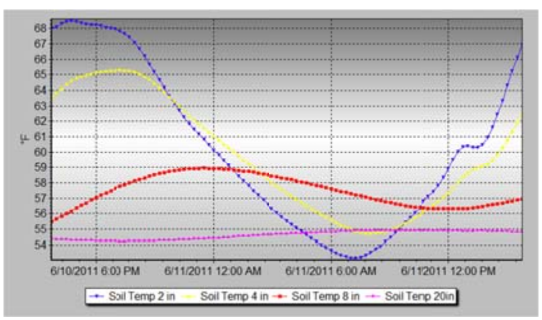
Figure 1. Locations of the automated weather stations that are part of the WAWN.

The AWSs in Powell and Sheridan were purchased by the University of Wyoming while the AWS at Worland was purchased with funds provided by the Washakie County Conservation District and the support of several associations led by the Wyoming Sugar Company LLC.

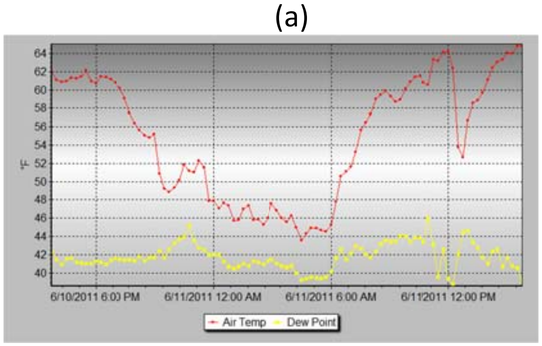
Results and Discussion

The configuration of the AWS system includes a data logger, weather monitoring sensors, a battery and solar panel, tripod, and a communication device. The weather variables recorded include solar radiation, air temperature, rainfall, relative humidity, wind speed and direction, barometric pressure, soil moisture, and soil temperature; some examples are provided on **Figure 2**. The information is recorded every 15 and 60 minutes and 24 hours (daily data).

The system also provides a table summarizing conditions during the last seven days as well as graphs of conditions during the last 30 days. Important information for the decision making process, such as reference evapotranspiration (ET_o) and rainfall, is also provided (**Figure 3**).

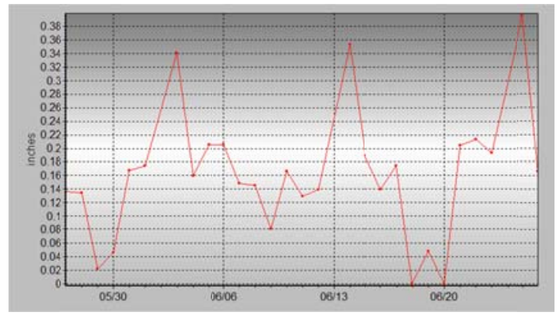


(a)

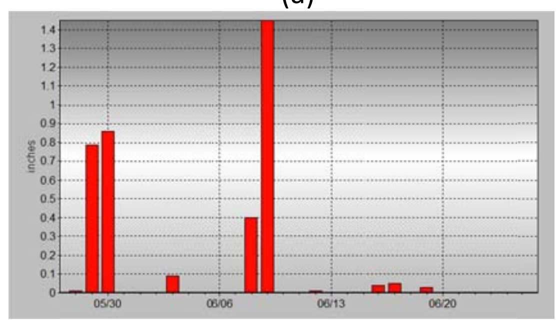


(b)

Figure 2. Data from the AWS located in Worland showing: a) soil temperature at different depths, and b) air temperature and dew point.



(a)



(b)

Figure 3. Data from the AWS located in Worland showing: a) reference evapotranspiration, and b) rainfall that occurred during the last 30 days.

Acknowledgments

Thanks to Joan Tromble for her support with this project.

Contact Information

For additional information, contact Axel Garcia y Garcia at 307-754-2223 or axel.garcia@uwyo.edu.

Effect of Phosphorus on Established and Newly Established Sainfoin

M.A. Islam[1], R.P. Belden[2], M.J. Killen[3], R. Violett[4]

[1]Assistant Professor and Forage Specialist, Department of Plant Sciences; [2]Manager, Laramie Research and Extension Center Greenhouse and Soil Testing Laboratory; [3]Farm Manager, Powell Research and Extension Center (PREC); [4]Research Associate, PREC.

Project funded by Department of Plant Sciences funds and allocation.

Introduction

Sainfoin (*Onobrychis viciifolia* Scop.), an introduced perennial forage legume, can be considered for use as a good alternative to alfalfa. Sainfoin is well adapted to calcareous soils (i.e., high calcium and pH) with low phosphorus. It has excellent drought tolerance and very good cold hardiness but poor tolerance to poor drainage and high acidic soils. It is very comparable with alfalfa, especially for quality and animal performance; however, hay yield may be slightly lower than alfalfa. Some important advantages with sainfoin are that it does not cause "bloat" problems in cattle and has no or little insect pests. Although sainfoin seems to perform well in low phosphorus soils, anecdotal evidence suggests that sainfoin may positively respond to high phosphorus.

Objectives

The objectives of this study are to determine appropriate dose response of sainfoin to added phosphorus and to establish management strategies.

Materials and Methods

Sainfoin, cultivar 'Shoshone', was established in 2007 at the Powell Research and Extension Center (PREC). Five phosphorus levels (0, 20, 40, 60, and 80 pounds P_2O_5/acre) were applied on May 6, 2009, with four replications. The same phosphorus treatments were also applied on newly established (2009) sainfoin plots. Different growth data, especially forage yield and quality, are being recorded.

Results and Discussion

No significant differences were observed among treatments for forage yield in 2007-planted sainfoin; however, numerically the highest yield was obtained in 2009-planted sainfoin with phosphorus treatment of 60 pounds P_20_5 (**Table 1**). Likewise, no differences were observed in forage quality (data not shown). Old sainfoin stands and surface application of phosphorus may have contributed to this non-significant result.

In 2011, a new stand of sainfoin was established, and phosphorus treatments will be incorporated into the established plots. It is expected that the study will provide significant responses of phosphorus applications in the next year's data set.

Acknowledgments

PREC field crews for their assistance in plot establishment and harvesting.

Contact Information

For additional information, contact the principal investigator, Anowar Islam, at 307-766-4151 or mislam@uwyo.edu.

Table 1. Sainfoin dry matter (DM) yields (in tons) as influenced by different phosphorus treatments at PREC in 2009 and 2010.

Treatment	DM Yield (tons/acre): sainfoin planted in 2007*						DM Yield (tons/acre): sainfoin planted in 2009#		
(pounds/acre)	2009			2010			2010		
	1st cut	2nd cut	Total	1st cut	2nd cut	Total	1st cut	2nd cut	Total
0 P_2O_5	3.3	2.5	5.8	1.3	1.4	2.7	2.3	2.4	4.7
20 P_2O_5	3.6	2.7	6.3	1.6	1.6	3.2	2.0	2.3	4.3
40 P_2O_5	3.3	2.3	5.5	1.3	1.2	2.5	2.1	2.3	4.4
60 P_2O_5	3.5	2.5	6.0	1.4	1.6	3.0	2.4	2.6	5.0
80 P_2O_5	3.5	2.3	5.8	1.5	1.6	3.1	2.1	2.4	4.5

*Harvesting dates: 1st cut = 6/23/2009, 2nd cut 8/31/2009; 1st cut = 6/22/2010, 2nd cut 8/10/2010

#Harvesting dates: 1st cut = 6/22/2010, 2nd cut 8/10/2010

Forage Yield and Seed Yield Potential of Novel Tall Fescue Under Irrigated Conditions in the Bighorn Basin of Wyoming

M.A. Islam[1], R. Violett[2]

[1]Assistant Professor and Forage Specialist, Department of Plant Sciences; [2]Research Associate, Powell Research and Extension Center.

Project funded by the Wyoming Crop Improvement Association (WCIA).

Introduction

Grass pastures are essential components of western U.S. agriculture, especially on cattle ranches of the Intermountain region. Unfortunately, the yield and quality of these grasslands are low and have declined over time, which has been further accelerated by soil degradation. Introduction of a novel (highly productive, palatable, and nutritious that does not cause toxicity problems to animals), drought tolerant, and winter hardy tall fescue system in these grass pastures may have potential to increase productivity, quality, sustainability, and profitability.

Tall fescue is one of the most productive cool-season grass species in the U.S. that can grow on a wide range of soils, has high drought and winter hardiness, and can be used for pasture, hay, stockpiling, silage, soil conservation, and turf grass. Due to prolific seed production ability, tall fescue will be a potential resource in producing seed in areas of northwest Wyoming.

Objectives

The main objective of this project is to identify novel tall fescue cultivars/lines that will be suitable for growing in the western mountain regions, specifically in Bighorn Basin areas, and generate information on growth, forage yield, and seed yield that will benefit not only local growers but also growers throughout Wyoming and perhaps beyond.

Materials and Methods

The study was started in early May 2009 at two locations: Powell Research and Extension Center (PREC) and the Stroh farm near Powell. The study consisted of two separate experiments: seed production and forage production. Standard seeding rates were used for both studies (8 pounds PLS [pure live seed]/acre for seed production and 20 pounds PLS/acre for forage production). In the seed production study, seven varieties/lines of tall fescue were planted as primary treatment in 22-inch rows with four replications. In addition, two treatments, namely three nitrogen (N) levels (0, 100, and 150 pounds N/acre) and three clipping times (none, early, and late), were imposed on top of these varieties/lines. In the forage production study, similar treatments followed on seven varieties/lines except that there was no clipping treatment, and the N levels were 0, 50, and 100 pounds N/acre. In 2010, N was applied in two splits: one in the early-growth and the second in the late-growth stage after the first cut for both studies. For forage yield, plots were mechanically harvested twice in 2010: June 28 and October 1 at PREC and June 30 and October 7 at the Stroh farm using a forage harvester. Plots for seed production in both locations were swathed and thrashed in 2010, respectively: July 21 and August 4 at PREC and July 27 and August 5 at the Stroh farm.

Results and Discussion

For all cultivars/lines, the lowest forage dry matter (DM) yield was associated with the control treatment (no N) while significant DM yield increase (2-3 folds) was obtained from the 50- and 100 -pound N/acre treatment (**Table 1**). A similar trend was also observed for the seed production study in both locations; however, clipping time had significant effect on seed yield for all cultivars/lines. The late clipping treatment consistently produced the lowest seed yield compared to no or early clipping, while early clipping seemed to produce the greatest seed yield. The highest yield was 603 pounds/acre from Cowgirl (150 pound N/acre) followed by 459 pounds/acre from PDF 584 (150 pound N/acre) at PREC (full data set not presented). Data will be collected in 2011, and reporting of expected outcomes will be ongoing.

Acknowledgments

The study is funded by the WCIA. We acknowledge Associate Professor Malay Saha with The Samuel Roberts Noble Foundation; and plant geneticist Blair Waldron and agronomist Rob Smith, Agricultural Research Service in Utah, for providing seeds of tall fescue cultivars/lines.

Contact Information

For additional information, contact the principal investigator, Anowar Islam, at 307-766-4151 or mislam@uwyo.edu.

Table 1. Effect of N on forage DM yield [pound/acre] of tall fescue cultivar/line under irrigation at PREC/Stroh farm in 2010.

		PREC			Stroh farm		
Tall fescue cultivar/line	N lb /acre	1st cut 6/28	2nd cut 10/1	Total	1st cut 6/30	2nd cut 10/7	Total
97TF1 584	0	1688	1246	2934	871	798	1669
	50	3240	4420	7660	1171	1816	2987
	100	3550	5079	8629	1916	2959	4875
Cowgirl	0	1795	1123	2918	667	694	1361
	50	2566	2978	5544	653	1638	2291
	100	3080	4643	7722	1617	3300	4916
Fawn	0	1722	1037	2758	810	585	1395
	50	2784	3651	6435	878	1824	2702
	100	3177	4338	7515	1520	2726	4246
KY 31	0	1988	1169	3157	582	666	1248
	50	3817	5361	9178	1028	1472	2499
	100	3948	6730	10678	2106	2560	4665
Maximize	0	1625	1023	2648	774	720	1494
	50	2478	2910	5389	1049	1681	2730
	100	2294	3711	6005	1659	2881	4541
PDF 584	0	1470	1228	2697	810	724	1534
	50	2042	3724	5766	1013	1782	2795
	100	2687	4243	6930	2105	2935	5041
Soft	0	1625	1387	3012	760	798	1558
	50	2241	3833	6074	1099	2072	3171
	100	2415	5297	7713	1738	2758	4495
Avg SD*		575	776	1137	271	554	743

*Average standard deviation

2010 Spring Barley Variety Performance Evaluation

M.J. Killen[1], R. Violett[2]

[1]Farm Manager, Powell Research and Extension Center (PREC); [2]Research Associate, PREC.

Introduction

The variety performance evaluations conducted by the Wyoming Agricultural Experiment Station are a continuous and ongoing program. In cooperation with the Western Spring Barley Nursery and private seed companies, a wide range of germplasm is evaluated each year.

Materials and Methods

The experimental design of all trials was three replications of a randomized complete block. Measurements included heading date, height, lodging, grain yield, test weight, and kernel plumpness. Data were analyzed using SAS® procedures for analysis of variance. The experiment was located at the Powell Research and Extension Center (PREC) during 2010. The soil was a Garland clay loam (fine, mixed, mesic; Typic Haplargid) and had a cropping history of: 2009, beets; 2008, barley; and 2007, beets. Fertilizer was applied for a yield goal of 100 bushels of grain per acre. Fertilizer was applied on March 18 at the rate of 120 lb/acre of N and 50 lb/acre of P_2O_5 in the form of urea (46-0-0) and diammonium phosphate (11-52-0). The soil in the study area was prepared for planting by fall plowing, roller harrowing, and leveling. On April 12, 36 barley varieties were established in plots 7.3 by 20 feet using double disk openers set at a row spacing of 7 inches. The seeding depth was 1.5 inches, and the seeding rate was 100 pounds of seed per acre. Weeds were controlled by a post application of a tank mixture of bromoxynil and MCPA (1 pt Bronate Advanced™) and pinoxaden (16.4 oz Axial® XL) broadcast at 0.50, 0.50, and 0.05 pounds active ingredient/acre on June 4. Furrow irrigations were April 22, June 8, June 23, July 4, July 16, and July 30. Subplots, 5.3 by 8 feet, were harvested on August 19 using a Wintersteiger plot combine.

Results and Discussion

Results from 2010 are presented in **Table 1**. Results are also presented annually at http://uwadmnweb.uwyo.edu/UWPLANT/key.htm

Acknowledgments

Appreciation is extended to the PREC staff for their assistance during 2011.

Contact Information

For additional information, contact Mike Killen at 307-754-2223 or mkillen@uwyo.edu.

Table 1. Agronomic performance of spring barley genotypes grown at PREC during 2010.

Variety	Row Type	Grade	Plant height	Heading date	Lodge	Grain yield	Test weight	Plump 6/64	Plump 5.5/64
			inches	Days from Jan. 1	1-9	bu/acre	lb/bu	% above screen	
Malt Use									
MT020204	2	F/M	37.6	177	3.0	193.6	53.1	93.3	98.1
2B06-0929	2	M	33.7	177	1.0	174.7	50.2	96.8	99.1
Merit	2	M	34.9	183	1	172.9	50.5	95.7	98.8
Merit 57	2	M	35.7	180	1	171.8	50.0	93.8	98.6
Moravian 69	2	M	29.7	181	1	171.2	50.2	96.2	98.9
2B05-0811	2	M	34.5	177	2.0	166.7	51.8	97.2	99.2
CDC Meredith	2	M	34.9	180	2.0	161.4	48.3	96.2	98.9
02Ab17271	2	M	34.9	181	1.0	161.3	51.6	95.0	98.7
2B06-0933	2	M	35.1	177	1.0	160.6	51.3	94.5	98.6
ND22421	6	M	33.4	174	1.0	154.6	50.1	97.9	99.7
2B07-1590	2	M	35.5	179	1.0	154.3	51.0	98.2	99.4
2ND25276	2	M	37.7	177	1.0	153.0	50.3	98.7	99.4
2B07-1562	2	M	36.0	177	2.0	152.5	51.4	97.5	99.3
Conrad	2	M	33.5	179	1	149.6	51.8	97.1	99.1
2B04-0175	2	M	37.9	179	2.0	149.4	52.2	97.9	99.4
Hockett	2	M	33.4	177	2	142.3	54.2	98.6	99.3
2ND26328	2	M	32.3	177	1.0	142.1	53.0	98.9	99.5
MT020155	2	F/M	37.6	174	2.0	141.5	52.0	95.3	98.6
Harrington	2	M	35.6	179	3.0	134.6	51.3	97.5	99.3
MT030042	2	F/M	33.1	177	3.0	133.6	55.4	97.0	98.9
AC Metcalfe	2	M	36.1	177	3.0	130.3	51.3	97.6	99.1
MT040073	2	F/M	35.1	177	3.0	125.6	53.4	96.1	98.7
Feed Use									
BZ505-172	2	F	34.0	177	1.0	183.8	52.9	98.5	99.5
04WNZ-124	2	F	28.6	183	1.0	181.8	51.3	96.8	99.1
04WA-113.22	2	F	35.9	177	1.0	172.2	52.4	97.7	99.9
05WA-316.K	2	F	34.7	177	2.0	172.2	52.1	97.0	99.0
2Ab04-X00017-4	2	F	36.1	177	2.0	169.1	52.3	98.0	99.2
CDC Austenson	2	F	34.7	179	1.0	166.9	52.6	97.1	99.2
UT04B2041-42	6	F	36.4	177	1.0	166.4	50.8	96.6	99.6
Baronesse	2	F	35.3	177	2.0	160.8	52.5	94.7	98.3
BZ505 192	2	F	33.7	180	1.0	158.1	54.6	97.6	99.0
05WA-316.99	2	F	37.7	177	4.0	154.8	49.9	95.6	98.6
UT99B1670-3530	6	F	34.0	174	1.0	149.3	48.2	97.9	99.1
CDC Coalition	2	F	38.4	179	2.0	148.9	50.5	97.5	99.0
05WA-329.49	2	F	38.7	177	2.0	148.6	53.1	98.1	99.4
Steptoe	6	F	36.0	174	5.0	146.6	49.8	98.2	99.3
Mean			**35.1**	**177.8**	**1.8**	**157.7**	**51.6**	**96.9**	**99.1**
LSD $_{0.05}$						**26.0**	**1.4**	**1.6**	**0.7**
CV%			**3.7**			**10.1**	**1.7**	**1.0**	**.4**

Lodge= 1 upright, 9 Flat; M=Malting, F=Feed.

2010 Spring Wheat Variety Performance Evaluation

M.J. Killen[1]*, R. Violett*[2]

[1]Farm Manager, Powell Research and Extension Center (PREC); [2]Research Associate, PREC.

Introduction

The variety performance evaluations conducted by the Wyoming Agricultural Experiment Station (WAES) are a continuous and ongoing program. In cooperation with the Uniform Regional Hard Red Spring Wheat Nursery and private seed companies, the WAES evaluates a wide range of germplasm each year.

Materials and Methods

The experimental design of all trials was three replications of a randomized complete block. Measurements included heading date, plant height, lodging, grain yield, and test weight. Data were analyzed using SAS® procedures for analysis of variance.

The experiment was located at the Powell Research and Extension Center (PREC) during 2010. The soil was a Garland clay loam (fine, mixed, mesic; Typic Haplargid) and had a cropping history of: 2009, dry beans; 2008, small grains; and 2007, dry beans. The soil was fertilized for a yield goal of 100 bushels of grain per acre. Fertilizer was applied on March 18 at the rate of 180 lb/acre N and 75 lb/acre of P_2O_5 in the form of urea (46-0-0) and diammonium phosphate (11-52-0). The soil in the study area was prepared for planting by fall plowing, roller harrowing, and leveling. On April 14, 48 wheat varieties were established in plots 7.3 by 20 feet using double disk openers set at a row spacing of 7 inches. The seeding depth was 1.5 inches, and the seeding rate was 100 pounds of seed per acre for all entries except durum types, which were seeded at a rate of 150 pounds of seed per acre. Weeds were controlled by a post application of a tank mixture of bromoxynil and MCPA (1 pt Bronate Advanced™) broadcast at 0.50, 0.50 lb active ingredient/acre on June 4. Furrow irrigations were April 22, June 10, June 23, July 8, July 16, and July 28. Subplots, 5.3 by 8 feet, were harvested on August 19 using a plot combine.

Results and Discussion

Results are presented in **Table 1**. Results are posted annually at http://uwadmnweb.uwyo.edu/UWPLANT/key.htm.

Acknowledgments

Appreciation is extended to the PREC staff for their assistance during 2010.

Contact Information

For additional information, contact Mike Killen at 307-754-2223 or mkillen@uwyo.edu.

Table 1. Agronomic performance of spring wheat genotypes grown at the PREC during 2010. *Durum seeded at 150 lbs/a unless indicated

Variety	**Plant height**	**Heading Date**	**Lodging**	**Grain yield**	**Test weight**
Hard Red unless indicated	inches	Days from Jan. 1	1-9	bu/acre	lb/bu
Volt	31.4	180	1.0	133.4	63.0
09FSP3	35.0	181	1	127.2	62.8
Hank	30.6	179	1.0	126.6	58.0
SD4112	35.7	177	1.3	124.1	61.3
09FSP 18	34.4	179	1.3	124.0	62.1
Kuntz	31.7	181	1.0	121.7	61.7
BW 928 CWRS	34.9	177	1	121.4	63.0
MT 0832	35.2	179	2	120.0	60.5
Fuzion (BZ901-717)	33.2	177	1.0	118.6	62.1
2375a	35.2	181	1	118.5	60.5
Alzada durum	28.2	177	2.3	117.8	61.5
03S0352-22	33.5	177	1	117.4	62.0
SD4011	34.4	177	1	117.2	62.1
MO3/3-23	36.3	180	2.3	116.5	60.2
MN07098-6	35.7	177	1	116.4	62.4
Brennan	30.4	177	1.7	114.7	62.7
03S0253-7	31.2	177	1	114.6	63.1
BW431 CWRS	39.5	177	1.7	114.6	61.8
NDSW0703 WSW	34.5	181	1	114.2	59.4
McNeal	35.3	181	1.0	114.2	60.1
Jedd CL	29.9	177	1.3	114.1	60.9
MT 0827	35.0	177	1.7	113.7	61.1
SD4076	34.0	177	1	113.4	63.6
NDSW0701 WSW	33.6	179	1	113.2	60.8
03S0119-12	32.6	177	1.3	112.9	63.7
NDSW0702 WSW	34.9	181	1.3	112.9	59.7
Verde	37.8	181	1.3	112.7	60.7
MT 0852	35.9	180	1.3	112.1	61.2
Choteau	35.0	181	1.0	111.2	61.5
WB 936	30.3	177	1.0	110.8	59.2
MN05214-3	29.6	177	1	110.6	63.2
MN06075-4	33.9	179	1	110.5	61.9
Vida	34.1	181	1.7	110.0	59.9
BW427 CWRS	37.5	177	1.7	109.9	60.8
MN06018	32.8	179	1	109.5	61.7
NDSW0612 WSW	35.2	185	1.3	109.4	61.4
SD4023	34.0	180	1.3	109.2	62.1
02S0091-9	29.9	177	1	106.9	61.0
MO5/1-2	39.6	177	2	106.3	61.0
MO6/1-24	35.7	177	1.7	105.9	62.4
02S0170-3	30.2	177	1.3	105.3	62.0
MO5/1-3	37.8	180	1	104.5	57.8
Keene	41.7	177	1	102.0	61.6
MO6/1-23	37.7	177	2	101.4	62.4
MN06028	28.6	179	1	101.2	62.8
SD3997	40.7	177	1	83.7	61.8
Chris	45.7	185	4.7	75.4	60.9
Marquis	46.3	185	4.3	71.3	59.1
Mean	**34.7**	**178.9**	**1.4**	**111.5**	**61.4**
LSD $_{0.05}$	**2.7**		**0.9**	**15.3**	**1.5**
CV%	**4.8**		**40.6**	**8.4**	**1.5**

2010 Dry Bean Performance Evaluation

M. Moore[1], M.J. Killen[2], R. Violett[3]

[1]Manager, University of Wyoming Seed Certification Service; [2]Farm Manager, Powell Research and Extension Center (PREC); [3]Research Associate, PREC.

Introduction

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

Objectives

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

Materials and Methods

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

Results and Discussion

Stand establishment was good, with timely planting and reasonable soil temperatures. Moderate summer temperatures and limited summer precipitation allowed all of the entries to reach maturity; however, a frost the third week of September affected the seed quality of the later lines. Yields across entries averaged 3,729 pounds per acre (**Table 1**). Use caution in assessing this data, as it is only from one growing season.

Contact Information

For additional information, contact the principal investigator, Mike Moore, at 307-754-9815, toll-free 800-923-0080, or mdmoore@uwyo.edu.

Table 1. 2010 Dry Bean Performance Evaluation.

Variety Name	Market class	Yield lbs./A	Seeds per pound	50% Bloom days after planting	Pod Maturity days after planting
Eclipse	Black	4398	2321	72	107
T-39	Black	3044	2353	70	107
Zorro	Black	3039	2281	72	106
Bellagio	Cran-vine	2768	889	65	107
CELRK	LRK	1915	863	61	96
T9903	Navy	3930	2161	65	105
Norstar	Navy	3568	2618	66	104
Indi	Navy	3548	2584	69	105
Avalanche	Navy	3408	2549	70	104
Lightning	Navy	3286	2167	65	106
OAC 07-2	Navy	2812	2534	68	108
Odyssey	Pinto	4995	1101	61	97
Lariat	Pinto	4719	1050	67	107
PT9-18	Pinto	4500	1278	62	103
Medicine Hat	Pinto	4492	1152	65	104
Mariah	Pinto	4387	1226	68	107
Quincy	Pinto	4325	1075	61	98
Montrose	Pinto	4251	1192	65	99
Maverick	Pinto	4243	1161	66	106
ND307	Pinto	4220	1156	66	107
Bill Z	Pinto	4089	1212	61	103
Jackpot	Pinto	4089	1188	67	98
Croissant	Pinto	4010	1310	66	105
Stampede	Pinto	3825	1174	66	107
Othello	Pinto	3711	1186	61	96
Max	Pinto	3662	1089	61	96
IP08-2	Pinto	3557	1381	67	104
SVS-0863	Pinto	3421	1553	67	107
Santa Fe	Pinto	3420	1099	66	103
NE2-06-08	Pinto	3416	1147	68	105
Sequoia	Pinto	3278	1320	61	98
Windbreaker	Pinto	3000	1519	65	107
Mean		3729	1526	66	103
CV		13.1	12	3.1	1.8
LSD		684	255	2.9	2.6

Effectiveness of Biological Products

A. Mesbah[1], R. Violett[2]

[1] Director, Powell Research and Extension Center (PREC); [2]Research Associate, PREC.

Project funded by Enviro Consultant Service, LLC.

Introduction

Enviro Consultant Service, LLC (ECS), based in Golden, Colorado, has been working with growers to provide bountiful crops using less synthetic fertilizers, herbicides, and pesticides since 1997. The goal of ECS is to assist growers in their efforts to raise the highest quality crops while being the best possible stewards of the land. The two major products the company sells are Bio-Stimulant by ECS™, a natural enzyme-based product that stimulates new life in the soil, and Harvest Energy by ECS®, a concentrated carbon product that provides an immediate source of energy to micro-organisms.

Objectives

The objectives of this research are to determine the effectiveness of the two products that ECS provides to growers and to determine timing and rate of application as well as tank mixing possibilities.

Materials and Methods

Trials have been conducted in sugar beet, barley, and dry bean plots after the crops have emerged and received the same management as the rest of the production field. All studies have been small plot projects with a randomized complete block design of four replications. Fertilizer and weed control programs have ranged from none to traditional amounts depending on the crop being managed. Tank mixing the products with glyphosate and other herbicides to reduce the number of trips across the field are currently being investigated and could aide in reducing producer costs of application.

Results and Discussion

Though no yield response has been observed to this point in the project, primarily because no one year of treatments has been the same, there are some possible attributes these products can bring to a producer. They seem to tank mix nicely with a combination of herbicides used in barley and sugar beets and may act as an adjuvant to enhance the effectiveness of the herbicides in weed control. More work is needed in this area, and a trial is currently being conducted in barley and sugar beet to help determine if this hypothesis is true.

Acknowledgments

We recognize the work of the center's farm crew, technical personnel, and others who play an integral role in our research activities.

Contact Information

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Sainfoin Variety Trial

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Project funded by the Powell Research and Extension Center.

Introduction

Sainfoin (*Onobrychis vicifolia* Scop.) is a member of the Fabaceae family and thus is capable of fixing nitrogen. The primary reason for using sainfoin is that it has never been known to cause bloat nor is it attacked by alfalfa weevil. Sainfoin has been grown in parts of Europe and Asia for hundreds of years. Various strains have been introduced to North America since about 1900. In the past 30 years, introductions from Turkey and Russia have shown a great deal of promise, and more farmers have been growing it for a forage crop since the release of the improved cultivars. Wyoming is no exception, and two of the more current cultivars available have been released by the University of Wyoming.

Objectives

The objectives of this variety trial were to determine if there are any yield differences among the commercially available sainfoin varieties and to compare sainfoin to a public alfalfa variety for both yield and relative feed value (RFV).

Materials and Methods

The trial was established on June 4, 2007, at the rate of 40 pounds of pure live seed (PLS)/ acre. Before seeding, 200 lbs/acre of 11-52-0 fertilizer was applied and incorporated into the soil. The plots were seeded with a grain drill and are 7 feet wide and 20 feet long. The trial was established as a randomized complete block design with four replications. The study area was seeded next to an alfalfa variety trial, and it was decided after planting to manage the two trials the same so that we could compare the performance of the sainfoin to the performance of Ranger alfalfa. Each spring, the study site was burned as to assist in furrow irrigation, and 200 pounds of 11-52-0 fertilizer was applied. RFV was tested on three occasions, the first being the establishment year, second being from the first harvest of 2008, and third being from the second harvest of 2009.

Results and Discussion

Results after four years of data collection are summarized in **Table 1**. Some points of interest are that sainfoin had a higher feed value the year of establishment but then decreased to the same level as Ranger alfalfa as it matured. Shoshone sainfoin preformed the best and even out performed Ranger alfalfa for yield with an average annual production over four years of 4.8 tons of dry matter/acre.

Table 1. Sainfoin variety trial four-year summary.

Irrigated Sainfoin Variety Trial, University of Wyoming Research and Extension Center, Powell, WY.(Established 2007)											
	2007	2007	2008	2008	2009	2009	6/21/10	8/11/10	2010	4yr total	4 yr
Variety	DM Yield	DM basis	DM Yield	DM basis	DM Yield	DM basis	DM Yield	DM Yield	total	DM Yield	% of
Name	ton/acre	RFV	ton/acre	RFV	ton/acre	RFV	ton/acre	ton/acre	DM yield	ton/acre	Ranger
Shoshone	0.93	185	6.79	135	5.88	135	3.02	2.66	5.68	19.28	102
Ranger alfalfa	1.43	147	7.31	137	4.99	136	2.70	2.60	5.29	18.90	100
Eski	0.83	212	6.70	132	5.77	149	2.90	2.66	5.56	18.85	100
Remont	0.93	196	6.60	144	5.52	138	2.69	2.66	5.35	18.41	97
Rocky Mt Remont	0.82	205	6.53	130	5.32	135	2.81	2.57	5.38	18.04	95
Delaney	0.93	165	6.59	138	5.15	145	2.38	2.61	4.99	17.66	93
Ave for Trial	0.89	193	6.64	136	5.53	140	2.75	2.63	5.38	18.52	
LSD (0.05)	0.29		0.25		0.36		0.19	0.24	0.31	0.45	
CV%	20.97		6.45		8.6		4.3	5.6	4.7	6.32	

Acknowledgments

We recognize the assistant farm managers, Brad May and Keith Schaefer, for all of their help in attending to this trial.

Contact Information

For additional information, contact the principal investigator, Randall Violett, at 307-754-2223 or rviolett@uwyo.edu or Mike Killen at mkillen@uwyo.edu.

2011 Sheridan Research and Extension Center Field Day

V.D. Jeliazkov[1]

[1]Associate Professor and Director, Sheridan Research and Extension Center.

History

The Sheridan Research and Extension Center (ShREC) is in Sheridan County, about 7 miles east of the City of Sheridan and is at an elevation of 3,800 feet. The ShREC is within the U.S. Department of Agriculture (USDA) plant hardiness zone 4 with an average growing season of 120 days. Average annual precipitation is 15 inches. The ShREC was jointly managed by the USDA and State of Wyoming through the University of Wyoming. The USDA opened ShREC in 1916 by leasing 160 acres of state land. In 1926, an additional 160 acres were purchased for the station. Wyoming State Highway 336 and the BNSF Railway cover about 14 of the 320 acres leaving the station with 306 total acres. Approximately 250 acres are farmed, and all of the crops are produced by dry-farming methods.

The ShREC has had many different names since it was established, including Sheridan Field Station, Sheridan Substation, and Sheridan Experiment Farm. The farm originally operated on funds from the Wyoming Farm Board of Commissioners and the USDA Bureau of Plant Industry. In 1919, the Farm Board of Commissioners was replaced by an agricultural advisory board and, in 1923, by the UW Board of Trustees. By 1953, the USDA stepped out of the picture, and the station was operated entirely by UW. Direct federal funding ceased in 1958. Currently, funds are appropriated by the state legislature. The director of the Wyoming Agricultural Experiment Station supervises ShREC programs.

Importance of ShREC

Since the start of ShREC, the aim has been to make research work useful to the farmers and ranchers of Wyoming. In the last 5-6 years, ShREC initiated research projects in horticulture and turf grass. The research in horticultural specialty crops expanded in 2011. The research is geared not only to farmers and ranchers but also to homeowners, golf course superintendents, and horticulturalists. In the past, the station has been incredibly important for northeastern Wyoming because many of the resources had yet to be developed.

Current Research Projects at ShREC

1) Evaluation of Dryland Alfalfa – The objective is to provide Wyoming growers with information on the performance of alfalfa varieties grown under dryland conditions. Each variety is assessed for establishment rate, seed heading data, yield, and forage quality. The experiment was initiated in 2007 and is continuing.

2) Small Grain Variety Trial – This was initiated in the spring of 2011 as a research and demonstration project for spring wheat, barley, and oat varieties.

3) Sainfoin Variety Trial – This was also initiated in spring 2011 as a demonstration project.

4) Homeowner Turf Trial – The objective is to demonstrate the appearance and resilience of different lawn grasses for the Sheridan area. The trial includes 29 varieties of turf grass, planted in September 2005.

5) Lignocellulosic Species for Biofuel Production – This is a newly funded project by the USDA Sun Grant Initiative. The goal is to develop economically feasible and environmentally sound production systems for emerging (alternative) biofuel crops.

6) Utilization of Coal-Bed Methane (CBM) Water for Irrigation of Agricultural Crops – The goal is to provide information on the use of CBM water for irrigation of various horticultural and field crops.

7) Establishment of Mints as Specialty Crops for Wyoming – The long-term goal is to establish a sustainable mint essential oil production industry in Wyoming. We are testing several mint species (peppermint, Scotch spearmint, native spearmint, and Japanese cornmint) for the environmental conditions of Wyoming.

8) Oilseed Crops as Potential Biodiesel Crops for Wyoming – This field study was initiated in fall 2010 and is evaluating coriander, winter canola, and winter mustard as biodiesel crops.

9) Optimization of High and Low Tunnel Organic Vegetable System for Sheridan Area – This is a project at the ShREC organic garden.

Contact Information

For additional information, contact Valtcho Jeliazkov at 307-737-2415 or vjeliazk@uwyo.edu.

Table 1. Precipitation at the Sheridan Research and Extension Center in inches

Month	2007 Precipitation	2008 Precipitation	2009 Precipitation	2010 Precipitation	2011 Precipitation	75 Year Ave. (Monthly)
Jan.	0.24	0.33	0.87	0.03	0.42	0.54
Feb.	0.28	0.10	0.03	0.15	0.34	0.51
Mar.	1.60	0.53	1.03	0.16	1.09	0.97
Apr.	0.24	0.39	0.73	1.96	1.92	1.90
May	4.00	5.27	0.36	5.13	6.13	2.55
Jun.	2.53	3.12	2.77	2.29		2.60
Jul.	0.65	1.88	0.89	1.31		1.22
Aug.	0.59	0.25	1.16	0.79		0.91
Sep.	0.96	1.80	0.09	0.18		1.44
Oct.	2.75	1.97	1.06	0.60		1.21
Nov.	0.14	0.38	0.13	0.31		0.77
Dec.	0.42	0.70	0.18	0.13		0.54
Total	**8.3**	**11.1**	**15.11**	**16.22**	**10.06**	**15.16**

Development of a Production System for Emerging Feedstock with Double Utilization

V.D. Jeliazkov[1]

[1]Associate Professor and Director, Sheridan Research and Extension Center.

Project funded by the U.S. Department of Agriculture's (USDA) National Institute of Food and Agriculture Sun Grant Initiative.

Introduction

The intent of this project is to develop economically feasible and environmentally sound production systems for emerging (alternative) biofuel crops for the North Central region. These crops will be used for production of high-value chemical (essential oil), which would make them attractive to growers.

Objectives

To accomplish the goals outlined in the introduction, this research and education grant will be used to:

1. Determine crop biomass yields, plant chemical (essential oil) content and composition, soil nutrient, and water dynamics in response to: (a) crop species, (b) nitrogen, and (c) site or irrigation.
2. Estimate the ethanol production from the lignocellulosic biomass of different crops and treatments by fermentation studies.
3. Evaluate the economics of different crops and treatments.
4. Disseminate research progress and results through on-site demonstrations, interactive video broadcasts, and extension.

Materials and Methods

Field experiments will be conducted in two sites at the Sheridan Research and Extension Center (ShREC) characterized with different soil types**.**

The following responses will be measured: 1. Fresh and dry matter yields of the alternative crops: wheat, switchgrass, and reed canarygrass. 2. Essential oil content in the essential oil crops by extraction with steam distillation. 3. Ethanol production from different crops and treatments will be evaluated in laboratory experiments. 4. Biomass quality analyses will be determined.

Results and Discussion

Our preliminary studies demonstrated some high-value crops would be suitable alternatives to commonly used lignocellulosic species, such as switchgrass, wheat, and reed canarygrass. The yields and ethanol production from these crops will be compared to those from wheat, switchgrass, and reed canarygrass at different fertility levels and at different sites. Economic analysis will identify which are the best crops for the North Central U.S. and at what fertility level. The advantage of the proposed crops over other lignocellulosic species currently under investigation would be the production of a high-value natural product, which may offset production costs, and, hence, may be more attractive to growers. Double utilization of crops may be more promising than crops grown only for the biomass. The revenue from these alternative crops is expected to be higher than from switchgrass, wheat, or reed canarygrass.

Acknowledgments

This project is in collaboration with researchers at the University of Tennessee and USDA-Agricultural Research Service.

Contact Information

For additional information, contact Valtcho Jeliazkov at 307-737-2415 or vjeliazk@uwyo.edu.

Establishment of Mints as Specialty Crops for Wyoming

V.D. Jeliazkov[1]

[1]Associate Professor and Director, Sheridan Research and Extension Center.

Introduction

Peppermint and spearmints ('Scotch' spearmint and 'Native' spearmint) are specialty crops grown for essential oil, which is a major aromatic agent (Lawrence, 2006). Peppermint is also grown for production of dry leaves, which are used in herbal teas. The essential oil of these mints is used in a number of consumer products such as chewing gum, toothpaste, mouthwashes, pharmaceuticals, confectionary, and aromatherapy. Peppermint has been grown in the northwestern U.S. for more than 100 years (Lawrence, 2006). Peppermint grown in some areas of the U.S. is considered of the highest quality and commands premium prices at international markets. To respond to the need of expanding peppermint and spearmint production in the U.S., Zheljazkov et al. (2010 a, b, c,) evaluated these mint species for the southeastern U.S.; however, one of the limiting factors for expanding peppermint production into the South was relatively low menthol content in the oil, compared to peppermint produced in more northern climates. To achieve high quality oil, peppermint could be grown in more northern latitudes such as Wyoming. Japanese cornmint is a major essential oil crop grown in Asia and South America. The essential oil of Japanese cornmint is the only source for production of crystal menthol, which is an important aromatic agent used in various industries. The U.S. is a major importer and consumer of menthol and de-mentholized oil. Currently, there is no production of Japanese cornmint in the U.S. Research conducted in 1972 in Indiana (Murray et al., 1972) and in 2010 in Mississippi (Zheljazkov et al., 2010d) have shown that this crop can be grown in various regions in the US. Japanese mint has not been tested in Wyoming.

Objectives

The long-term goal is to establish sustainable mint essential oil production in Wyoming. Specific objectives for the next 2-3 years are to:

(1) Evaluate productivity and oil quality of mint oils produced in Wyoming; (2) Study optimizing nitrogen (N) fertilization for four mint species that could be suitable for the ecological conditions of Wyoming; (3) Evaluate a means to increase oil content in peppermint, spearmints, and Japanese cornmint.

Materials and Methods

To achieve objective 1, research plots of the four mint species will be established at the Sheridan Research and Extension Center (ShREC) and, in 2012, at the Laramie Research and Extension Center, and grown for 2-3 years. Virus-free transplants were already purchased.

To achieve objective two, four field experiments (one for each mint species) will be established. Experiments will run for two cropping seasons (2012 and 2013). The N fertilizer application rates will be based on the current recommendation in Oregon and Washington, on recent relevant research (Zheljazkov et al., 2009; Zheljazkov et al., 2010a, b, d).

The third objective will be met by a field experiment to be established at ShREC. Several plant hormones (elicitors) will be tested for their potential to increase essential oil content. This will follow work recently published by the project leader (Zheljazkov et al., 2010e; Zheljazkov and Astatkie, 2011a, b). The data to be collected from the trials will include: (1) initiation and duration of growth stages – by regular observations during the two cropping seasons; (2) plant height and biomass yields from every plot by measurements at harvest and cutting the whole plots; (3) essential oil content through steam distillation in the ShREC laboratory; (4) essential oil composition.

Contact Information

For additional information, contact Valtcho Jeliazkov at 307-737-2415 or vjeliazk@uwyo.edu.

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Grape Demonstration Trials at Sheridan, Wyoming

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Project funded by Wyoming Agricultural Experiment Station and Northern Wyoming Community College District (Sheridan College).

Introduction

Grapes have been grown for thousands of years in the Mediterranean region. Tradition seems to endure; nowadays, countries in the Mediterranean region are still the major grape and wine producers. Most families in that region would have their own vineyards and produce their own wine. Grapes are currently grown in many countries around the world. According to the U.S. Department of Agriculture's National Agricultural Statistics Service, U.S. grape production in 2010 comprised 944,800 acres, with total production of 6,856,000 tons. There are many different varieties of wine and table grapes. The available wine grape varieties are said to number more than 5,000. Interest in growing grapes in Wyoming has increased quite significantly in recent years. Many grape varieties are able to handle Wyoming's cold winters. To respond to this interest, two separate projects have been initiated at the Sheridan Research and Extension Center (ShREC) and at Sheridan College.

Objectives

The objectives of these demonstration trials were to test different varieties of grapes, to record productivity, and to determine growth performance for the environmental conditions of the Sheridan area.

Materials and Methods

Different varieties of grapes were established at two locations in Sheridan: ShREC and Sheridan College. The vineyard at ShREC was established in 1989 with 20 different varieties. Each year, the yield for each plant is recorded. In another trial in 2007, 38 varieties were planted at Sheridan College next to the Agriculture Center Building **(Figure 1)**.

Results and Discussion

Yields at the vineyard at ShREC have been recorded over the years; however, since this was a demonstration project only, without replicates as required for a research project, we could not report yields. The 38 varieties planted at Sheridan College are yet to produce berries. After three winter seasons, one-third of the varieties survived. The 2011 growing season and subsequent harvests are expected to provide valuable information for the potential of various grape varieties in the Sheridan area.

Contact Information

For additional information, contact Valtcho Jeliazkov at 307-737-2415 or vjeliazk@uwyo.edu.

Figure 1. List of varieties planted in the trial at Sheridan College.

Variety	Date Planted
King of the North	5/19/07
LaCrosse	5/19/07
Frontenac	5/19/07
Frontenac Gris	5/19/07
LaCrescent	5/19/07
Bluebell	5/19/07
DeChaunac	5/19/07
Edelweiss	5/19/07
Prairie Star	5/19/07
Reliance	5/19/07
Seyval Blanc	5/19/07
GR-7	5/19/07
St. Pepin	5/19/07
Valiant	5/19/07
Vignole	5/19/07
Swenson White	5/19/07
Canadice	5/19/07
Einset	5/19/07
Himrod	5/19/07
Landot Noir	5/19/07
Leon Milot	5/19/07
Marechall Foch	5/19/07
Marquette	5/19/07
Marquis	5/19/07
Neptune	5/19/07
Concord Seedless	5/19/07
Glenora	5/19/07
Mars	5/19/07
Fredonia	5/19/07
St. Croix	5/19/07
Swenson Red	5/19/07
John Viola	6/05/07
Elvira	6/05/07
Caco	6/05/07
Frontenac/3309	6/05/07
Kay Gray	6/05/07
Brianna	5/13/08
Sheridan	5/13/08

Growing Fruit Trees in the Sheridan Area, Wyoming

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Project funded by the Wyoming Agricultural Experiment Station.

Introduction

Many types of fruit trees can grow well in Wyoming. In 1987, the first fruit trees were planted in the orchard at the Sheridan Research and Extension Center (ShREC), and since then others have been added to the orchard. Currently, the orchard has 56 fruit trees. Apple trees make up the majority with 37 trees of 18 varieties. There are 12 plum trees representing seven varieties, six cherry trees representing five varieties, two crabapple trees, and one experimental peach. The peach tree was planted in 2010 and survived the winter.

Objectives

The primary objective was to test multiple fruit tree varieties and determine which ones perform well in the Sheridan area. A secondary objective was the observation of pests and diseases. Information on which diseases and insects are problematic and how to control them will make the recommendations more accurate.

Materials and Methods

The trees were planted in early spring. The orchard is irrigated throughout the summer using drip tape. Pruning is performed early during each spring season. Yield data has been collected over the years.

Results and Discussion

In the last few years, the trees in the orchard were grown without the use of chemical fertilizers or pesticides. Over the years, there were various pest and disease problems. The main disease was fire blight, *Erwinia amylovora*. This has caused severe damage to many trees, forcing the removal of some limbs and entire trees. The younger trees seem to represent varieties with some resistance to this disease. Of the apple trees planted in 1987, only one tree, variety 'McIntosh', is still alive, whereas the rest of the apple trees were lost due to the severity of the disease. Fire blight spreads rapidly through bacteria in the spring. Cool, wet springs are especially favorable conditions. The fruit trees that survived seem to represent potential suitable species and varieties for the Sheridan area.

Observations of pests and disease and collecting yield data will continue in the years to come. This long-term project demonstrates that fruit trees can be successfully grown in the Sheridan area provided that proper pest and disease control measures are implemented. We are working to secure outside funding for the establishment of a larger orchard with wider species and variety selection. Such an orchard will help to provide reliable data to farmers, ranchers, homeowners, and others in the Sheridan area and possibly beyond.

Figure 1. Apple tree with fire blight infection.

Figure 2. Pear tree approaching harvest

Figure 3. Web worm damage in Apple tree.

Figure 4. Apple tree with blemish-free fruit.

Acknowledgments

We would like to thank current and past summer student workers at ShREC.

Contact Information

For additional information, contact Valtcho Jeliazkov at 307-737-2415 or vjeliazk@uwyo.edu.

Homeowner Turf Trial at Sheridan Research and Extension Center

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[1]Research Associate, [2]Farm Manager (former), [3]Farm Manager (current), [4]Associate Professor and Director, Sheridan Research and Extension Center.

Project funded by Wyoming Agricultural Experiment Station.

Introduction

Growing healthy lawn can be challenging. One of the most important decisions is in which variety to plant. As a way to aid in this decision, 29 turf grass varieties were planted at the Sheridan Research and Extension Center (ShREC) in September 2005 by Justin Moss, then director at ShREC (**Table 1**). This observation trial has attracted much interest from people in and around the Sheridan area.

Objectives

The objective of the project is to demonstrate the appearance and resilience of different lawn grasses in the Sheridan area.

Materials and Methods

The 10- by 40-foot plots were hand-seeded in 2005. The plots have been maintained since then, and they are all watered 1-inch per week during the growing season and mowed at the same height.

Results and Discussion

This observation trial has been helpful for many people as they decide what kind of grass to plant. The grass is growing in native soil, with all the environmental conditions that a typical homeowners' lawn will encounter.

Acknowledgments

We appreciate the help from the student workers at ShREC over the last six years.

Contact Information

For additional information, contact Dan Smith at 307-737-2415, Valtcho Jeliazkov at vjeliazk@uwyo.edu, or visit the ShREC station at 663 Wyarno Road east of Sheridan and observe the trials.

'Supreme' Buffalograss Blend	Bermudagrass and Zoysiagrass Blend
Blue Grama	Perennial Rye
Crested Wheat 'Nordan'	Outside Pride 'Perennial Rye Blend'
Pubscent Wheat 'Rush'	'Sodar Streambank' Wheatgrass
Hybrid Wheatgrass 'Hycrest & CDII'	Orchardgrass
Western Wheat 'Rosanna'	Timothy
North West Tough Lawn Tall Fescue	'Rose' Creeping Red Fescue
'Tall Fescue' Ace	'Eureka II' Hard Fescue
Rebel Sun & Shade Tall Fescue Mix	'Sheeps' Blue Fescue
'Northern Seed Mix' Expert Garden	'Sheridan Seed Mix' Native Plus
'Shady Mix' Ace	'Shady Mix' Pennington Seed
'Pure Premium Shady Mix' Scotts	'Colonial' Bentgrass
'Classic Sun & Shade' Scotts	'Fultz' Alkaligrass
'Penncross' Bentgrass	Environlawn

Table 1. Turf grass varieties in the trial at the Sheridan Research and Extension Center.

Improving Extraction Efficiency for Natural Products

V.D. Jeliazkov[1], C.L. Cantrell[2]

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[2]Research Chemist, U.S. Department of Agriculture-Agricultural Research Service's National Center for Natural Products Research, University, Mississippi.

Introduction

Plant chemicals (natural products) have been used by humankind for thousands of years as medicines, to improve food and beverage taste and flavor, in pharmaceutical industries, in perfumery and cosmetics, and in eco-friendly pesticides. These plant chemicals are extracted from plant biomass using different approaches such as distillation, water or chemical solvent extraction, expression, and others. The method of extraction can and, in most instances, does alter chemical composition of the plant natural product, and, hence, its properties. Some extraction methods are more efficient than others but may also require greater energy inputs or more sophisticated equipment. The choice of extraction method for a given natural product depends on its anticipated use, its expected properties, the availability of extraction equipment, energy and environmental conservation considerations, tradition, and other factors.

Various agricultural factors – variety selection, fertilization, irrigation, climate, soil properties, harvesting stage, post-harvest processing, and extraction method – can significantly affect natural product yields, composition, and various properties such as bioactivity. Finding the best extraction conditions for a given natural product is important for the industry.

Another issue that needs to be addressed is the fact that various researchers use different extraction methods for extraction of the same natural product and report different composition.

Objectives

The objectives of this study are: (1) to improve extraction efficiency of essential oils from common plants such as peppermint, spearmint, oregano, dill, fennel, and others, and (2) to compare steam distillation to microwave distillation methods and estimate changes in essential oil yield and composition.

Materials and Methods

Essential oil crops needed for the testing will be grown at the Sheridan Research and Extension Center. The objectives will be accomplished by testing various physical methods such as microwave in combination with various chemical extractors. For example, the availability of microwave made a revolution in the way and the speed food at home is prepared. Some commercial companies dealing with natural products have been using microwave distillation of essential oil; however, the research overall is insufficient.

Our research will be conducted in the extraction laboratory at Sheridan Research and Extension Center. The laboratory has steam and hydrodistillation units and a sophisticated research-grade, solvent-free microwave laboratory station (**Figure 1**).

Results and Discussion

Improved extraction efficiency may result in improving oil quality and yield. Results from this study are expected to benefit the natural product industry, and the growers of essential oil and medicinal plants. In addition, the results are expected to provide the basis for comparison of published studies using different extraction methods.

Contact Information

For additional information, contact Valtcho Jeliazkov at 307-737-2415 or vjeliazk@uwyo.edu.

Figure 1. Steam distillation (left) of mint from container experiments at ShREC. Solvent-free microwave extraction labstation (right) at ShREC.

Natural Products in Juniper Trees

V.D. Jeliazkov[1], C.L. Cantrell[2]

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[2]Research Chemist, U.S. Department of Agriculture-Agricultural Research Service's National Center for Natural Products Research, University, Mississippi.

Introduction

Juniper species are found across the globe. Rocky Mountain juniper (*Juniperus scopulorum* Sarg.) is found in the western part of North America. Another juniper, Eastern red cedar (*Juniperus virginiana* L.), a native plant in the U.S. and Canada, grows throughout North America. The Eastern red cedar is more naturally abundant in the eastern U.S.; however, it is also found in the North Central U.S., including Wyoming. The two species hybridize under natural conditions in the North Central U.S., creating numerous chemotypes (trees with different chemistry).

The leaves (needles) of Rocky Mountain juniper and Eastern red cedar contain two important natural products: podophyllotoxin and essential oil. Podophyllotoxin is used as a precursor to the semi-synthetic anti-cancer drugs etoposide and teniposide (**Figure 1**). These compounds have been used for the treatment of lung cancer, testicular cancer, neuroblastoma, hepatoma, and other tumors. Additional derivatives of podophyllotoxin are used in the treatment of psorosis and malaria, and as a treatment for rheumatoid arthritis.

Currently, the Himalayan mayapple (*P. hexandrum*) is the species used for commercial isolation of podophyllotoxin. This species, however, is only collected in the wild in Asia, and it has been declared an endangered species. A viable alternative domestic source of podophyllotoxin seems to be Juniperus species.

Rocky Mountain juniper and Eastern red cedar have been extensively used as ornamentals and planted across the U.S. One such planting was initiated in 1917 at the Sheridan Research and Extension Center (ShREC). Several successive plantings of Rocky Mountain juniper have been done at the ShREC over the following few decades. As a result, we have hundreds of Rocky Mountain juniper trees at ShREC planted at different times and apparently with different origin.

Objectives

The long-term goal is to develop cultivar(s) of junipers that can be used for production of podophyllotoxin and essential oil in the United States.

The objectives of this study are: (1) sample junipers and identify trees with the highest podophyllotoxin concentration; (2) establish the limits of variations of essential oil content and composition in juniper trees across Wyoming and other neighboring states; (3) establish a nursery of juniper trees with high podophyllotoxin concentration or desirable essential oil profile at ShREC to be used as genetic material for further cultivar development.

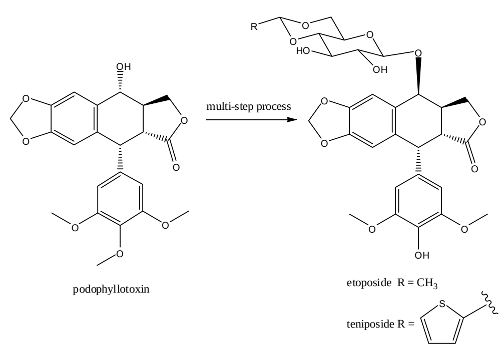

Figure 1. Schematic representation of the commercial process converting podophyllotoxin into either etoposide or teniposide.

Materials and Methods

We will sample juniper trees at approximately 100 sites across Wyoming and neighboring states using Global Positioning System information and analyzing for podophyllotoxin and essential oil content, and essential oil profile. A Geographic Information Systems map with these resources will be created and made available to the public. The trees showing the highest concentration of podophyllotoxin, or essential oil, or essential oil with desirable properties, will be sampled again, propagated through rooting of cuttings, and established as a breeding nursery at ShREC.

Figure 2. Rocky Mountain junipers in South Dakota.

Results and Discussion

Our nursery will be used for cultivar development to meet specific market requirements for podophyllotoxin, or essential oil profile. Currently, there is no known juniper cultivar for production of natural products (although there are a number of cultivars from several juniper species for ornamental purposes).

Contact Information

For additional information, contact Valtcho Jeliazkov at 307-737-2415 or vjeliazk@uwyo.edu.

Oilseed Crops as Potential Biodiesel Crops for Wyoming

V.D. Jeliazkov[1]

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Introduction

Biodiesel is one of the renewable fuels that is produced mainly from canola, sunflower, and other oilseed crops. For use in vehicle diesel engines, biodiesel is typically blended with fossil diesel fuel (2-30 percent), but it may also be used in pure form (100-percent biodiesel). Biodiesel is also used for heating. There are significant environmental advantages of using biodiesel over fossil fuel. Biodiesel:

1) may provide energy independence for regions without fossil fuel production,
2) may increase nitrogen oxide emissions but reduce carbon dioxide emissions by 80 percent,
3) can reduce particulate and other emissions that are harmful to humans,
4) is not toxic but is readily biodegradable,
5) may act as a lubricant and enhance engine life,
6) has a higher cetane number compared to diesel fuel and hence may improve engine starting in cold temperatures.

Additionally, crops that are used for biodiesel production may be grown on marginal lands that may not be otherwise suited for other major field or vegetable cropping systems.

While individual oilseed crops such as camelina, canola, sunflower, and others have been tested in Wyoming and neighboring states, there is no comprehensive or side-by-side comparison of oilseeds in the region. Also, while the nitrogen (N) requirements of canola have been investigated, N requirements of similar species such as mustard, or new species such as coriander, have not been studied.

Objectives

The objective of this study is to evaluate the effect of N on winter canola, winter Indian mustard, and coriander on seed yield, oil content, yield, and fatty acid composition.

Materials and Methods

Winter canola, winter mustard, and coriander were seeded in October 2010 at the Sheridan Research and Extension Center (ShREC). Four different N rates will be applied to each crop.

Results and Discussion

Due to late planting in the fall of 2010, the three crops emerged in the spring of 2011. Mustard emergence was rather sporadic, canola was somewhat better, while most coriander emergence was very good. Canola and mustard reached flowering in the beginning of June, whereas coriander was in stem elongation phase and was expected to reach flowering within weeks (**Figure 1**). The experiment will be repeated in the fall of 2011. In addition, a separate experiment will be initiated to determine the optimal planting dates for mustard and coriander. Crops will be harvested in physiological maturity, plants will be threshed, and seed samples will be analyzed for oil content and fatty acid composition. Results will be posted on the Agriculture Experiment Station website and possibly published in a journal. It is hoped that this preliminary study will provide information to farmers and ranchers in the region who are interested in oilseed production as a cash crop or for producing their own biodiesel. A project proposal with several collaborators including farmers, animal scientists, Extension personnel, and others was submitted to Western Sustainable Agriculture Research and Education on the development of a sustainable production system for biodiesel production. If the project is funded, the work on oilseeds and biodiesel crops at the ShREC will expand.

Figure 1. Coriander, canola, and mustard at ShREC on June 20, 2011.

Acknowledgments

Thanks to Byron Nelson and Adrienne Tatman for setting up the field experiment.

Contact Information

For additional information, contact Valtcho Jeliazkov at 307-737-2415 or vjeliazk@uwyo.edu.

Optimization of High- and Low-Tunnel Organic Vegetable Systems

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[1]Associate Professor and Director, Sheridan Research and Extension Center.

Introduction

There is significant interest on extended-season vegetable production systems in Wyoming. High-tunnel systems have been a focus of recent research and demonstration projects across the state; however, there are fewer studies on row covers or low-tunnel production systems, especially for organic vegetables and herbs. Low-tunnel systems have been widely used in vegetable and small fruit production, and grower interest in these systems is increasing. There are various types of plastics available for low tunnels, with distinct properties for meeting different requirements of the production systems. Generally, most producers use perforated plastic films, with various degrees of biodegradability and light transmission. In addition, frost blankets are used to protect crops in low tunnels when necessary. Similar to high tunnels, low tunnels modify humidity, air temperature, soil temperature, and solar radiation. They also help protect produce from wind, hail, strong rains, and pests, which improves marketable yields.

Objectives

In 2009 and 2010, several small specialty crop and vegetable trials were conducted at the Sheridan Research and Extension Center (ShREC) (Panter and Tatman, 2010). The five-year goal of this project, which will build on those trials, is to assist with the establishment of sustainable early- and late-season organic production of vegetables, small fruits, and herbs in Wyoming. Specific objectives include:

(1) A comparison of three production systems: high tunnel, low tunnel, and no covers for:
  - 1.1. Early spring production of cool-season vegetables and herbs
  - 1.2. Late-season (fall) production of the above crops and additional vegetables, small fruits, and herbs.

Materials and Methods

Cabbage, cauliflower, broccoli, lettuce, and basil were established in the spring of 2011 in the organic garden at the ShREC. Transplants were started from certified organic seed in the greenhouses at Sheridan College. After 45 days in the greenhouses, transplants of the five crops were transplanted (1) in a high tunnel, (2) in a low tunnel, and (3) outside with no cover (**Figure 1**). The experiments will continue with late-season production of vegetables, small fruits, and herbs. The extent of the experiment late in the season will depend on funding availability.

Measurements to be taken include: pests and disease incidence, days until maturity, fresh and dry yields, content of nutrients, and phytochemicals.

Panter, K., and A.O. Tatman. 2010. Specialty crops research for Wyoming. Final report. http://www.uwyo.edu/UWEXPSTN/Reports/files/Specialty_Crops_Final_report_11-5-10.pdf

Acknowledgments

The author thanks Emi Erickson from Sheridan College for making greenhouse space available. Thanks also to Adrienne Tatman, Berva Brock, and E. Jeliazkova for helping in the greenhouse and with field experiments.

Contact Information

For additional information, contact Valtcho Jeliazkov at 307-737-2415 or vjeliazk@uwyo.edu.

Figure 1. Five vegetables in the organic garden at ShREC on June 19: no cover (left), low tunnel (middle), and high tunnel (right).

Shelterbelt Project at the Sheridan Research and Extension Center

V.D. Jeliazkov[1], A. Tatman[2], D. Smith[3]

[1] Director, [2]Research Associate, [3]Farm Manager, Sheridan Research and Extension Center.

Introduction

The Sheridan Research and Extension Station (ShREC) was started in 1916 by the U.S. Department of Agriculture. The shelterbelt, located west of the office, was planted in 1917 as a beautification project as well as a variety trial. Later, the secondary objective was to evaluate various tree species as windbreaks and assess their longevity. Originally, 3,625 trees were planted in a space of 100 ft. x 500 ft. Of those, only 24.5-percent survived. Throughout the years, the shelterbelt has been added to, and trees that died have been replaced several times. Many successive plantings have been accomplished over the years (**Figures 1-3**).

Objectives

Around 2005, all of the mature trees in the shelterbelt and on the station have been mapped using a Global Positioning System and ArcMap Geographic Information System. The goal is to create a tree identification trail that will be used as a learning tool for visitors.

In 2011, ShREC initiated studies to characterize plant chemicals in some of the tree species. For example, most evergreens in the shelterbelt contain essential (volatile) oil. One of them, Rocky Mountain juniper, also contains chemicals used in the production of anti-cancer drugs. Also in 2011, we started collecting samples for deposition at the University of Wyoming herbarium. This work will continue through the year. The next step is to identify all young trees that have been added to the shelterbelt but do not have identification numbers. The shelterbelt at ShREC is a unique system that offers various opportunities for research and demonstration. We intend to continue with the observation of the shelterbelt trees.

The identified tree species in the shelterbelt include:
Pinus ponderosa (ponderosa pine)
Pinus edulis (pinyon pine)
Fraxinus pennsylvanica (green ash)
Prunus pumila (western sandcherry)
Gleditsia triacanthos (honeylocust)
Populus tremuloides (quaking aspen)
Juglans nigra (black walnut)
Celtis occidentalis (hackberry)
Prunus americana (wild plum)
Picea pungens (Colorado blue spruce)
Juniperus scopulorum (Rocky Mountain Juniper)

Figure 1. View of the shelterbelt looking south from the north property boundary.

Figure 2. Inside the shelterbelt (note owl in center of photograph).

Figure 3. Inside the shelterbelt.

Contact Information

For additional information, contact Dan Smith at 307-737-2415 or visit the ShREC to see the shelterbelt and other research that is taking place.

Utilization of Coal-Bed Methane Water for Irrigation of Agricultural Crops

V.D. Jeliazkov[1]

[1]Associate Professor and Director, Sheridan Research and Extension Center.

Introduction

Coal-bed methane (CBM) is naturally occurring methane that is enclosed in coal seams and trapped by underground water. To release the CBM to the surface, the water in the coal seams has to be pumped out. While the quality of CBM water varies significantly, some research has demonstrated its feasibility for irrigation of rangelands. Major issues with some of the discharged water associated with CBM production are high pH, high salts and Na content, and high sodium absorption ratio (SAR). These properties of CBM water affect normal plant growth but also may have significant negative effects on soil chemical and biological properties.

There has been a tremendous amount of water discharged to the surface in Wyoming because of CBM production. Currently, much of the water is stored in containment ponds. Growers in Wyoming have been using CBM water for irrigation of alfalfa and, to a lesser extent, other forages; however, there is very limited published research on the short- and long-term effects of CBM water on crops, agricultural soil, and the environment.

Remarkably, there are no known published studies on the use of CBM water with low dissolved solids to be used for irrigation of horticultural crops. Natural soils have different chemical and physical properties from the greenhouse growth media, which are mostly based on peat and perlite.
The Sheridan Research and Extension Center (ShREC) is located in an area with intensive CBM production and subsequent CBM water availability. There are number of CBM wells near and some at the ShREC property. Local growers, companies that manage CBM water in the Sheridan area, and many members of the general public would like to see more research on the use of CBM water. There is a need for the development of feasible methodologies for the use of CBM water stored in reservoirs.

Objectives

The goal of the proposed research is to generate information for the development of feasible technologies for the use of CBM water in agriculture, with the following specific objectives:
(1) Evaluate CBM water suitability for irrigation of horticultural crops grown on growth medium other than soil
(2) Evaluate CBM water for irrigation of forages and other field crops

(3) Develop means and methods for pretreatments of CBM water to rectify its limitations and make it suitable for irrigation of agricultural crops

Materials and Methods

The project is expected to develop into a major program at ShREC. The first step is the assessment of CBM water for irrigation of various crops in controlled environment conditions. The second step will be the establishment of a unique set-up at ShREC for the assessment of CBM water for irrigation of forages such as alfalfa. The third phase will be meeting objective 3.

Acknowledgments

The author thanks Adrienne Tatman, Berva Brock, and E. Jeliazkova for helping in the greenhouse and with field experiments.

Contact Information

For additional information, contact Valtcho Jeliazkov at 307-737-2415 or vjeliazk@uwyo.edu.

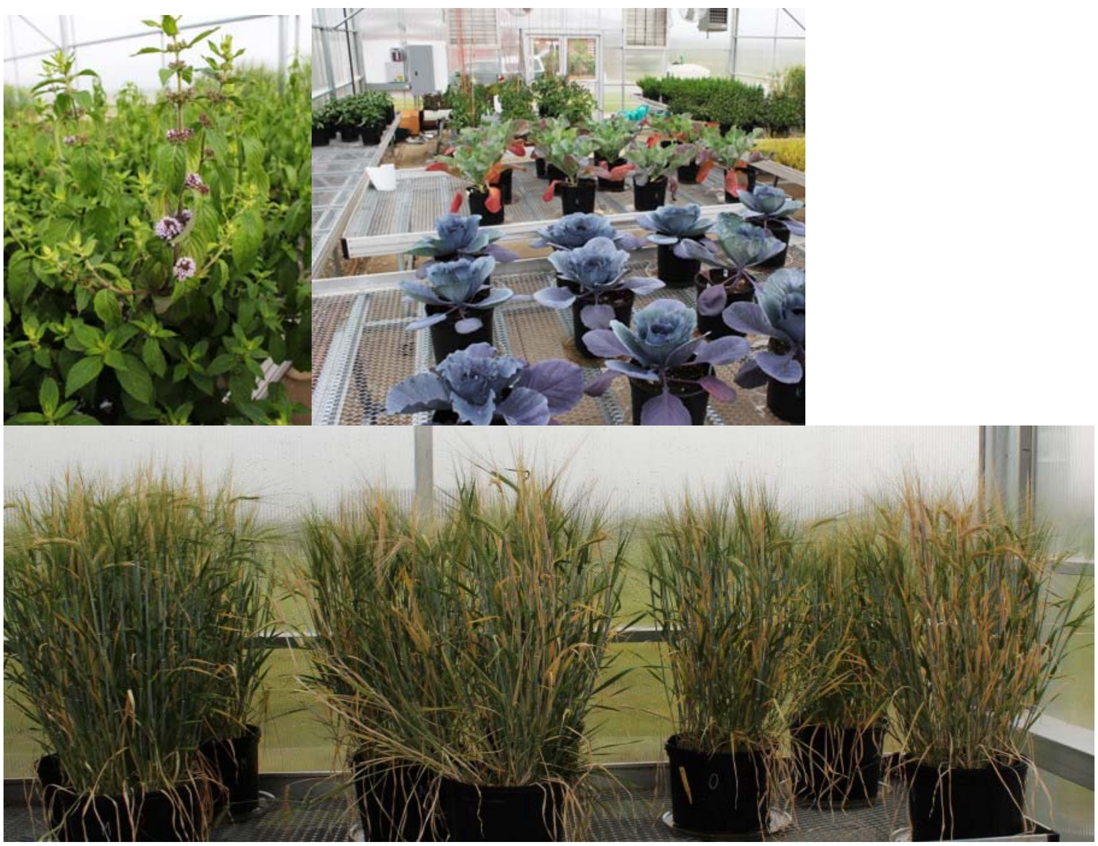

Figure 1. Ongoing greenhouse experiments on the utilization of CBM water for irrigation of various horticultural and agronomic crops.

Vegetable Production and Nutritional Contents in Season-Extension Systems

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Funded by the Wyoming Department of Agriculture Specialty Crops Block Grant program.

Introduction

Peppers, tomatoes, and eggplants were grown in a high tunnel, under row covers, and in the field during the summers of 2009 and 2010 at the Sheridan Research and Extension Center. High tunnels are unheated season-extending structures, intended to add one or two months to the growing season. Row covers are cloth blankets set over rows of vegetable or small fruit crops. These covers serve to lengthen the growing season as well, and they also help keep insect and disease problems to a minimum.

Objectives

The specific objective was to evaluate three production methods, including two season-extension systems, for yield and nutritional content using several vegetable crops. Nutritional parameters of total phenols, total flavonoids, and anti-oxidant activity were assessed as these are important in human health. Flavonoids are found in many fruits and vegetables and have anti-oxidant activity. Phenols are found in some plant oils and have antiseptic and antibacterial action. Anti-oxidant activity is important for removing potentially damaging oxidizing agents.

Materials and Methods

In 2009, peppers grown were ‘King of the North’ and ‘Purple Beauty’; tomatoes grown were ‘Rutgers’ and ‘Cosmonaut’; and eggplants were ‘Black’ and ‘Turkish Orange’. In 2010, tomato and eggplant varieties were the same as in 2009, but the peppers grown were ‘King Crimson’ and ‘California Wonder Orange’. In both years, five plants of each variety were planted in either the field, under row covers, or in a high tunnel. All produce grown was harvested when mature, counted, weighed, and sent to the

University of Nebraska-Lincoln Small Molecule Analysis Lab for determinations of total phenols, total flavonoids, and anti-oxidant activity. The number of fruits sent in varied by plant variety.

Results and Discussion

The number of plants grown each season in this study was quite limited, making any recommendations difficult. And since pepper varieties were different in the two growing seasons, no comparisons can be made. As for yields in each of the three growing locations, the variety of the plant was important.

Readers are encouraged to access the full final report for tables and graphs of yield and nutritional data (see ***Contact Information***, below).

In 2009, peppers showed the highest yields under row covers, but in 2010, yields were higher in the high tunnel, mostly due to varietal differences. In 2009, tomato yields were highest in the field, while in 2010 yields were highest in the high tunnel. In 2009, 'Turkish Orange' produced no fruit under the row cover while 'Black' produced most under the high tunnel. In 2010, 'Turkish Orange' yielded no fruit at all in the field, but 'Black' produced the most under the row cover. Reasons for lack of fruit production with eggplants were most likely poor pollination and grasshopper preference for these plants.

To make specific variety recommendations for yields or nutritional information, additional studies would need to be accomplished on a much larger scale.

Acknowledgments

We would like to thank former graduate student Diana Cochran for her assistance in transplanting in 2009.

Contact Information

For additional information, contact Karen Panter at 307-766-5117 or kpanter@uwyo.edu.

The full final report is available online at

http://wyagric.state.wy.us/images/stories/news/specialtycrop/scg-vegetabletrials.pdf

and at

http://www.uwyo.edu/uwexpstn/_files/docs/Specialty_Crops_Final_report_11-5-10.pdf

Vegetable Yield Evaluations and Nutritional Contents

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Project funded by the Wyoming Department of Agriculture Specialty Crops Block Grant program.

Introduction

This project was carried out during the growing seasons of 2009 and 2010 at the Sheridan Research and Extension Center. Different fertilization regimes were utilized each season, with conventional fertilizer used in 2009 and both conventional and organic used in 2010. Nutritional parameters of total phenols, total flavonoids, and anti-oxidant activity were assessed as these are important in human health. Flavonoids are found in many fruits and vegetables and have anti-oxidant activity themselves. Phenols are found in some plant oils and have antiseptic and antibacterial action. Anti-oxidant activity is important for removing potentially damaging oxidizing agents.

Objectives

The specific objective was to determine yield and nutritional differences by using two different fertilizers: an organic type and a conventional type. The crops grown for nutritional analyses during both years were tomatoes, peppers, beets, and carrots. Each was tested for total phenols, total flavonoids, and anti-oxidant activity at the University of Nebraska-Lincoln (UNL) Small Molecule Analysis Lab.

Materials and Methods

In 2009, the varieties of each plant grown were:

Tomatoes: ‘Paragon’, ‘Early Red Chief’, and ‘Bush Ace’
Peppers: ‘Orion’, ‘Lipstick’, ‘Chocolate’, ‘California Orange’, and ‘California Wonder’
Beets: ‘Kestral’, ‘Cylindra’, and ‘Lutz’
Carrots: ‘Little Finger’, ‘Danvers’, and ‘Atomic Red’.

In 2010, production problems in the greenhouse rendered tomato and pepper seedlings unusable; replacement plants were purchased at a local garden center.

The varieties grown in 2010 were:
Tomatoes: 'Husky Red', 'Super Fantastic', and 'Yellow Perfection'
Peppers: 'Better Belle', 'Mandarin', 'Golden Wonder', and 'Red Beauty'
Carrots: 'Danvers Half Long', 'Little Finger', and 'Atomic Red'
Beets: 'Kestral', 'Cylindra', and 'Lutz'.

In both years, tomato and pepper plants were transplanted into the field while carrots and beets were seeded directly. Plants were fertilized with either 0, ½ rate, or full rate of conventional 24-8-16 fertilizer in 2009 (0, ½ tablespoon, and 1 tablespoon per gallon of water). In 2010, organic kelp fertilizer (2-5-0.2) was also used at 0, ½ rate, or full rate, in addition to the conventional type (0, 1 tablespoon, and 2 tablespoons per gallon of water). Produce was harvested when mature, counted, weighed, and sent to UNL for nutritional analyses.

Results and Discussion

Since the varieties of tomatoes and peppers grown in the two growing seasons were different, comparisons cannot be made. Also, production was low in most cases. Nutritionally, none of the tomatoes or peppers stood out.

Variety and growing season had as much impact as fertilizer type and rate. No clear recommendations can be made based on fertilizers due to low production.
Readers are encouraged to access the project final report for yield and nutritional data tables and graphs (see ***Contact Information***, below).

Acknowledgments

We would like to thank former graduate student Diana Cochran for her assistance in transplanting and seeding in the field in 2009.

Contact Information

For additional information, contact Karen Panter at 307-766-5117 or kpanter@uwyo.edu.

The full final report is available online at

http://wyagric.state.wy.us/images/stories/news/specialtycrop/scg-vegetabletrials.pdf

and at

http://www.uwyo.edu/uwexpstn/_files/docs/Specialty_Crops_Final_report_11-5-10.pdf

Weed Controls and Insect Pest Evaluations

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Funded by the Wyoming Department of Agriculture Specialty Crops Block Grant program.

Introduction

Insect and weed management strategies are vitally important for growers of horticultural crops. If vegetable growers could make predictions about insect and weed populations, based on time of year and fertilizer usage, they would be far better able to take steps to minimize damage and maximize yields.

Objectives

The overall goal of this project was to develop and promote sustainable specialty horticultural practices for Wyoming. More specific objectives were to manage weeds using different mulches and control strategies and to evaluate insect orders on vegetables grown under different fertilization schemes.

Materials and Methods

In 2009, weed control plots were set up in 4 ft x 4 ft square plots. Treatments were: no weed control, clear plastic mulch, black plastic mulch, polyethylene fabric mulch, wood chip mulch, hand weeding, and flame weeding. Plots were set up the same way in 2010.

Insect-trapping yellow sticky cards were set out in plots of tomatoes, peppers, carrots, and beets grown under different fertilization schemes. Plants were fertilized in 2009 with either 0, ½ rate, or full rate 24-8-16 conventional fertilizer (0, ½ tablespoon, or 1 tablespoon per gallon of water). In 2010, 0, ½ rate, or full rate organic fertilizer was also utilized (0, 1 tablespoon, or 2 tablespoons per gallon of water).

Sticky cards were set out, one per plot, and changed every two to three weeks. Cards were read on each side in 3 cm blocks and the numbers of insects in the orders Diptera (true flies), Hymenoptera (ants, bees, etc.), Thysanoptera (thrips), Orthoptera (crickets, grasshoppers, etc.), Coleoptera (beetles), Odonata (dragonflies, damselflies, etc.), Hemiptera (whiteflies, aphids, leafhoppers, etc.), Neuroptera (lacewings, etc.), and Lepidoptera (moths, butterflies, etc.) were recorded.

Results and Discussion

In 2009, weed control plots were almost completely destroyed by grasshoppers, so little data were recorded. Hand weeding three plots required a total of 6.6 minutes on two occasions.

In 2010, the control plots contained bindweed, pigweed, and foxtail. The clear plastic mulch cracked and disintegrated, but no weeds grew through the plastic. In the black plastic mulch plots, no weeds grew through, and the plastic stayed intact. The polyethylene fabric effectively stopped weeds from growing through, but it ripped. Bindweed grew through the wood chip mulched plots. The hand-weeded plots required 9.5 minutes to weed out the bindweed, 51 seconds to weed out pigweed and bindweed, and 20 seconds to weed out the foxtail. On flame-weeded plots, it took 6.5 minutes to burn bindweed, 11.5 minutes to weed out bindweed and kochia, and 3.25 minutes to remove a small amount of bindweed and pigweed.

Insect activity in 2009 showed no discernible differences among the fertilizer treatments. Thrips and flies comprised the largest populations on the cards in both 2009 and 2010.

A recommended weed management strategy cannot be discerned from this study as grasshoppers would have to be controlled first. Insect populations and orders varied according to time of the growing season. Thrips populations can be expected to be very high during July and August. This is important not only because thrips cause plant damage, but they are also vectors of viruses, which render plants unusable.

Acknowledgments

We would like to thank former graduate student Diana Cochran for her assistance.

Contact Information

For additional information, contact Karen Panter at 307-766-5117 or kpanter@uwyo.edu. The full final report can be found online at

http://wyagric.state.wy.us/images/stories/news/specialtycrop/scg-vegetabletrials.pdf

2011 SAREC Field Day

J. Freeburn[1]

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

Project funded by the Wyoming Agricultural Experiment Station.

Introduction

The Sustainable Agriculture Research and Extension Center (SAREC) near Lingle began with the purchase of the first property in 2002. The UW employees from both the Torrington and Archer stations moved to SAREC in 2006 and began research in earnest. SAREC is a unique facility among agricultural research centers in Wyoming because of the foresight of the review team that developed the strategic plan in 1999 and 2000. The team specified that SAREC would be a facility where integrated, systems-oriented research would take place. SAREC has nearly 400 acres of irrigated cropland, more than 1,000 acres of rainfed cropland, and more than 2,000 acres of native range and improved pasture along with a feedlot capable of handling both cattle and sheep. The employees at SAREC are dedicated to completing relevant research that will benefit the agricultural community in southeast Wyoming, other areas of the state, and beyond. There are three tenure track faculty members, one research scientist, a research associate, a project manager, and an operations staff of up to nine supporting the approximately 75 research projects completed each year at SAREC. Research efforts range from long-term systems projects funded from U.S. Department of Agriculture grants to small demonstrations completed at the suggestion of SAREC Focus Group leaders.

2007-2011 SAREC PRECIPITATION

Month	2007 Precipitation	2008 Precipitation	2009 Precipitation	2010 Precipitation	2011 Precipitation	30 Year Average Precipitation
January	0.13	0.1	0.46	Trace	0.18	0.31
February	0.13	0.18	0.15	0.92	0.18	0.4
March	0.76	0.25	0.66	1.04	0.99	0.7
April	1.48	0.42	2.57	3.38	2.37	1.68
May	1.46	1.91	0.91	2.62	4.57	2.54
June	0.21 Hard freeze on 6-8-07	2.43	3.27	4.31	1.77	2.09
July	0.99	1.4	0.86	1.01		1.78
August	0.28	2.44	3.45	0.85		1.19
September	0.25	1.04	0.65	0		1.27
October	1.53	0.55	1.64	0.95		0.95
November	0.09	0.34	0.12	0.55		0.57
December	0.99	0.04	0.37	0.59		0.36
Total	8.3	11.1	15.11	16.22	10.06	13.84

Background Information

The weather at SAREC has been highly varied the past few years – 2008 was very dry, but both 2009 and 2010 were above average for precipitation. That wet trend has continued into 2011. September 2010 was record dry, with zero precipitation recorded. The dry fall conditions made the establishment of rainfed wheat a difficult proposition.

Facility Improvements and Acquisitions

In the past year, two major improvements have taken place at SAREC. A high tunnel greenhouse was constructed with grant funds from the Wyoming Business Council's Agribusiness Division and the University of Wyoming. A large machine shed was also constructed to keep valuable research and production machinery in good shape.

Additional improvements such as a new concrete pad for silage storage, a new stock water pipeline, a new plot planter built by Bob Baumgartner, and a used farm truck were acquired in the past year.

Educational programs such as the ongoing High Plains Ranch Practicum are held at SAREC. A crop field day takes place in July, and a new livestock field day was held in December. Diverse groups such as the Wyoming Bankers Association, the Goshen County Stockgrowers and Cattle-Women, school groups, the Wyoming Youth ChalleNGe, international exchanges, local conservation districts, and others used SAREC as a meeting and educational site in the past year.

Acknowledgments

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

Contact Information

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Greenhouse Gas Emissions from Dryland Winter Wheat Fallow System under Conventional, No-Till, Organic and Transition to Organic Management

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Project funded by USDA NIFA Organic Transitions program

Introduction

The fallow phase of a conventional dryland winter wheat-fallow cropping system relies on a combination of tillage and chemical weed control aimed at storing sufficient amounts of water in soil profile for the subsequent winter wheat crop. Rising costs of management inputs coupled with declining climatic certainty in this region, necessitates exploring less costly production alternatives that continue delivering economically feasible returns. Alternatives include improving soil through reducing tillage intensity or reducing chemical inputs and converting to organic operation. There is a growing interest in organic production because of the high premium for organically-certified winter wheat (https://attra.ncat.org/attra-pub/organic crop.html; retrieved June 25, 2011). Studies conducted in different climatic systems indicate that organic practice supports building soil organic matter through increased biomass inputs to the soils. However, dryland winter wheat organic production does not rebuild soil organic matter (SOM) effectively as it depends on frequent soil disturbance and carbon (C) and nitrogen (N) mineralization and losses to greenhouse gases (GHG) that are the major factors for global warming and climate change. Moreover, very few studies have been conducted to estimate the changes in soil fertility and productivity while transitioning to organic dryland farming. We hypothesize that transitioning to organic from a no-till system is more sustainable than transitioning to organic from a conventional system because of the significant SOM build up in the no-till fallow phase.

Objectives

The overall objective of this study is to compare agroecosystem C and N budgets in long-term conventional (CT), no-till (NT), and organic (OR) systems, and assess the effects of transitioning from CT and NT to organic production. Specifically, we are monitoring carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions, soil quality, plant growth parameters, weed ecology, residue inputs, and crop productivity.

Materials and Methods

This research was established at the University of Wyoming James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) as a three-year monitoring study in wheat-fallow strips managed as conventional, no-till and organic approaches. Conventional wheat-fallow utilizes tillage, and chemical weed control; no-till uses chemical weed control only; and organic uses tillage only. In addition to monitoring long-term management, treatments representing systems in transition to organic (TO) were superimposed in conventional and no-till strips. The TO plots have tillage as the only form of land preparation and weed control. This research follows winter wheat and fallow phases replicated five times. Soil (0-10 cm), plant height, growth stage and biomass, soil and air temperature, and GHG measurements are taken biweekly. Each plot is equipped with a permanently installed PVC base. Gas samples are collected to 15-mL pre-evacuated glass vials sealed with rubber septa at 0, 15, and 30 minutes after the chamber is deployed on top of the base. Gas samples are analyzed for N_2O, CH_4 and CO_2 on a Schimadzu GC-2014 gas chromatograph at the agroecology laboratory in the Plant Sciences Department. Soil, plant, and residue samples are analyzed for total C and N. Soil samples are analyzed for water content, plant available N, and labile C. Another set of soil samples is collected from 0-5 and 5-15 cm depth at the beginning of the experiment for baseline assessment of general soil characteristics.

Preliminary Results

Initial measurements in long- term CT, OR, and NT plots indicated that a CT approach is an important source of N_2O and CO_2 in wheat phase only, possibly due to higher tillage. No-till increases surface residue accumulation (Fig.1) and reduces N_2O and CO_2 emissions in wheat phase only (data not presented). The organic approach had less N_2O but greater CO_2, which is indicative of low SOM-N and high turnover of plant residue through repetitive tillage. Transitioning from no-till to an organic system may help offset spring CO_2 emissions in the organic wheat phase.

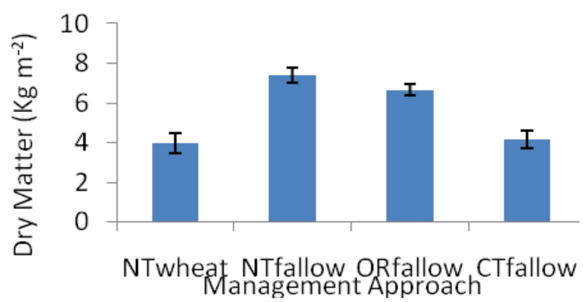

Fig. 1: Early spring soil surface residue dry matter (kg m^{-2}) from no-till winter wheat (NTwheat) and fallow (NTfallow), organic fallow (ORfallow), and conventional fallow (CTfallow) sampled in April 2011. Note: no residue present in ORwheat and CTwheat.

Acknowledgments

We would like to thank Dr. Jim Krall, Robert E. Baumgartner, Sarah Legg, Jenna Meeks, and others for field and lab assistance.

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Stripe Rust Management in Irrigated Winter Wheat with Foliar Fungicides

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[1] Professor, [2] Research Scientist, [3] Research Associate, Department of Plant Sciences.

Introduction

Rust diseases on small grains can be yield-limiting in Wyoming and other production areas in the High Plains. Increased rust severity and increased yield loss is associated with cool, wet weather early in the growing season and the planting of susceptible cultivars. Little information is available about rust impact as well as rust management on locally grown winter wheat cultivars. Therefore, research was initiated to study the effect of stripe rust on winter wheat.

Objectives

Objectives were to determine the effect of local isolates of the stripe rust fungus (*Puccinia striiformis*) on a popular winter wheat cv. 'Jagalene.' Several new fungicide formulations (Prosaro®, Stratego Pro®, and TwinLine®) were tested for rust management efficacy under southeast Wyoming growing conditions.

Materials and Methods

Research plots were at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Plots received overhead irrigation to increase disease pressure and to provide a rigorous challenge for disease management. Five foliar fungicide treatments were evaluated for rust management. The field plot was planted on October 24, 2009, and fungicide treatments were applied June 2, 2010, when flag leaves were fully emerged. Treatments were applied in a total volume of 18.6 gal/A at 30 psi boom pressure (four #8002 flat fan nozzles spaced at 20 inches). Stripe rust was first evaluated on June 18. Plants were evaluated for stripe rust incidence (presence) and stripe rust severity (surface area affected) on the flag leaves. Plots were harvested on August 12 to determine yield, moisture-content, and test weight. All data were analyzed via ANalysis Of VAriance, or ANOVA. A portion of the data is presented below.

Results and Discussion

Moderate to severe stripe rust developed in the field from natural infection (**Table 1**). Evaluation on June 18 revealed all fungicide treatments significantly reduced the number of flag leaves infected with stripe rust (93 to 100 percent reduction) compared to the nontreated check ($P \leq 0.05$). On June 18, all treatments significantly reduced stripe rust severity (leaf surface area affected) compared to the nontreated check ($P \leq 0.05$). The greatest rate of Prosaro® had significantly less stripe rust severity compared to the lowest rate of Stratego Pro® ($P \leq 0.05$). By June 30, stripe rust was present on 100 percent of the flag leaves. All fungicide applications made on June 2, however, significantly reduced disease severity on flag leaves by 37 to 85 percent compared to the nontreated check (*P*≤0.05). All fungicide treatments significantly improved yields (range 79- to 113-percent increase) compared to the nontreated check, and all fungicide treatments significantly improved test weights (*P*≤0.05). The moisture percentage present in harvested grain for all fungicide treatments was significantly greater than the nontreated check (data not shown, *P*≤0.05). This research revealed that it is essential to protect the flag leaf from rust to achieve yield potential. The new generation fungicides provide excellent tools for protecting flag leaves when rust is anticipated. The need to protect the flag leaf from rust and other diseases provides the best guidance for timing fungicide application(s) and minimizing fungicide use.

Contact Information

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Table 1. Results for stripe rust management in irrigated winter wheat with foliar fungicides (G.D. Franc *et al*. 2011).

Treatment and rate (product/A)[Z]	Stripe rust disease estimates per 5 ft of row			Winter wheat yield and quality	
	# flag leaves infected (18 Jun)[Y]	% of flag leaf surface area affected (18 Jun)[X]	% of flag leaf surface area affected (30 Jun)[X]	bu/A	test weight (lbs/bu)
Nontreated check	49.9 a[W]	15.0 a	88.5 a	25.4 c	31.9 b
Stratego Pro (4.0 fl oz) + Induce (0.125 % v:v)	3.6 b	1.5 b	56.0 b	45.4 b	47.2 a
Stratego Pro (5.0 fl oz) + Induce (0.125 % v:v)	1.6 b	1.2 bc 0.3 bc	37.0 bc	53.4 a	46.2 a
Prosaro 421 SC (5.0 fl oz) + Induce (0.125 % v:v)	0.1 b		13.0 e	54.2 a	46.4 a
Prosaro 421 SC (6.5 fl oz) + Induce (0.125 % v:v)	0.0 b	0.0 c	17.0 de	52.3 ab	46.4 a
Twinline (8.0 fl oz)..	0.9 b	1.0 bc	28.0 cd	53.4 a	51.3 a

[Z] Fungicides were applied on June 2 with the aid of a portable (CO_2) sprayer in a total volume of 18.6 gal/A @ 30 psi boom pressure (four #8002 flat fan nozzles spaced @ 20 inches). The wheat had a fully emerged flag leaf at the time of application. Plots were harvested on August 12. Stratego; propiconazole + trifloxystrobin: Prosaro; tebuconazole + prothioconazole: Twinline; pyraclostrobin + metconazole.

[Y] Evaluations were based on the average of ratings taken from two five-foot row sections per plot. An estimated 200 flag leaves were present per five-foot row section.

[X] Data were converted to percentage using the appropriate Barratt-Horsfall conversion scale.

[W] Treatment means followed by different letters differ significantly (Fisher's protected LSD, *P*≤0.05).

Soil Organic Matter and Microbial Dynamics Of Sustainable Agriculture Systems Project

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Project funded by USDA-NRI Agricultural Prosperity for Small and Medium Sized Farms Program.

Introduction

Wyoming crop and livestock producers have always had options for utilizing soil and water resources for higher productivity and better environment. Growing interest toward certified organic and reduced-input approaches indicates a response of the farming community to maintain high productivity, environmental quality, and farming system sustainability (Clark, 1998). Greater diversity of crop rotations, inputs of organic materials such as farm-yard-manure and green manure, and minimum soil disturbance are the practices considered to support higher soil microbial activity and thereby positive effects on soil quality. However, very little is known about the effects of differing production systems and approaches on soil organic matter (SOM) and microbial dynamics on the Wyoming High Plains, especially in the irrigated systems of crop-range-livestock production.

Objectives

The main objective of this research is to evaluate SOM and microbial dynamics of conventional, reduced input, and organic approaches of crop-range-livestock production in eastern Wyoming. More specifically, we are interested in evaluating total SOM and dynamics of active fraction of soil organic carbon (SOC) and nitrogen (N), microbial community composition, and functional groups of nitrogen cycling microorganisms.

Materials and Methods

This study constitutes a part of an interdisciplinary, long-term project evaluating economic and environmental sustainability of organic, reduced input and conventional production approaches of cash crops and beef-calf production on the Wyoming High Plains. The conventional production approach uses inputs like chemicals and fertilizers to maximize production. On the other hand, the reduced-input production approach uses production inputs like conservation tillage and integrated pest management to supplement more intensive management. In the organic production approach, pest control and nutrient management are based on practices allowed by the USDA National Organic Program standards. The experiment was established in 2009 using the overhead sprinkler irrigation system at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC). Soil samples are collected from each plot four times a year from transects set in each plot. Soil cores (0-6 inch) collected from sixteen sampling points along the transect are composited, homogenized, placed in sterile sample bags, and stored at 39°F for SOM dynamics study, -4°F freezer for microbial community observation, and -112°F for microbial functional group study. Laboratory analyses are run on different laboratories for SOM and microbial dynamics parameters.

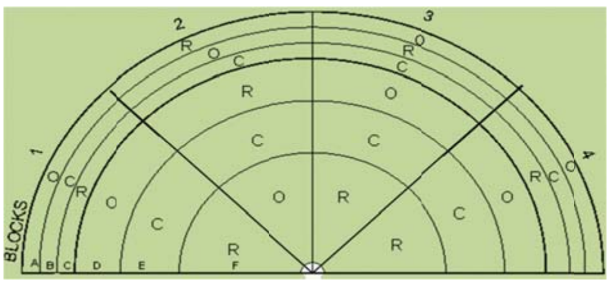

Figure 1. Plot layout: Tiers A, B, C = cash-crop plots; tiers D, E, and F = beef-calf plots: O = organic, C = conventional, R = reduced-input.

Results and Discussion

Results from the first and second years revealed that SOC and N parameters have started responding to the management approaches and production systems. For inorganic N in beef calf system, the fraction of soil N that is readily available for plant uptake, there were no differences in 2009 (Beef-09), but in 2010 reduced input plots had more inorganic N than conventional and organic plots (Beef-10). In the cash crop system (Cash-09 and Cash-10), inorganic N in conventional and reduced input plots was variable, but higher than organic plots. Similarly, management approaches affected the total mineralizable carbon and N, which is the amount that is released from SOM during a season, microbial community composition, and other soil quality variables. Groups of soil microbes with specific roles in cycling N are expected to respond to management approaches, but are to be analyzed. Further investigation will lead to better understanding of the differences among these management approaches in the cold, dry conditions of Wyoming crop-range-livestock farming.

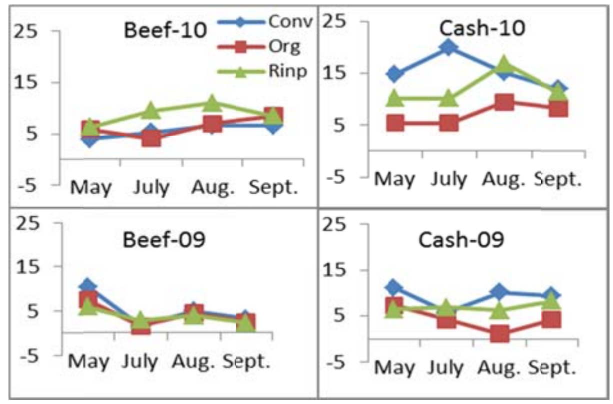

Figure 2. Seasonal dynamics of inorganic N in beef calf and cash crop plots 2009-2010.

Acknowledgments

We would like to recognize the hard work of our laboratory assistants, SAREC crew, and others who supported this research.

Contact Information

For additional information, contact Jay Norton at jnorton4@uwyo.edu.

Reference

Clark, M.S., W.R. Horwath, C. Shennan, and K.M. Scow. Changes in soil chemical properties resulting from organic and low-input farming practices. Agronomy Journal. 90: 662–671.

Trace Gas Emission from Conventional, Reduced-Input, and Organic Approaches Of Crop–Range–Livestock Farming In Wyoming

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Project funded by USDA-NRI Agricultural Prosperity for Small and Medium-Sized Farms Program.

Introduction

There is growing interest toward organic and reduced-input management of cropping systems. Increasing interest in these practices has been accelerated by the escalating input costs, and increasing dependence on off-farm inputs. Organic and reduced input management approaches have several benefits to the soil and environmental health, both immediately and into the future. These management approaches, however, might have environmental impacts due to emissions of greenhouse gasses (GHGs) such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). There is a wide research gap on greenhouse gas emissions from agricultural lands in Northern High Plains. Therefore, we designed an experiment to compare efficiency of crop and soil management practices on mitigating trace gas emission. We established six sub-plots within each production system (conventional, reduced input and organic approach of cash crop and beef-calf forage production) imbedded in the on-going sustainable agriculture system project (SASP). This research bears its strength to provide valuable information on emissions of greenhouse gases from plots under conventional, reduced input, and organic management approaches of cash crop and beef-calf forage production. Any payment for reduction in GHGs or sequestration of CO_2 may improve the economic performance of some of these alternative production approaches. Therefore, full understanding of the differences across practices is vital in order to fully evaluate environmental and economic performance of the production alternatives.

Objectives

The main objective of this research is to evaluate the economic and environmental sustainability of conventional, reduced input and organic approaches of crop-range-livestock production in an irrigated system. More specifically, we are interested in evaluating the emission of greenhouse gases such as CO_2, CH_4 and N_2O associated with these production approaches.

Materials and Methods

The experiment was established at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC), near Lingle. Six 6.5 ft x 6.5 ft plots were established randomly within each treatment of the SASP field (**Figure 1**). Greenhouse gas samples are collected from chambers consisting of permanent polyvinyl chloride (PVC) pipe anchor (8-inch i.d.; 1.97-inch height) and a PVC cap (8-inch i.d.; 2.95-inch height) with a vent tube and sampling port. Gas samples are collected with a syringe at 0, 15, and 30 minutes after installation of chambers, gas samples in the syringes are injected into 15-mL evacuated glass vials sealed with rubber septa, and stored in cold place for laboratory measurements (**Figure 2**). Composition of the gas trapped in chambers is measured on an automated Gas Chromatograph (Schimadzu GC-2014) equipped with thermoconductivity, flame ionization, and electron capture detector.

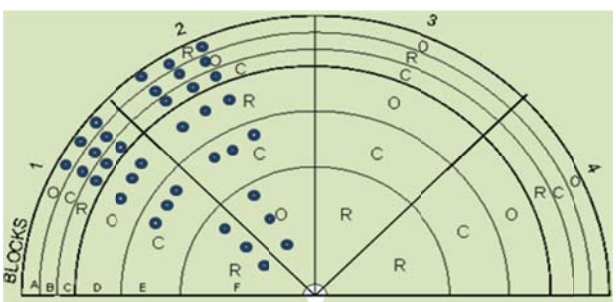

Figure 1. Plot layout: Tiers A, B, C = cash-crop plots; tiers D, E, and F = beef-calf plots, and gas emission was measured in replicate 1 and 2.

Results and Discussion

This experiment has been recently established at SAREC, and we are in very early stage of data collection and protocol development for field and laboratory evaluation. However, effects of soil management approaches on soil biological activities and, subsequently, the difference on the emission of greenhouse gases are expected. Conventional tillage exposes soil and allows rapid oxidation of organic matter thereby resulting into higher gas flux to the atmosphere. Moreover, fertilizer input provides pulse to microbial oxidation. Reduced tillage and application of organic manures in alternative production systems such as reduced input and organic production system, on the other hand, slows down the physical oxidation and chemical breakdown of organic matter thereby reducing the flux of greenhouse gases to the atmosphere. Therefore, we expect lesser emission of greenhouse gases from reduced input and organic plots as compared to the conventional plots. However, evaluation of result will provide wider insight on how these management approaches affects the environment.

Figure 2. Gas chambers established in irrigated field and measurement of trace gases

Acknowledgments

We would like to recognize the hard work of the field and lab assistants who have supported this experiment.

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Assessment of Fenugreek for Adaptation to Southeast Wyoming

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Project funded by the Wyoming Department of Agriculture through the U.S. Department of Agriculture's (USDA) Specialty Crop Grant program.

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is a valuable specialty crop in the family of *Fabaceae*, and it is used both as an herb and as a spice. Recent studies have shown that consumption of fenugreek can decrease cholesterol levels in liver and blood plasma and reduce blood sugar levels thus decreasing diabetes incidence. Fenugreek has been reported to be a good breast milk stimulator. Also, fenugreek has potential to be used as animal feed. Unfortunately, there is no known information available on whether this important specialty crop will grow to maturity in the central High Plains of Wyoming.

Objectives

The objective of the project is to evaluate some promising genotypes/accessions of fenugreek in two varying Wyoming environments for the phenotypic adaptability and stability for growth, seed yield, and quality.

Materials and Methods

Seeds of 13 genotypes/accessions were sown in replicated experiments during the late spring of 2010 at two locations: James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle (irrigated and dryland) and the Laramie Research and Extension Center (LREC) (irrigated). The seeding rate was 25 pounds pure live seed (PLS)/acre. For forage yield, plots were mechanically harvested in late August-early September, 2010. The seeds were harvested using a combine in mid-October, 2010.

Results and Discussion

Initial forage dry matter (DM) data showed promising and interesting results for some of the lines (**Table 1**). For example, at SAREC, line F80 produced the highest DM yield (2,130 pounds/acre) while line IT produced the lowest DM yield (950 pounds/acre) under irrigated conditions. In contrast, line IT produced the highest DM yield (740 pounds/acre) in dryland conditions. Dry matter yield variations were also observed at LREC under irrigated conditions with the highest yield (1,380 pounds/acre) from line F96. Similarly, large variations were also observed for seed yield under irrigated (range 730-2,010 pounds/acre) and dryland conditions (range 60-350 pounds/acre) at SAREC and under irrigated condition at LREC (range 20-520 pounds/acre) (**Table 1**). The highest seed yield (2,010 pounds/acre) was obtained from line F96 under irrigation at SAREC. Forage quality was in the acceptable range at both locations; the range of crude protein was 14-20 percent (complete data not shown).

The study is being repeated in 2011. It is expected that selection of well-adapted, high-performing fenugreek genotypes/accessions may result in development of cultivars that will be specifically suitable for Wyoming and neighboring states.

Acknowledgments

The Wyoming Department of Agriculture, through the USDA, for funding and Emi Kimura for assistance in data collection.

Contact Information

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Table 1. Forage dry matter (DM) and seed yield of fenugreek genotypes/accessions under irrigated and dryland conditions at SAREC and LREC in 2010.

Genotypes/ accessions	SAREC		LREC	SAREC		LREC
	Irrigated	Dryland	Irrigated	Irrigated	Dryland	Irrigated
	Forage DM yield (pounds/acre)			Seed yield (pounds/acre)		
Amber	1270	310	970	750	80	20
F17	1350	520	1250	1480	130	60
F70	1350	300	290	900	60	90
F75	1380	560	600	1360	180	190
F80	2130	330	620	1040	100	100
F86	1550	310	400	1060	150	170
F96	1610	670	1380	2010	350	310
IT	950	740	620	730	130	250
L3068	1040	340	160	810	160	50
LRC3375	1500	460	1140	1340	200	520
LRC3708	1630	410	900	1300	140	370
Tristar	1370	260	840	1170	170	200
X92	1300	450	830	1090	180	130
LSD(0.05)	1000	330	630	400	250	320

Cool-Season Grass Response to Irrigation, Drought, and Planting Time

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Project funded partially by The Samuel Roberts Noble Foundation.

Introduction

Demand for new and suitable plant materials is a long-term issue and is increasing continuously, especially in the Intermountain West. Cool-season grass pastures are essential components in the West; however, the yield and quality of these grasslands are low and declining. Major limitations are lack of appropriate varieties or selections and limited growth response to irrigation and/or dryland conditions.

Objectives

The objectives of this study are to evaluate different advanced lines of C3 grasses with the inclusion of some local varieties or cultivars in relation to their growth, yield, and quality response to irrigation, drought, and planting time; and to develop proper management strategies to improve production.

Materials and Methods

Species used in this study include tall fescue (seven lines), tall wheatgrass (three lines), western wheatgrass (five lines), and wildrye (two lines). Fall planting was made in late August 2008 whereas spring planting was in early May 2009.

Results and Discussion

Data collected on different growth parameters, persistence, and forage quality in 2009 and 2010 for both plantings seem to be significantly different among species and lines. For example, forage dry matter yield varied significantly among lines and even lines within same species (**Tables 1** and **2**). Data will be collected intensively each spring and fall for at least two more years. Data are being collected in 2011. It is expected that selection of well-adapted, high-performing genotypes/lines of C3 grasses may result in development of cultivars that will be specifically suitable for Wyoming and neighboring states.

Acknowledgments

The Noble Foundation for partial funding.

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Table 1. Forage yield of different cool-season grasses in 2009-10 growing season under irrigation at SAREC.

Species	Line/cultivar	Dry matter yield (pounds/acre)		
		First cut	Second cut	Total
		6/7/2010	7/27/2010	
Canada wildrye	NFCWR1	2595	2638	5233
	Mandan	3632	2675	6307
Tall fescue	97TF1584	2647	781	3427
	PDF584	3672	1387	5059
	Barolex	2343	1264	3606
	Enforcer	2653	1394	4047
	Fawn	2975	1543	4519
	JesupMax	2931	1230	4162
	TFSoft	2899	1473	4372
Tall wheatgrass	NFTW6001	2967	1439	4406
	NFTW6020	2336	1725	4061
	Jose	2995	1955	4950
Western wheatgrass	NFWW8070	2805	1958	4764
	TCSERD-Select	3375	2689	6065
	Arriba	2834	2263	5097
	Barton	2637	1661	4298
	Rosana	2550	1364	3914
LSD (0.05)		864	593	1194

Table 2. Forage yield of different cool-season grasses in 2009-10 growing season in dryland at SAREC.

Species	Line/cultivar	Dry matter yield (pounds/acre)		
		First cut	Second cut	Total
		6/7/2010	7/27/2010	
Canada wildrye	NFCWR1	1669	166	1835
	Mandan	2232	902	3134
Tall fescue	97TF1584	2620	422	3041
	PDF584	2983	319	3302
	Barolex	2344	470	2814
	Enforcer	1921	486	2406
	Fawn	2553	726	3280
	JesupMax	2440	598	3038
	TFSoft	1871	448	2319
Tall wheatgrass	NFTW6001	3278	289	3567
	NFTW6020	3391	388	3779
	Jose	2877	392	3269
Western wheatgrass	NFWW8070	2321	325	2646
	TCSERD-Select	2112	769	2881
	Arriba	2745	282	3027
	Barton	2297	495	2793
	Rosana	1805	442	2247
LSD (0.05)		784	279	845

Forage and Grain Yield Potential of Small Grains in the Great Plains of Wyoming

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Project funded by The Samuel Roberts Noble Foundation.

Introduction

Small grains such as wheat (*Triticum aestivum* L.), rye (*Secale cereale* L.), and triticale (X *Triticosecale* Wittmack) are primarily used as grain crops but can also be used as annual forages. They are well adapted throughout the United States and southern Canada. Although wheat, rye, and triticale are primarily grown as winter pasture, they can be used for silage or hay crops. Additionally, small grains, especially triticale and rye, are often used as cover crops or in companion seedings with legumes, particularly alfalfa (*Medicago sativa* L.). Major limitations are lack of appropriate varieties or selections and limited early fall/winter growth.

Objectives

The objectives are to test the potential for forage and grain yield of different experimental lines of wheat, rye, and triticale.

Materials and Methods

The experiment was initiated in fall 2008 at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Two experimental lines along with a standard variety as a control were used from each species. The lines were seeded into two adjacent plots with three replicates. The adjacent plots represented forage-only use and dual purpose forage- and grain-use. Harvesting for forage started at the same time for both plots but stopped for forage- and grain-use plots at first hollow stem stage. The first harvest was on November 26, 2008 (both plots), second harvest was on May 11, 2009 (forage-only use plots), and third harvest on June 16, 2009 (forage-only use plots). Seed harvest was on July 31, 2009 (forage- and grain-use plots).

Results and Discussion

Although this is an ongoing experiment, the first harvest indicated a significant difference between lines for forage yield

(**Photo 1, Table 1**). For example, the range of triticale forage yield varied from 408 pounds/acre (control 'Presto') to 980 pounds/acre (line NF96213) at the first harvest. There was not enough forage to harvest for winter rye at first cut. Rye and triticale lines seemed to produce more early growth compared to the controls. Experimental lines performed similar to or, in some cases, better than controls. Likewise, forage yield differences were also observed for seed yield among the lines (e.g., wheat, 2,002-3,837 pounds/acre), (rye, 2,352-3,237 pounds/acre), and (triticale, 2,089-2,854 pounds/acre) (**Figure 1**). The controls had better seed yield than experimental lines; however, line NF95134A (wheat), Maton II (rye), and NF96210 (triticale) among the lines had the greatest seed yield potential. Higher forage producer lines produced greater seed yields.

The study is being repeated in 2010-11, and it is expected that the study will show significant differences between species or lines and provide useful information to producers, scientists, academicians, and personnel of seed companies.

Acknowledgments

The study was funded by The Samuel Roberts Noble Foundation.

Contact Information

For additional information, contact the principal investigator, Anowar Islam, at 307-766-4151 or mislam@uwyo.edu.

Photo 1. Forage harvesting using a harvester.

Species	Line/Variety	Dry matter yield (pounds/acre) First cut	Second cut	Third cut	Total
		11/26/08	5/11/09	6/16/09	
Wheat	NF94120	784	1638	2624	5046
	NF95134A	760	2652	1763	5176
	Jagalene	557	3417	1931	5905
Rye	Bates RS4	768	3378	1196	5342
	Maton II	722	3610	872	5205
	Winter rye	0	2639	2345	4983
Triticale	NF96213	980	2025	1630	4635
	NF96210	845	3017	1373	5235
	Presto	408	2452	2011	4871
LSD (0.05)		214	641	993	1848

Table 1. Forage yield of different small grains in 2008-09 growing season.

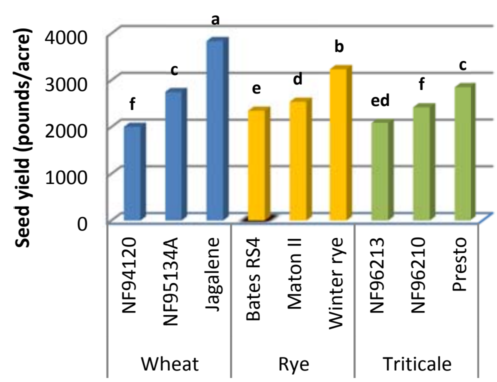

Figure 1. Seed yield of different small grains in 2008-09 growing season.

Forage Legumes Establishment Through Seed Scarification and Companion Crop

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Project funded by Department of Plant Sciences funds and allocation.

Introduction

There is increasing interest among producers in the Central West and High Plains to grow forage legumes such as cicer milkvetch, sainfoin, and medic as alternatives to alfalfa. Establishment of these legumes, however, is difficult because of low germination, hard seed coat, low seedling vigor, high weed competition, and disease. Seed scarification (a physical damage to break the hard seed coat without lowering seed quality), use of companion crops, and seed-inoculation with right inoculants may enhance establishment. Using companion crops (oat) in establishing alfalfa is common in the regions, but information is lacking whether the same technique can be unitized in other forage legumes establishment.

Objectives

Objectives of this study are to find out appropriate methods for seed scarification, apply best method(s) of scarification to increase seedling emergence in the field, and use a companion crop to enhance seedling establishment.

Materials and Methods

To accomplish the objectives, seed scarification studies were initiated in early spring 2009 at the greenhouse complex of the Laramie Research and Extension Center (LREC). Treatments included in this study were heat, freeze-thaw, mechanical, and acid scarification with five replications. A number of varieties from four legume species were used. The field study is being conducted at the LREC and the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. In May 2009, legumes were planted in four replicated plots perpendicular to oat at both locations in such a way that half of the plots had oat whereas the rest had none.

Results and Discussion

Data suggest that acid and mechanical scarifications greatly reduced hard seed contents (**Table 1**), thus enhanced germination of some of the varieties used in the study. Oat, as a companion crop, may have potential to suppress weed infestation (**Figure 1**) and enhance establishment of different forage legumes.

Contact Information

For additional information, contact Anowar Islam at 307-766-4151 or mislam@uwyo.edu.

Table 1. Hard seed (HS) of four varieties of alfalfa, three varieties of sainfoin, three varieties of cicer milkvetch (CMV), and one variety of medic as influenced by heat (2 hr), freeze thaw (F-T) (3 cycles), mechanical (Mech.) (5 min), and acid scarification (5 min) (SD in parentheses)

		Control	Heat	F-T	Mech.	Acid
		HS (%)				
Alfalfa	Ranger	0.0 (0.0)	1.0 (1.4)	0.0 (0.0)	0.2 (0.4)	1.8 (0.8)
	Vernal	6.0 (2.8)	2.2 (1.3)	0.0 (0.0)	0.0 (0.0)	1.6 (0.9)
	Ladak	6.0 (5.7)	3.0 (1.9)	1.0 (1.0)	0.0 (0.0)	3.4 (2.2)
	Falcata	7.0 (1.4)	12.0 (2.2)	0.6 (1.3)	1.2 (0.4)	2.6 (1.1)
Sainfoin	Shoshone	5.0 (1.4)	3.2 (2.8)	3.6 (2.4)	8.0 (1.9)	5.4 (3.6)
	Eski	2.0 (0.0)	1.2 (1.3)	1.0 (0.7)	2.2 (1.8)	1.2 (0.8)
	Remont	1.0 (1.4)	2.4 (1.3)	2.8 (1.3)	1.0 (0.0)	2.8 (2.2)
CMV	Monarch	77.0 (15.6)	80.8 (6.5)	73.8 (9.2)	33.0 (6.2)	74.6 (6.3)
	Oxley	63.0 (9.9)	68.4 (9.3)	61.0 (4.1)	47.2 (6.7)	59.4 (5.4)
	Lutana	63.0 (9.9)	65.8 (5.2)	57.6 (9.2)	54.4 (7.9)	63.6 (7.6)
Medic	Laramie	23.0 (7.1)	26.2 (5.4)	3.0 (2.2)	4.2 (1.9)	1.2 (2.2)

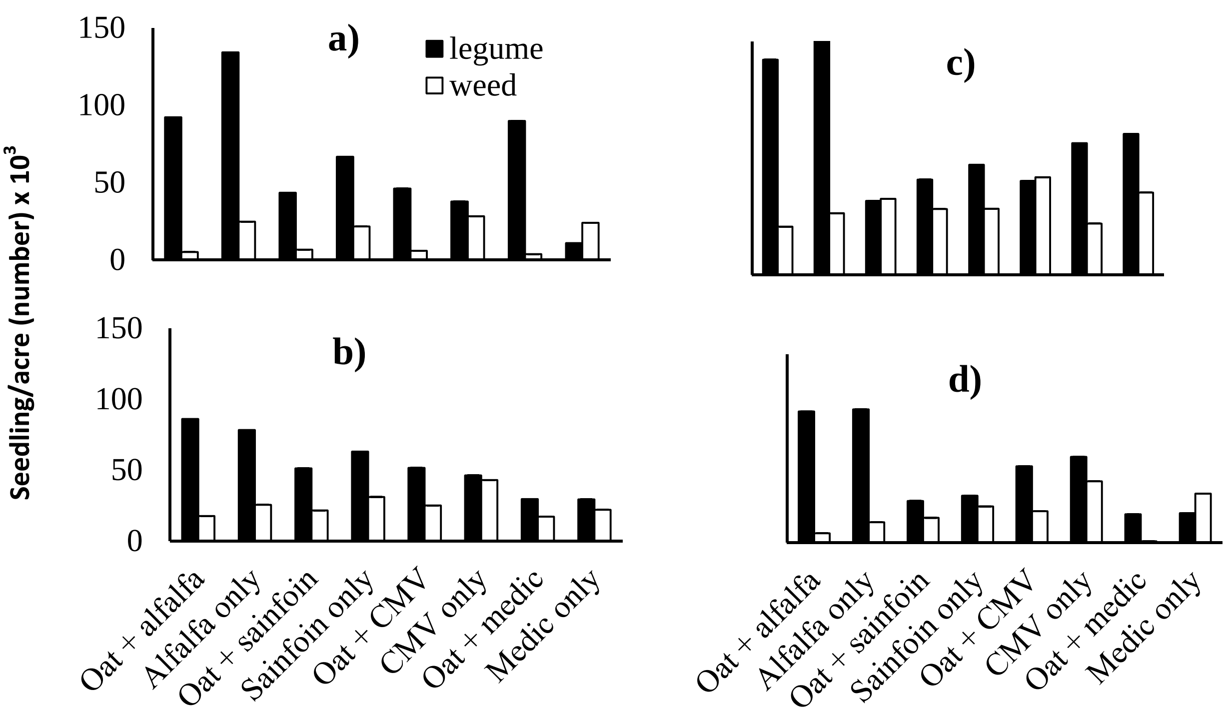

Figure 1. Legume and weed seedling count at first harvest (a) and second harvest (b) at SAREC; and first harvest (c) and second harvest (d) at LREC. The first and second harvests were made on July 14 and September 8, 2009, at SAREC and July 30 and September 25, 2009, at LREC, respectively.

Sustaining Legumes in Grasslands to Reduce Nitrogen Fertilization: A Multi-Regional Assessment

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Project partially funded by a grant from the U.S. Department of Agriculture's Current Research Information System (CRIS).

Introduction

The cost of fertilizer nitrogen (N) relative to prices received for milk, beef, and other livestock products has increased substantially. This situation is causing a re-evaluation of synthetic fertilizer N use on farms and ranches, and it is generating a renewed interest in lower cost alternatives to sustain productivity. Forage legumes offer the potential to lower fertilizer N costs on ag lands and may be a more sustainable option for pasture-based production, not only economically but also in terms of impact on water quality, fossil fuel consumption, and climate change. Sustaining forage productivity using legumes requires establishment of an optimal balance of legume-to-grass biomass in mixture. Little is known about how optimal balance of grasses and legumes will affect grassland ecosystems and their productivity. Quantifying this sustainable balance is the central mission of this research.

Objectives

The main objectives are to: 1) Identify an optimal grass-legume balance in mixture that sustains high yield stability over time and 2) Quantify legume N contribution to grass growth and its variation across environments.

Materials and Methods

The experimental design was randomized, complete with one grass (MaxQ tall fescue) and one legume (Ameristand 403T alfalfa) species planted at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC). Ten treatments were replicated three times giving 30 total plots. Five grass/legume mixtures with no supplemental N were used. Five grass/legume seed ratios were 1:0, 0.75:0.25, 0.50:0.50, 0.25:0.75, and 0:1. Five nitrogen application treatments to tall fescue monoculture plots included 45, 90, 135, 180, and 270 pounds N/acre. The study was planted in fall 2009 (September 10), and the seeding rate for both tall fescue and alfalfa was 22 pounds (pure live seed)/acre. The first split of N was applied on April 21, 2010. Two to three harvests (depending on weather) will be made each year for five years, and dry matter and quality will be estimated. An economic analysis will be conducted at the end of the study. In 2010, three harvests were made: June 7, July 26, and October 7.

Results and Discussion

The first year's forage yield data showed significant variations among the treatments (**Table 1**). For example, the highest yield (9,169 pounds/acre) was obtained from 0.50:0.50 tall fescue/alfalfa mix treatment followed by 0.25:0.75 tall fescue/alfalfa mix (7,276 pounds/acre), and tall fescue 180 pounds N (7,243 pounds/acre) treatments. Interestingly, no difference was observed between 0.25:0.75 tall fescue/alfalfa mix and tall fescue 180 pounds N treatments. The 0.50:0.50 tall fescue/alfalfa mix treatment produced more than a 100-percent increase in yield compared to only tall fescue plots (4,431 pounds/acre). There were variations among treatments for forage quality especially for crude protein (CP, range 9-20 percent) with a tendency of higher CP in higher proportion of legumes mix and higher N treatments. This is an ongoing study, and data is being collected and analyzed. The first harvest of 2011 was made June 8. It is expected that selection of appropriate grass/legume mixture may sustain high-yield stability over time and provide economic benefits to producers through high forage yield and quality and reduced input costs.

Acknowledgments

This is a regional study involving collaborators from the following NCCC-31 states: Maryland, Minnesota, Pennsylvania, Utah, Virginia, Wisconsin, and Wyoming.

Contact Information

For additional information, contact the principal investigator, Anowar Islam, at 307-766-4151 or mislam@uwyo.edu.

Table 1. Dry matter yield (pounds/acre) of tall fescue (TF)/alfalfa (Alf) mix at SAREC in 2010.

Trt	TF-Alf	1st*cut	2nd cut	3rd cut	Total
1	TF-Alf (1:0)	866	2675	890	4431
2	TF-Alf (0:1)	1273	2180	1164	4618
3	TF-Alf (0.75:0.25)	1302	2587	1726	5614
4	TF-Alf (0.50:0.50)	1342	4529	3297	9169
5	TF-Alf (0.25:0.75)	1197	3826	2252	7276
6	TF 45 lb N	1433	3149	1546	6128
7	TF 90 lb N	1162	2700	1677	5538
8	TF 135 lb N	1092	2860	1911	5864
9	TF 180 lb N	1096	3020	3126	7243
10	TF 270 lb N	1247	2502	2743	6492
LSD (0.05)		560	1583	1220	1983

*Cuts: 1st – 6/7/2010; 2nd – 7/26/2010; 3rd – 10/7/2010.

Tolerance of Tall Fescue to Aminocyclopyrachlor at Two Application Timings and Two Sowing Dates

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Project funded partially by DuPont.

Introduction

Many hay meadows, pastures, and rangelands in the western U.S. have been invaded by perennial weeds such as field bindweed (*Convolvulus arvensis*), Canada thistle (*Circium arvense*), and leafy spurge (*Euphorbia esula*). Establishment of improved forage grasses on these invaded lands can be difficult, especially if more than one invasive weed is present. Herbicide options for management of multiple weeds during the grass establishment phase are limited. For example, Paramount® (quinclorac) may be used effectively for control of field bindweed when establishing tall fescue, but it will provide only suppression of Canada thistle or leafy spurge. Milestone® (aminopyralid) provides excellent control of Canada thistle but no control of field bindweed or leafy spurge. Plateau® (imazapic) provides excellent control of leafy spurge and has been used successfully for pasture renovations, but it will cause severe injury to tall fescue if applied during the establishment phase. If multiple perennial weed infestations are present in a pasture, herbicide options for establishment of tall fescue are prohibitively expensive, as mixtures of several of the above herbicides would be required.

A promising new herbicide is currently being developed by DuPont that has excellent effect on field bindweed, Canada thistle, and leafy spurge, as well as many other perennial and annual broadleaf weeds. Additionally, this new herbicide has shown good tolerance on established tall fescue. The recently approved common name for the herbicide is aminocyclopyrachlor. It has been classified by the Weed Science Society of America as a synthetic auxin, similar to herbicides such as 2,4-D, Milestone® (aminopyralid), and Tordon® (picloram). Based on unpublished data collected by university weed scientists in several Western states, we believe that aminocyclopyrachlor may be an excellent tool for the establishment of tall fescue on hay meadows and pastures that have been invaded by perennial weeds.

Objectives

The objective of this field study is to test the tolerance of tall fescue to aminocyclopyrachlor at various rates and timings. We believe that it will be possible to find a rate and application timing that will provide adequate control of perennial weed infestations, while still being safe for newly seeded tall fescue.

Materials and Methods

Small plots at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle were utilized for this research. The study utilized three rates of aminocyclopyrachlor (0, 0.5, and 1.0 ounce of active ingredient per acre) applied at three timings (fall seeding followed by fall application; fall application prior to spring seeding; and spring seeding followed by spring application). Rates chosen for this research have provided excellent control of perennial weed infestations in other university trials (unpublished data). Three tall fescue cultivars (fawn, Kentucky-31 E+, and the experimental line PDF 584) were sown in each plot to quantify any differences between cultivars with respect to injury.

Results and Discussion

Data being recorded include periodic visual injury ratings, stand reduction, aboveground biomass (annually), and maturity date. Weed control data are also being collected for any weeds present, but this is not the main objective of this experiment.

The study is being repeated at the Laramie Research and Extension Center to **observe** the environmental and elevation effects. The plots were established in 2010 following the same protocol used at SAREC.

The reporting of data will be ongoing. It is expected that this study will generate new information for aminocyclopyrachlor to use in tall fescue.

Acknowledgments

SAREC farm crew members and Emi Kimura for assistance in data collection and harvesting.

Contact Information

For additional information, contact the principal investigator, Anowar Islam, at 307-766-4151 or mislam@uwyo.edu.

Turf Grass Variety Trials

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Project funded by the Wyoming Department of Agriculture through the U.S. Department of Agriculture's (USDA) Specialty Crop Grant program.

Introduction

Producers in Wyoming face challenges to successfully establish turf grasses because of arid to semiarid climatic conditions. There are a few varieties available, but limited scientific information is available whether the varieties are suitable for Wyoming's climate.

Objectives

To provide information for various turf grass varieties suitable for Wyoming's climate.

Materials and Methods

Two identical trials were successfully established at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) during 2009 under irrigated and dryland conditions with four replicates. The four species sown in each trial were Kentucky bluegrass (Bandera, Common 85/80, and Midnight), tall fescue (Blackwatch, Tar Heel II, and Watchdog), buffalograss (Bison, Bowie, and Cody), and blue grama (Alma, Bad River, and Hachita). Sowing of plots took place in May 2009. Sowing rates based on pounds per 1,000 square feet were 4, 10, 2, and 3 for Kentucky bluegrass, tall fescue, buffalograss, and blue grama, respectively.

Results and Discussion

Tar Heel II (tall fescue), Common 85/80 (Kentucky blue), Cody (buffalograss), and Bad River (blue grama) performed similarly or even better in dryland conditions compared to irrigated (**Table 1**) showing their high drought tolerance and low water requirement. Based on two years data, overall ranking was: tall fescue ≥ Kentucky blue > blue grama ≥ buffalograss. Tar Heel II (tall fescue), Common 85/80 (Kentucky blue), Bad River (blue grama), and Cody (buffalograss) are among the most promising varieties.

Data collection is continuing in 2011. Results obtained from this experiment warrant future detailed study.

Acknowledgments

The Wyoming Department of Agriculture, through the USDA Specialty Crop Grant program, for funding and Emi Kimura for assistance in data collection.

Contact Information

For additional information, contact the principal investigator, Anowar Islam, at 307-766-4151 or mislam@uwyo.edu.

Table 1. Turf grass variety performance under irrigated and dryland conditions at SAREC. Data (visual ratings*) were collected August 5, 2010.

Species/Variety	Coverage (%)	Vigor	Color	Dormancy (%)	Steminess	Leaf texture	Density	Seed head	Contamination† (%)
				Irrigated					
Blue grama									
Alma	95.0	7.0	6.3	17.5	7.5	7.5	8.5	9.0	20.0
Bad River	100.0	7.8	6.8	13.8	7.3	7.3	9.0	9.0	15.0
Hachita	77.5	7.0	6.8	17.5	7.5	7.5	7.8	9.0	48.8
Buffalograss									
Bison	91.3	7.3	6.8	13.8	7.3	7.0	8.5	8.3	23.8
Bowie	97.5	7.3	6.0	10.0	7.3	7.3	9.0	7.5	11.3
Cody	100.0	7.3	5.8	22.5	8.0	8.0	9.0	8.3	11.3
Kentucky blue									
Bandera	98.8	7.5	7.8	20.0	7.5	7.5	9.0	9.0	2.5
Common 85/80	96.3	7.3	6.3	52.5	7.3	7.0	8.5	9.0	2.8
Midnight	97.5	8.8	8.8	10.5	7.5	7.5	9.0	9.0	5.0
Tall fescue									
Blackwatch	100.0	7.0	6.0	50.0	6.8	6.5	9.0	9.0	0.0
Tar Heel II	97.5	7.5	7.5	42.5	6.0	6.0	8.0	9.0	0.0
Watchdog	95.0	8.3	8.0	38.8	6.5	6.5	8.3	9.0	2.5
SD (range)	0-7.1	0-1.2	0-1.5	7.1-29.9	0-1.0	0-1.3	0-1.3	0-0.9	0-23.2
				Dryland					
Blue grama									
Alma	97.5	4.8	4.3	53.8	5.3	5.3	8.0	8.8	27.5
Bad River	100.0	2.3	2.3	71.0	3.8	3.5	9.0	8.8	17.5
Hachita	93.8	3.5	2.8	71.3	3.3	3.3	8.5	9.0	40.0
Buffalograss									
Bison	86.3	4.3	4.0	60.0	4.8	4.8	7.5	8.5	66.3
Bowie	95.0	4.5	4.3	50.0	4.3	4.3	8.8	7.5	52.5
Cody	98.8	3.3	3.3	62.5	4.3	4.5	9.0	7.5	37.5
Kentucky blue									
Bandera	98.8	5.5	4.5	49.5	5.0	5.0	9.0	8.3	42.5
Common 85/80	100.0	2.5	1.5	73.8	2.3	2.3	9.0	9.0	40.0
Midnight	93.8	1.8	1.8	93.8	1.3	1.3	8.5	9.0	45.0
Tall fescue									
Blackwatch	95.0	2.5	2.5	81.3	2.5	2.5	8.8	9.0	0.0
Tar Heel II	96.3	5.0	5.5	52.5	4.8	4.8	8.3	9.0	0.0
Watchdog	91.3	4.0	4.0	68.8	3.3	3.0	9.0	9.0	0.0
SD (range)	0-15.5	0.9-3.5	0.5-3.5	4.8-42.7	0.5-3.0	0.5-3.0	0.1.5	0-1.0	0-39.0

*Visual ratings are based on 1 to 9 rating scale where, in most cases, 1=poorest or lowest and 9=best or highest. For steminess and seed head, 9=no stem or seed head and 1=highest stem or seed head. †Contamination includes weeds and other undesirable species.

Soil Fertility Challenges in Northern High Plains Organic Farming Operations

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Project funded by the U.S. Department of Agriculture's Organic Agriculture Research and Extension Initiative.

Introduction

Since implementation of the U.S. National Organic Program (NOP) in 2002, the number of certified organic farms has continually increased. According to the U.S. Department of Agriculture's Economic Research Service, Wyoming currently ranks second in total organic acreage, yet unique soil fertility challenges exist for organic farmers in the Northern High Plains areas such as Wyoming and western Nebraska. Of particular concern are issues related to low organic matter content and calcareous (lime-rich) soils that reduce phosphorus (P) availability. Furthermore, there is a perception that few educational resources exist to support Northern High Plains farmers seeking to overcome these challenges in order to transition to organic status. Phosphorus is an essential element for healthy crops, yet calcareous soils in the Northern High Plains tend to be low in this mineral. Farmers seeking to boost P in their soils must add fertilizers or other amendments; however, organic farmers are limited with respect to the fertilizers or amendments allowed for use under the NOP. Unfortunately, there is little information regarding the agronomic effectiveness of some fertilizers or amendments on calcareous soils, especially with respect to P. The Organic Agriculture Research and Extension Initiative project seeks to address these issues.

Objectives

The goal of this study is to assess the impact of alternative soil amendments on nutrient cycling, particularly P, in calcareous soils under organic management. Specific objectives are to: a) investigate the effects of alternative soil amendments (approved for use under the NOP); b) examine the agronomic and economic viability of the alternative soil amendments via bench-top trials at the Laramie Research and Extension Center greenhouse; c) monitor on-farm trials of the alternative soil amendments for comparison to the research trials; and d) assess the soil microbial mechanisms that affect organic matter and P availability through laboratory incubations of various microbial inoculants.

Materials and Methods

Field experiments are conducted on an irrigated 36-acre half-pivot (**Figure 1**) at the James C. Hageman Sustainable Agriculture Research and Extension Center.

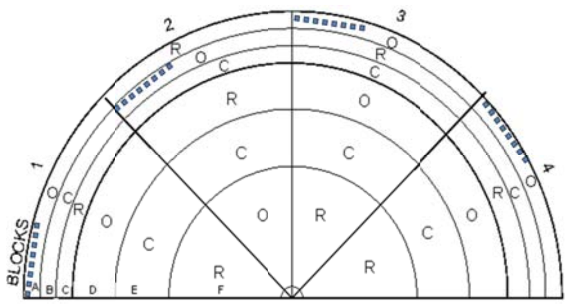

Figure 1. Plot layout of organic fields (A1, B2, A3, A4).

This project began in 2009 and utilizes a four-year, four-crop rotation: oats/alfalfa; alfalfa; corn; dry beans. The following alternative soil amendments were applied in 2010: Bio-Humas humates @ 0.95 oz. in half gallon of water/plot; SP-1 compost tea @ 2.8 oz. in half gallon of water/plot; steamed bone meal @ 1.6 lbs./plot; Ida-Gro Pelletized Phosphate @ 1.85 lbs./plot. Amendments were applied alone and in combinations at the manufacturer's recommended rate in 8 ft. x 20 ft. plots. The humates and compost tea are liquids applied using a hand-pump and 8' spray boom. The bone meal and rock phosphate are granular substances hand-cast over the plots. For comparison, two controls were included: one receiving compost/manure and one receiving no treatments.

Results and Discussion

First-year results represent baseline available P content of the soils (**Table 1**) prior to application of amendments. Results confirm that the soil is low in available P. Soil data collected in 2011 and 2012 will provide insight into any impacts of the chosen alternative soil amendments.

Table 1. Baseline available P data from 2010.

Field Location	Olsen P (ppm)
A-1	8 (low)
B-2	10 (low)
A-3	4 (very low)
A-4	4 (very low)

Acknowledgments

We acknowledge the assistance and expertise provided by the excellent SAREC staff and project manager Jenna Meeks.

Contact Information

For more information, contact Renée Gebault King at rking10@uwyo.edu or Jay Norton at 307-766-5082 or jnorton4@uwyo.edu.

Interplanting Annual Ryegrass, Wheat, Oat, and Corn to Mitigate Iron Deficiency in Susceptible Dry Edible Bean Cultivars.

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Partial financial support provided by a grant from Western SARE (GW08-016).

Introduction

Soils in Wyoming are generally calcareous in nature, exhibit high pH and are low in organic matter. Under such conditions, the solubility of iron is low resulting in low iron availability for plant uptake. Plants grown under such conditions frequently suffer from iron deficiency manifested by interveinal chlorosis beginning with the youngest leaves, appearance of necrotic spots on leaves, and increased susceptibility to insect pests and diseases. Iron is required for many physiological and biochemical processes in plants.

Studies have shown that under soil iron deficiency conditions, some grasses such as wheat, oat, corn, and barley produce root exudates in the rhizosphere which are effective in chelating sparingly soluble inorganic iron compounds. Legume-grass intercropping has been practiced worldwide for many generations to enhance on-farm biodiversity, promote biological dinitrogen fixation, increase dry matter production and grain yield, and increase resource use efficiency. Studies have demonstrated that iron deficiency chlorosis in peanut monoculture was more severe than in corn-intercropped peanuts. When the roots were physically separated between peanuts and maize, peanut plants closest to corn remained green while those further away were chlorotic suggesting that root exudates from corn increased bioavailability of iron for peanut plants.

Objectives

The objective of this study was to determine the effect of interplantings of annual ryegrass, oat, corn, and wheat, in mitigating iron deficiency in susceptible dry bean market classes in calcareous soils.

Materials and Methods

A field experiment was established under sprinkler irrigation at the University of Wyoming James C. Hageman SAREC near Lingle, Wyoming in 2009 and repeated in 2010. The study consisted of three dry bean market classes (‘Buckskin’ pinto beans, ‘Schooner’ navy beans, ‘T-39’ black beans), and four grass species (‘Gulf’ annual ryegrass, ‘Oslo’ spring wheat, ‘Russell’ oat, ‘Pioneer 38N85’ corn). Soil samples were collected from each plot at planting and during the growing season. Bean leaf samples were also collected throughout the gorwing season.

Results and Discussion

Grass intercropped dry bean plants had greater chlorophyll content than bean monocultures (**Figure 1**). Navy and black beans were more compared to pinto beans. However, all grass species had a similar effect with no statistical differences in chlorophyll content in beans intercropped with all four grass species. Therefore, all four grass species seemed to work equally well in decreasing iron deficiency symptoms.

Figure 1. Black and navy bean monocultures were more chlorotic than corresponding bean intercropped with grasses.

While results from this study showed that annual ryegrass can mitigate iron deficiency chlorosis in dry beans, grass intercropping did not result in consistently greater dry bean yields in field studies. In fact, dry bean yields were reduced by grass intercrops in some cases. Additional studies will be required to determine the appropriate grass and dry bean densities, as well as the optimum time of removal of the grass intercrop to alleviate iron deficiency chlorosis symptoms, while also increasing dry bean yield.

Contact Information

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Locally Relevant Weed Management Programs for Corn with Flexible Crop Rotation Options

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Introduction

Due to climatic restrictions, Wyoming is not one of the top producing corn states in the U.S., ranking 36th in total production of corn for grain. However, increasing corn prices and availability of adapted hybrids have consistently increased corn acreage in the northern Wyoming counties (Big Horn, Park, and Washakie), and remains one of the most profitable crops in the rotation for growers in Goshen, Laramie, and Platte counties. Because the value of corn production in Wyoming and much of the High Plains region is low compared to Midwestern states, herbicide manufacturers rarely consider issues that are specifically related to our region. As a result, corn herbicide recommendations that are appropriate for the main U.S. corn growing regions are often not applicable to growers in Wyoming.

The primary concern with many corn herbicides is their tendency to persist in the high pH, low organic matter soils that are typical in our region. Corn growers in Wyoming and the High Plains rely on much more diverse crop rotation than the primary corn producing states. A vast majority of corn herbicides on the market today prohibit planting of sugarbeet or dry bean in the year following application. As an illustration, there are currently over 45 herbicides registered for use in corn which contain the active ingredient atrazine. If an atrazine-containing product is used in corn, sugarbeet and dry bean planting is prohibited until at least the second cropping season after corn. Other effective corn herbicides such as Balance Flexx or Callisto prohibit planting sugarbeet or dry bean for 18 months after application. Consequently, it is difficult for Wyoming growers to find a suitable herbicide program that will allow them to rotate to either sugarbeet or dry bean the following year.

Objectives

The objective of this research will be to provide locally relevant herbicide recommendations for corn growers in

Wyoming and the High Plans region, that will allow for rotation to either sugarbeet or dry bean the following crop season.

Materials and Methods

Field trials have been established in field corn and sweet corn at the James C. Hageman Sustainable Agriculture Research and Extension Center. Both trials utilize preemergence (PRE) herbicides, postemergence (POST) herbicides, as well as PRE/POST combination treatments. All herbicides use in these trials will allow sugarbeet or dry bean to be planted in the following year.

Results and Discussion

This research has just been initiated, and data collection is currently underway. Full results will be made available following the 2011 growing season.

Contact Information

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MCPA Synergizes Feral Rye Control

With Beyond® Herbicide in Clearfield Winter Wheat

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Introduction

Economic losses due to feral rye in the western U.S. have been estimated at $27 million dollars. Feral rye can cause economic losses 10-times that of other annual grasses including cheat grass, Italian ryegrass, jointed goatgrass, and wild oat when growing at similar densities. Historically, selective control of feral rye in winter wheat has been difficult. Prior to the introduction of Clearfield winter wheat, feral rye management relied exclusively on cultural practices such as extended crop rotations. The introduction of Clearfield winter wheat provided growers a new tool for management of winter annual grasses in winter wheat; however, feral rye is often the most difficult winter annual grass weed to control in Clearfield winter wheat. Beyond® herbicide can provide good to excellent feral rye control, but application timing and rate have a significant effect on control. The Beyond® herbicide label requires use of either methylated seed oil (MSO), crop oil concentrate (COC), high-surfactant oil concentrate (HSOC), or a combination of non-ionic surfactant (NIS) plus a nitrogen fertilizer source. MSO can cause greater injury to certain Clearfield wheat cultivars compared to NIS. Increasing the amount of nitrogen fertilizer in the spray solution can also increase feral rye control. When used in Clearfield winter wheat, up to 50% of the carrier solution may be liquid fertilizer, with either 28-0-0, 32-0-0, or 10-34-0 being allowable nitrogen sources.

Objectives

The initial objective of this research was to evaluate feral rye control with Beyond® in Clearfield winter wheat with various combinations of liquid fertilizer and MCPA-ester. Based on the results of the field study, subsequent objectives included determining whether MCPA-ester synergizes feral rye control with Beyond®.

Materials and Methods

Field studies were conducted in Nebraska in 2006 to 2007, and Nebraska and at SAREC in 2008 to 2009 to evaluate the effect of liquid fertilizer rate (2.5, 25, or 50% of the spray solution) on the efficacy of Beyond® (imazamox) or Clearmax (imazamox plus MCPA-ester) herbicides applied in the fall or spring for feral rye control. The nitrogen fertilizer used in these studies was liquid ammonium phosphate (10-34-0) at Sidney in both years and UAN (32-0-0) at SAREC. Greenhouse studies were then conducted at the Laramie R&E Center to directly compare the effect of liquid fertilizer and MCPA-ester on feral rye control with Beyond®.

Results and Discussion

Fall applications provided greater feral rye control compared to spring applications. Adding MCPA-ester to the spray solution consistently increased feral rye control with Beyond®. MCPA-ester increased feral rye control by up to 18% at Lingle, and up to 70% at Sidney when it was added to Beyond®. Subsequent laboratory studies have been carried out with Colorado State University, but the mechanism of synergism between these two herbicides remains unclear. Although the mechanism of why MCPA-ester increases feral rye control with Beyond® is unknown, this research has shown conclusively in field and greenhouse studies that MCPA-ester has a synergistic effect with Beyond® herbicide for feral rye control. Based on these results, if feral rye is a troublesome weed in Clearfield winter wheat, adding MCPA-ester (in addition to the other recommended adjuvants) may increase control of this economically damaging weed.

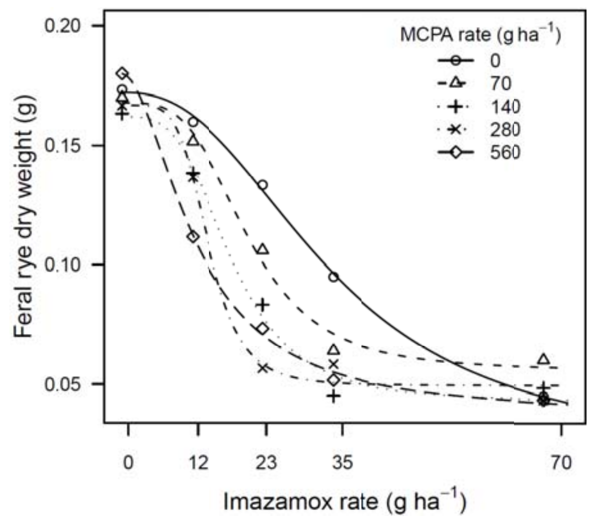

Figure 1. Response of feral rye to Beyond® (imazamox) as influenced by MCPA-ester.

Acknowledgments

Thanks to Dr. Phil Westra and Dr. Dale Shaner for helpful conversations during the later stages of this research.

Contact Information

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Proso Millet Tolerance to Saflufenacil

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Introduction

Proso millet is a short-season summer cereal with a low water requirement. Proso millet is well adapted for the crop production systems of western Nebraska, southeast Wyoming, and eastern Colorado. Proso millet grows slowly at first and is a relatively poor competitor with weeds during the first few weeks of growth. Atrazine and propazine have been shown to provide effective residual weed control in proso millet. However, no triazine herbicide is currently labeled for use in proso millet in the U.S. Chemical weed control in proso millet relies on POST-applied herbicides, and many of these herbicides can result in some crop injury.

Proso millet growers, particularly those using a no-till system, would like to have a herbicide with soil residual activity that they could apply with their preplant burndown treatment prior to planting proso millet. There are currently no soil-applied herbicides labeled for use in proso millet, which frequently results in the need to apply a POST herbicide for weed control.

Saflufenacil is a new herbicide being developed for preplant burndown and selective PRE broadleaf weed control in several crops. It has both soil and foliar activity. Previous studies have compared tolerance of proso millet, hybrid pearl millet, and foxtail millet to saflufenacil applied PRE and suggested a potential use for saflufenacil in proso millet and pearl millet, but recommended additional studies to define use rates and optimum application times.

Objectives

The objectives of this study were to evaluate proso millet tolerance to saflufenacil, and determine whether proso millet cultivars differ in their response to saflufenacil applied PRE.

Materials and Methods

Field studies were conducted in 2008 and 2009 at the University of Nebraska-Lincoln High Plains Agricultural Laboratory located near Sidney, NE and at the University of Wyoming Sustainable Agriculture Research and Extension Center near Lingle, WY. Early preplant (EPP) treatments were applied 7 to 14 d prior to seeding and PRE treatments were applied within 1 d after seeding proso millet. Postemergence herbicide treatments were applied when proso millet plants were in the 2- to 5-leaf stage of development. Crop injury was estimated for all treatments 4 wk after POST herbicide. Greenhouse studies were conducted at the Laramie Research and Extension Center to determine whether proso millet cultivars differ significantly in their response to saflufenacil. A foxtail millet cultivar was also included for comparison.

Results and Discussion

Saflufenacil treatments reduced proso millet stand compared to the nontreated check. Timing of application also affected proso millet stand with 16% greater stand following EPP compared to PRE treatments. Although saflufenacil rate did not affect plant stand when applied EPP, 19% fewer proso millet plants survived the 1.8 oz ai/A rate than the 0.9 oz ai/A rate when saflufenacil was applied PRE. It appears that crop safety is improved by applying saflufenacil EPP rather than PRE, especially at higher application rates. Grain yield was not affected by any saflufenacil treatment. In this study, proso millet plants were able to recover from the early season stand loss and leaf injury to produce grain yields that were no different from the nontreated check. While there is potential to injure proso millet with saflufenacil, particularly when applied PRE at 1.8 oz ai/A, under many conditions proso millet is able to recover from this early season injury with no affect on grain yield. Under adverse growing conditions, such as high soil pH, the ability of proso millet to recover from early season herbicide injury may be reduced and grain yields may be adversely affected. Unfortunately, we were unable to use the grain yield data from Lingle in 2009 to confirm this speculation, but crop injury symptoms suggested the likelihood of this outcome. Six different proso millet cultivars responded similarly to saflufenacil application in greenhouse studies (Figure 1). All proso millet cultivars were significantly more tolerant to saflufenacil compared to the foxtail millet 'White Wonder'. This herbicide, while relatively safe for use in proso millet, should not be used in foxtail millet, or severe crop injury may result.

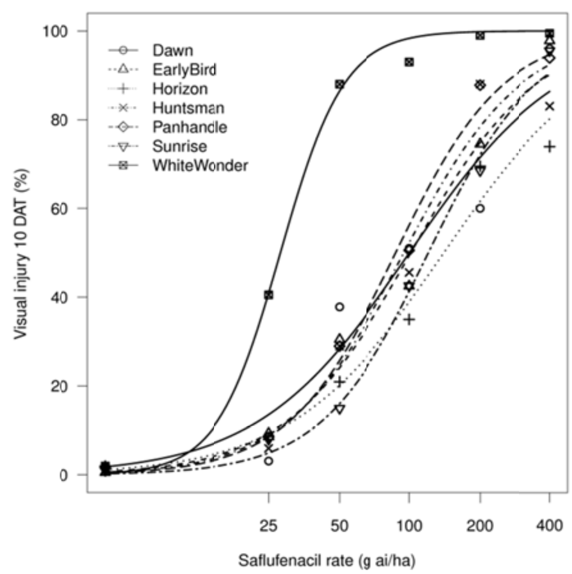

Figure 1. Injury caused by saflufenacil on six proso millet cultivars and one foxtail millet cultivar ('White Wonder').

Acknowledgments

The authors wish to recognize the assistance of Robert Higgins and Bob Baumgartner for their able assistance in conducting the field studies and Nevin Lawrence for his help with the greenhouse study.

Contact Information

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Winter Wheat Response to Pre-plant Applications of Aminocyclopyrachlor

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Introduction

A general trend for declining summer fallow acres has been observed in the U.S. since 1970, however this practice is still utilized on approximately 14.8 million acres. Weed control during the fallow period is important to prevent water use by weeds, as winter wheat yield is highly correlated to the amount of water in the soil profile at the time of planting. Use of no-till practices during the fallow period can result in greater soil water at the time of winter wheat planting and a corresponding increase in wheat yields compared to conventionally tilled fallow.

When fallow tillage is reduced or eliminated, winter wheat growers are much more reliant on herbicides for weed control. Glyphosate is perhaps the most commonly used herbicide for weed control in no-till and reduced-till fallow systems, and it has no practical soil residual activity. Herbicides that provide residual weed control can be advantageous in no-till fallow by reducing the number of herbicide applications required. Several herbicides with soil residual activity are registered for use in fallow prior to winter wheat planting, including atrazine, chlorsulfuron plus metsulfuron, and triasulfuron.

Aminocyclopyrachlor is a new herbicide that has activity on many annual and perennial broadleaf weeds. Aminocyclopyrachlor provides control of several species that can be troublesome in the winter wheat-fallow rotation of the High Plains region of the United States such as kochia and field bindweed. Grass species vary widely in their response to soil residues of aminocyclopyrachlor. The weed spectrum, grass selectivity, and soil residual properties of aminocyclopyrachlor make it a potentially useful herbicide for winter wheat-fallow rotations.

Objectives

Given the relative lack of information about crop response to aminocyclopyrachlor soil residues, field studies were conducted in Nebraska and Wyoming in 2007 through 2009 to evaluate winter wheat response to aminocyclopyrachlor applied in the fallow period prior to wheat planting.

Materials and Methods

Field studies were initiated at the High Plains Agricultural Laboratory near Sidney, Nebraska in 2007 and 2008, and at the Sustainable Agriculture Research and Extension Center near Lingle, Wyoming in 2008 to evaluate winter wheat response to aminocyclopyrachlor applied prior to planting. At all three locations, aminocyclopyrachlor was applied at four rates (15, 30, 60, and 120 g ha^{-1}) and three application timings [6, 4, and 2 months before planting (MBP)]. Wheat injury was evaluated after emergence in the fall, early the following spring, and again just prior to (Lingle) or shortly after (Sidney) seed head emergence.

Results and Discussion

Aminocyclopyrachlor caused significant yield losses when applied in the fallow period prior to wheat planting. Even when there was little to no apparent wheat injury, wheat yield loss up to nearly 90% was observed (Figure 1). Wheat injury ratings of 5% at heading corresponded to yield losses of 67, 90, and 23% at Sidney in 2008, Sidney in 2009, and Lingle in 2009, respectively. Similarly, a 10% wheat injury rating corresponded to yield losses of 80, 95, and 37%.

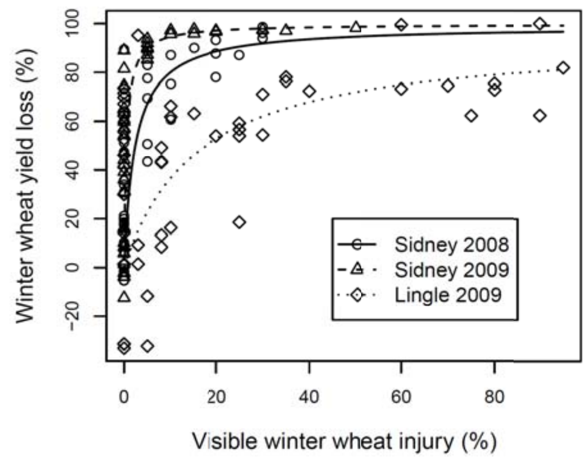

Figure 1. Relationship between winter wheat yield loss and injury symptoms in response to aminocyclopyrachlor applied prior to wheat planting for three field experiments.

The results of this research indicate that the potential for aminocyclopyrachlor to injure winter wheat is too great for this herbicide to be a tool in the winter wheat-fallow rotation. The lack of visible injury symptoms in winter wheat makes the use of aminocyclopyrachlor in fallow systems particularly risky.

Acknowledgments

The authors wish to recognize Robert Higgins and David Claypool for their able assistance with the conduct of these field studies.

Contact Information

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Evaluation of *Camelina sativa* as an Alternative Dryland Seed Crop in Southeast Wyoming

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Project funded by Wyoming Agricultural Experiment Station and Western Sustainable Agriculture Research and Education (SARE).

Introduction

The desire for energy security and new Environmental Protection Agency regulations mandating lower sulfur content in diesel fuel have stimulated interest in vegetable oil (biodiesel) as an alternative fuel. A 1- to 2-percent blend of biodiesel can restore the lubricity that was lost in diesel as a result of the lowering of the sulfur content. *Camelina sativa* has been reported to be a drought tolerant oilseed crop with oil qualities that make it attractive as a biodiesel crop.

Objectives

The goal was to evaluate camelina as a partial fallow replacement under the dryland growing conditions of southeastern Wyoming.

Materials and Methods

Since 2008, 10 acres of dryland camelina has been grown at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle to evaluate cropping systems impacts when camelina is included in a crop rotation. A winter wheat-camelina (camelina replacing fallow) rotation scheme was compared to the traditional winter wheat-fallow system in field scale replicated trials. The experimental design consisted of four replications with each treatment block (plot) encompassing approximately one-half acre. The experiment was repeated in each year of the three years. It is to be continued for a fourth year (2011). In 2011, a 12-treatment nitrogen/phosphorus (N/P) fertilizer trial has been imposed on a portion of each camelina block.

Plots were sown using conventional equipment in mid-March 2008, but they required replanting in mid-May so sowing was delayed until mid-April in 2009 and 2010. Yield sampling was accomplished by harvesting approximately 7,500 square feet of each plot using a small plot combine in late July.

Results and Discussion

There was visually and quantitatively a dramatic impact from cropping camelina in place of fallow at SAREC. Mean yields of camelina after wheat were far below economic viability in 2008 and 2009 (**Table 1**).

Year	Yield (lb/a)
2008	314 B
2009	92 A
2010	709 C
Mean	371
LSD 0.05	134

Table 1. Camelina yield over three years following winter wheat in dryland crop rotation at SAREC.

Although grasshoppers no doubt contributed to the low yield of 92 lb/acre in 2009, it is believed that, although there was some recovery from the long-term drought, lack of soil moisture was a primary factor. For the camelina season (roughly the first six months of the year, January 1 to July 30) precipitation was 45, 52, 70, 93, and 140 percent of the 30-year mean of 9.5 inches for 2006, 2007, 2008, 2009, and 2010, respectively. Camelina yield in 2010 improved substantially to more than 700 lbs/acre but was still below the anticipated threshold of 800 lbs/acre. This no doubt was from the increased precipitation during the first half of 2010, which exceeded the long term (30-year) average precipitation by 40 percent. As a consequence of the level of precipitation, wheat yields following camelina averaged 70 percent of those after fallow in 2009 and 2010 (**Table 2**). In 2010, however, yields were only marginally reduced after camelina compared to fallow (24.1 vs 25.6 bu/acre). This indicates that in some years camelina may replace fallow without harming wheat yields.

Year	2009	2010	Two-year mean
Camelina	3.2	24.1	13.7
Fallow	13.2	25.6	19.4
Mean	8.2	24.8	16.5
LSD 0.05	NS	NS	NS

Table 2. Comparison of winter wheat yield (bu/acre) over two years following camelina or fallow in dryland crop rotations at SAREC.

Acknowledgments

Western Sustainable Agriculture Research and Education grant program and the SAREC staff.

Contact Information

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Evaluation of *C. sativa* as an Alternative Irrigated Seed Crop in S.E. Wyoming

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Project funding and support came from the Wyoming Agricultural Experiment Station, Western Sustainable Agriculture Research and Education (SARE), Curtis Meier farm, and Barkley AG Enterprises.

Introduction

The desire for energy security and new Environmental Protection Agency regulations mandating lower sulfur content in diesel has stimulated interest in vegetable oil (biofuel) as an alternative fuel. A 1- to 2-percent blend of biofuel in diesel can restore the lubricity that is lost in diesel as a result of the lowering of the sulfur content. Recently, ASTM International conditionally approved the use of biofuel for blending into jet fuel. *Camelina sativa* is an oilseed crop with oil qualities that make it attractive as a biofuel crop. Against this background, there is no known information about its production potential under irrigation in southeast Wyoming.

Objectives

The goal was to evaluate camelina under sprinkler irrigated growing conditions of southeast Wyoming.

Materials and Methods

Three trials that utilized supplemental water application were conducted in 2009. Two were at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle, and a third was with a cooperator near LaGrange. All trials contained multiple varieties or experimental lines in a replicated plot design. The results, coupled with dryland results, help to explain the conclusion to date pertaining to the outlook for camelina production in southeast Wyoming.

Results and Discussion

Camelina yields under sprinkler irrigation were promising with yields averaging 1,000 lb/acre (**Table 1**) in trials of commercially available varieties. It is worth noting that at this location, a neighboring trial containing experimental lines (**Table 2**) had average yields that were a third higher, indicating that varieties with substantially higher yield potential are on the horizon. Experimental lines in the advanced experimental line nursery topped out at 2,300 lb/acre.

Cultivar	Plant height in	Test weight lbs/bu	Grain yield lbs/acre
Celine	38	47.8	1225
Ligena	36	47.4	1048
Calena	37	49.9	1022
Cheyenne	37	49.9	965
MT-5	37	49.7	938
Jungle Gold	36	50.1	801
MT-1	---	---	---
Mean	37	49.1	1000
LSD (0.05)	NS	NS	189

Table 1. Results from commercially available camelina varieties and lines at SAREC in 2009.

It is also worth noting that camelina, at maturity, can be impacted by wind and water damage as was the case at the LaGrange location. Shattering just prior to harvest is believed to have been caused by the combination of a final irrigation followed by high winds. Another factor was moderate hail during flowering, which caused stem breakage and damage to flowering heads. Shattering at maturity was observed in a 2008 trial not reported here due to high winds with rain, so shatter resistance should be considered as an objective in a breeding program. Our findings to date suggest that camelina is best suited to limited and full irrigation in southeast Wyoming. With the drought appearing to have moderated, we look forward to the final year of experiments in 2011 on dryland, because under conditions of higher precipitation, as was the case in 2010, production of camelina in place of fallow should prove to be more attractive. To date, during the first half of 2011, precipitation has been higher than the long-term average. It is anticipated, after 2011, that it can be reported that camelina may be able to replace fallow without harming wheat yields in two out of four years.

Top three lines	SAREC Yield lb/acre	LaGrange Yield lb/acre
CS6	2300	457
CS32	2173	447
CS2	2163	
CS33		434
Trial mean	2004	378
LSD (0.05)	304	108

Table 2. Summary of results from a 2009 advanced experimental line irrigated nurseries showing results from top performing lines at SAREC and a farm near LaGrange.

Contact Information

For additional information, contact the principal investigator, Jim Krall, at 307-837-2000 or jkrall@uwyo.edu.

Alternative Diets for Developing Replacement Heifers

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Project funded by the Wyoming Agricultural Experiment Station.

Introduction

Bio-fuel production is driving an unprecedented change in animal agriculture throughout the United States. The growing corn ethanol and soy-diesel industries provide significant economic benefits to grain producers; however, the resulting increases in feed prices and lack of suitable alternative energy-dense feedstuffs present serious challenges for traditional livestock production systems. In fact, corn prices have increased more than 100 percent in the last 24 months. To offset higher feed costs, alternative production strategies are needed for beef producers to remain viable and competitive in the beef industry. One means of achieving this lofty goal is to use more expensive feeds during critical stages in the life cycle of beef cattle where a high plane of nutrition is necessary for optimal economic and reproductive performance while utilizing less expensive feedstuffs during less critical periods. Adopting such alternative production systems could result in reduced feed costs without sacrificing animal performance, and thereby improve the financial stability of beef enterprises in Wyoming and across the nation.

The beef industry serves as one of the most important value-added enterprises in the U.S. with more than a million farms and ranches benefiting directly from cattle receipts. In 2002, gross receipts from the sale of cattle and calves totaled more than $45 billion and accounted for more than 21 percent of all agricultural receipts. This makes the beef sector the single largest agricultural enterprise in the U.S. Therefore, developing low-input production systems that allow U.S. cattle producers to maintain current levels of quality and productivity while concomitantly lowering input costs are essential for both the regional and national economies.

Every dollar generated from cattle sales results in $4 of total economic activity in local communities. If weanling calves from the current eastern Corn Belt cow herd (2.5 million cows) and the High Plains region (3.5 million cows) are sold for $500 each, the resulting impact would be an estimated $5 billion and $7 billion, respectively, in annual economic activity for these regions. Therefore, the potential loss of family-owned operations not only impacts the beef industry but rural communities as a whole. With the onslaught of growing competition in world markets and rising feed costs domestically, new "low-input" systems must be developed and implemented if the U.S. is to remain a leader in world beef markets.

Current low-input programs: Developing replacement heifers to the traditional benchmark of 60 to 65 percent of their mature body weight (MW) is a considerable expense for beef cattle enterprises. Therefore, lower input replacement heifer development strategies have been investigated. One such strategy utilizes low-quality, forage-based diets and targets heifer growth in an effort to achieve 50 to 55 percent of their MW at breeding; however, a potential limitation of developing heifers to only 50 percent of MW is that only 35 percent of heifers developed to 50-percent MW have been shown to reach puberty by the start of the breeding season, which is considerably less than previously observed in a large, multi-state study using traditionally managed heifers, where 89 percent (1,357/1,527) of the heifers were cyclic at the beginning of the breeding season. Heifers experiencing multiple estrous cycles prior to breeding have a greater probability of conceiving early in the breeding season. Therefore, to prevent a reduction in reproductive performance during the breeding season, low-input heifer development strategies must result in a high proportion of heifers attaining puberty several weeks prior to the breeding season. A concern with current low-input systems that rely on developing heifers to a lighter weight is that fewer heifers will attain puberty and thus have reduced reproductive performance during the breeding season. Moreover, developing heifers to only 50 percent of their MW gives the producer a lesser margin of error in animal management as compared to traditional developmental strategies. Hence, if an unforeseen managerial problem occurs, such as the harsh winter blizzards as seen in recent years, it is feasible that heifers may not achieve the 50-percent target, potentially resulting in poorer reproductive performance.

Objectives

The objective of the current study is to examine the impacts of developing heifers, both early-weaned and normal-weaned, on non-traditional diets.

Materials and Methods

One hundred heifers from the University of Wyoming herd in Laramie were randomly allotted to either a corn-based diet or a diet with dried distillers grains replacing corn. The diets were formulated to be equal in protein and energy and balanced to achieve 1.5 lbs/day. Diets were maintained from weaning until the breeding season.

Results and Discussion

Data from the first year of the study are currently being collected and will be made available later this year.

Acknowledgments

We would like to recognize the Laramie Research and Extension Center staff and the entire crew at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) for the much appreciated hard work. Additionally, we would like to thank SAREC Director Jim Freeburn for his role in organizing research efforts.

Contact Information

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Alternatives to Traditional Confinement and Concentrate Feeding Programs That Benefit Both the Ruminant and Crop Enterprise

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Project funded by the Five State Ruminant Consortium.

Introduction

Increases in feed prices and lack of suitable alternative energy-dense feedstuffs, due to the corn ethanol and soy-diesel industries, present challenges for traditional livestock production. To remain competitive in the global agricultural industry, sheep and beef producers need alternative, lower input, production systems.

The goal of this project is to provide research-based technical support that enables sheep producers to adapt smoothly to a new production paradigm that is less reliant on corn.

The capacity of livestock producers to adjust to these dramatic changes in feed availability/price and adapt to low-input growth systems that contradict traditional growth paradigms will likely determine their long-term viability.

Our working hypothesis is that we can create a sustainable, low-input management strategy that produces replacement ewes comparable in performance to ewes managed traditionally with high-cost feedstuffs by utilizing a low-input, forage-based management program that utilizes feeding energy-dense feeds during critical junctures of development. This program will allow for the development of replacement ewes at a dramatically reduced cost while increasing reproductive performance and lifetime productivity.

Objectives

The objectives of this proposal are the development of ewe lamb feeding strategies, acquisition of new knowledge, and implementation of innovative outreach programs that will impact livestock producers not only across Wyoming but over the United States.

Materials and Methods

Immediately after weaning, ewe lambs will be divided into one of three treatments: 1) hay and a corn-based supplement to achieve a growth rate of 0.75-1.0 lbs/d for 75 days. After 75 days of feeding, lambs will be fed a slow-growth diet (0.25-0.5 lbs/d) until being flushed with the high-growth diet two weeks prior to breeding, 2) crop residue and a supplement formulated to achieve a steady growth rate of 0.5 lbs/d until two weeks prior to breeding, when they will be flushed with the high-growth diet, or 3) crop residue and supplement formulated to achieve slow growth (0.25 lbs/d) until fed a high-growth diet two weeks prior to breeding.

Lambs will be housed at the James E. Hageman Sustainable Agriculture Research and Education Center (SAREC) near Lingle. Lambs will graze crop residues (corn, sugar beets, alfalfa, etc.). Jugular blood samples will be collected seven days apart at initiation of the study and again every 30 days through the breeding season to determine attainment of puberty. Lamb weights will be taken prior to feeding every 30 days to monitor growth, and diets will be adjusted accordingly. Two teaser rams with chest markers will be placed in each pen to simulate breeding. Lambs that have been marked will be removed from the pen.

Results and Discussion

Data from the first year of the study is currently being collected and will be made available later this year.

Acknowledgments

We would like to recognize the hard work of Brent Larson, Sheep Unit manager at the Laramie Research and Extension Center, and the entire SAREC crew for the much appreciated hard work. Additionally, we would like to thank Jim Freeburn, SAREC director, for his role in organizing research efforts.

Contact Information

For additional information, contact Scott Lake at 307-766-3892 or scotlake@uwyo.edu.

Effects of Age at Weaning and Post-Weaning Management On Feedlot Performance and Carcass Characteristics of Beef Steers

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Project funded by the Five State Ruminant Consortium.

Introduction

The recent surge in grain prices has placed a heavy financial burden on feedlot operators. Current feeder calf production systems rely heavily on feeding high levels of corn to increase carcass quality. While this system has been effective in producing quality carcasses (high marbling) at an acceptable body weight for more than a decade, high-input costs and grain prices will force a philosophical change in the industry toward low-input systems that produce high quality cattle grown to equivalent market weights. Forage-based development programs will be necessary if the U.S. is to remain a leader in world markets.

Objectives

Since early weaning from 120 days until about 205 days provides an excellent window for nutritional management to improve marbling, we believe feeding corn-based diets to early weaned calves followed by a period of slow growth that allows for “compensatory” skeletal growth will create equivalent-sized market cattle with higher quality grades at lower input costs. Utilizing existing low-cost feed resources such as crop residues and standing winter forage can result in a savings of approximately $60 per steer depending on feeding period length and feed costs. The savings anticipated with such a shift in management practices could prove to be the difference between negative and profitable feeding margins.

Materials and Methods

Eighty Angus-based steer calves raised at the University of Wyoming were assigned to two weaning strategies. Calves were born between March 1 and April 30, 2009, and all pairs were managed as a common group prior to the initiation of the study. Calves assigned to the early weaned (EW) strategy (n=40) were weaned July 17, 2009, at an average of 120 days of age. The steer calves in the EW were transported to the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) and placed in the feedlot. The EW steer calves were acclimated to a typical corn-based, high-concentrate diet targeting an ADG of 1.4 kg for 90 days. At 205 d of age, the EW steers were reassigned to one of two nutritional management programs in a 2X2 factorial designed study. Twenty steers remained on the high-concentrate diet from the initial EW phase until they achieved a 12th rib fat thickness of 1.3 cm (EWF), while the remaining 20 were placed on a low-input management system where they were allowed to graze corn crop residues for 60 days (EWC). Due to the cold, wet conditions, steers were supplemented for the last 28 days of residue grazing with alfalfa hay fed three times per week to achieve average daily supplemental hay intakes of 4 lb/hd for the initial 14 days, followed by 10 lb/hd during the final 14 days. At 275 d of age, the EWC steers were returned to the feedlot and fed a high-concentrate, corn-based diet until they achieved a 12^{th} rib fat thickness of 1.3 cm.

The 40 calves assigned to the normal wean (NW) strategy were weaned October 22, 2009, at an average of 205 d of age. Similar to the EW group, 20 of the NW steers were placed on a backgrounding diet for 45 d to acclimate to a corn-based, high-concentrate finishing diet (85 percent corn) and fed until they achieved a 12^{th} rib fat thickness of 1.3 cm (NWF). The remaining 20 NW steers were placed on a corn-based ration in the feedlot until the corn crop residues were available for grazing and then were allowed to graze the residue for 60 d before returning to the feedlot (EWC), where they were acclimated to a high-concentrate diet and fed until they reached a 12^{th} rib fat thickness of 1.3 cm.

Results and Discussion

Dry matter intake during the GrowSafe period tended (P=0.09) to be greater for calves that were maintained in the feedlot rather than grazed corn stalks, while G:F tended (P=0.10) to be greater for calves that had grazed corn stalks. Research has reported that early-weaned calves had the greatest efficiency, followed by calves that entered the feedlot at 202 d of age, and yearlings had the lowest feed efficiency (P < 0.01). The total number of days on feed was greater (P < 0.01) for the EW calves compared to the NW calves, as well as calves that were maintained in the feedlot compared to those allowed to graze cornstalks. Typically, steers fed high-concentrate diets from weaning until slaughter are younger than steers allowed to graze pasture after weaning prior to entering the feedlot. However, some reports have suggested that early-weaned cattle spent the greatest amount of time in the feedlot, followed by cattle that entered at 202 d of age, and yearlings spent the least amount of time to achieve a similar fat thickness. However, ADG was greatest for early-weaned calves, intermediate for calves placed into the feedlot at 202 d of age, and lowest for yearlings.

Calves that were weaned early and kept in the feedlot (EWF) tended to have heavier (P=0.09) HCW compared to NWC and EWC calves. However, no differences were detected for ADG (P=0.41), 12^{th} rib fat depth (P=0.72), LM area (P= 0.54), YG (P=0.77), marbling score (P=0.45), or quality grade (P=0.50) due to weaning date or nutritional strategy. Myers et al. (1999) reported no differences between growing treatments for carcass weight; fat thickness; LM area; yield grade; or marbling score.

For more specific details about our study, including tables that show the feedlot performance of steers and other information, contact Scott Lake.

Contact Information

For additional information, contact the principal investigator, Scott Lake, at 307-766-3892 or scotlake@uwyo.edu.

Effects of Winter Protein Supplementation On Subsequent Calf Feedlot Performance and Carcass Characteristics

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Project funded by the Five State Ruminant Consortium.

Introduction

At present, little is known about the underlying mechanisms whereby alterations in conceptus nutrient deprivation result in permanent changes in structure, physiology, and metabolism of the neonate, a condition referred to as "fetal programming." It has been demonstrated that protein supplementation during the last trimester of pregnancy can impact the growth and reproductive success of the heifer calf progeny, and also that more steer calves grade choice than progeny from non-supplemented cows.

Although good evidence exists that protein supplementation can enhance offspring development, detailed studies are needed to determine if there are changes in potential nutrient transport during pregnancy, and if the steer progeny have differing rates of gain. This is particularly important for the Northern Great Plains region, where a large proportion of feeder calves are generated. Even when genetics and nutritional management of calves are constant, growth characteristics and subsequent carcass composition vary considerably. Additionally, the relatively large variations in tenderness in postmortem beef muscle from animals of similar genetics, sex, age, and nutritional management cannot presently be explained. Therefore, the objectives of the proposed experiment are to evaluate the impacts of maternal protein supplementation during the last trimester on: 1) uterine blood flow to the fetus and 2) growth rates and feed efficiency of steer calves from weaning to finish; and 3) the economic impacts of maternal protein supplementation on carcass quality of subsequent calves. This research will allow the development of new approaches to optimize fetal development and subsequent productivity and marketability of beef cattle.

Materials and Methods

A two-year project will be conducted at the Gudmundsen Sandhills Laboratory (University of Nebraska-Lincoln [UNL]) involving 135 crossbred, mature cows per year. Previous research has demonstrated this to be an appropriate number of cows to provide sufficient statistical power to generate reliable results without using more animals than necessary. Pregnant, Marchcalving cows will graze dormant upland range from December 1 to February 28 and will receive the daily equivalent of either 0, 1, or 2 lbs (DM) per cow of a protein supplement (used in previous experiments).

An additional winter treatment will be corn stalk grazing with no supplement. Winter treatments will be replicated three times per year, and winter pasture will serve as an experimental unit. Calves will be weaned in either late August or early December. Other than during the treatment times listed, the cattle will be managed in a common herd.

Because a substantial amount of cattle in the Great Plains Region are produced in regions that are either too high in altitude or receive inadequate moisture to support corn production, an additional 150 mature crossbred cows will be randomly assigned to receive either 0, 1 or 2 lbs of protein supplement at the University of Wyoming. Supplementation will begin December 1 through the end of February. The non-supplemented group will graze winter pasture until either weather or forage quantity dictates that forage be supplemented. Low quality hay will be fed to provide roughly equal nutrient content of corn stalks grazed at UNL.

Cows at both UNL and UW will be estrous synchronized and artificially inseminated with semen from one bull (one bull at each institution) for both years of the experiment. Synchronization and artificial insemination will allow determination of any treatment influences on gestation length. Steer calves from UNL will be shipped to the feedlot in North Platte where growth performance will be monitored through harvest. Steer calves from UW will be individually fed utilizing GrowSafe technology at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Measurements to be collected include cow body condition score and body weight at key management intervals (weaning, pre-calving, and pre-breeding), gestation length, calf body weight (birth, weaning, entry into and exit from the feedlot, and hot carcass weight), calf carcass quality grade and tenderness (in a subset of steers), morbidity, and mortality. Longissimus muscles will be collected on a subset of steers to determine shear force in a meat laboratory. Further, an economic analysis of profitability differences among treatments will be conducted.

Results and Discussion

Data from the first year of the study is currently being collected and will be made available later year.

Acknowledgments

We recognize the hard work of Travis Smith, Beef Unit manager at the Laramie Research and Extension Center, and the entire SAREC crew for the much appreciated hard work. Additionally, we would like to thank Jim Freeburn, SAREC director, for his role in organizing research efforts.

Contact Information

For additional information, contact Scott Lake at 307-766-3892 or scotlake@uwyo.edu.

Economic and Environmental Sustainability of Conventional, Reduced-Input, and Organic Approaches on Western Crop–Range–Livestock Farms

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Project funded by the National Research Initiative, Organic Research and Extension Initiative.

Introduction

Agricultural producers continually battle with fluctuating profit margins. As such, producers are increasingly interested in alternative production systems that decrease costs, increase yields or increase value. Common alternative approaches to address these areas include reduced-input and organic production. Comparisons regarding conventional, reduced-input and organic production systems are available; however, limited information is available specific to the Western High Plains and Intermountain regions where integrated crop-range-livestock systems are prevalent. This project aims to determine whole-farm viability of integrated agriculture by studying a cash-crop system involving common crop rotations in the area and a beef-calf system comprised of cow/calf pairs and forage crops.

Objectives

The first objective is to quantify parameters that underlie long-term viability, competitiveness and efficiency of these three production approaches. Parameters to be measured include: 1) soil biological, physical and chemical properties; 2) soil hydraulic properties, moisture and temperature; 3) weed, pathogen, arthropod and nematode populations; 4) crop growth, yield and quality; 5) livestock performance; 6) economic viability, and 7) marketing potential. Second, results will be extended to producers, agricultural educators, consultants and others. Finally, research components and strategies will be incorporated into secondary, undergraduate and graduate education.

Materials and Methods

Conducted at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC), the SAREC Ag Systems project, started in 2009, utilizes 36 acres of pivot irrigated crop land (Figure 1), 400 acres of rangeland and 24 cattle.
The cash-crop system consists of four, one-acre plots for each approach, totaling 12 acres. The conventional crop rotation of dry beans-corn-sugar beets-corn is managed using traditional recommended rates for synthetic fertilizers, chemicals and tillage. With the same base rotation as conventional plots, the reduced-input approach incorporates triticale as a cover crop after dry beans and follows conservation tillage practices. The organic rotation of alfalfa/oats-alfalfa-corn-beans (dry or edible) follows organic production standards under the U.S. National Organic Program (NOP).

The beef-calf component is comprised of four, two-acre forage plots under each approach (24 acres) and 24 cow/calf pairs. The crop rotation consists of three years of alfalfa/grass with silage corn in the fourth year. Cattle in the conventional treatment are given antibiotics and growth hormones, unlike those in the reduced-input treatment which are managed as “natural.” In compliance with the NOP, organic cattle are not given synthetic chemical technologies and are fed only organic feed.

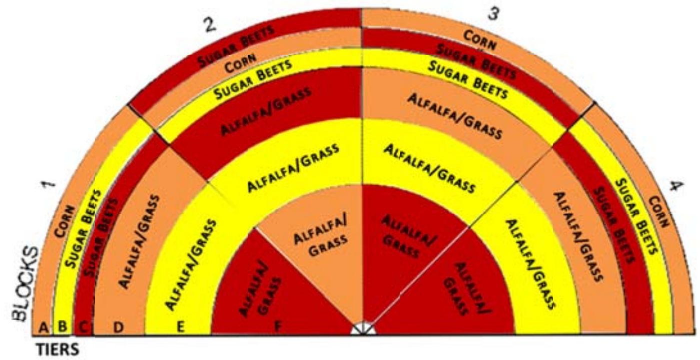

Figure 1. SAS Project 2011 Plantings.
Color code: Orange=organic, red=reduced-input, yellow=conventional

Results and Discussion

Data collection and analysis for an integrated, complex project is a constant on-going task. While data such as individual plot yields, soil microbiology activity and calf weights are available, the SAS project focuses on the entire production system and thus it is essential to accumulate and evaluate several years of data before drawing conclusions. Providing baseline information regarding conventional, reduced-input and organic production approaches will allow producers to quantitatively assess benefits and challenges of each system.

Acknowledgments
The authors would like to thank the staff at SAREC for their daily commitment to this project and the producer collaborators for their expertise.

Contact Information
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Wyoming Hereford Association 2010-2011 Forage-Based Bull Performance and Efficiency Test

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This is a cooperative project between the consignors, University of Wyoming, Wyoming Business Council Agribusiness Division, and the Wyoming Hereford Association.

Introduction

As grain prices continue to rise, and ethanol production continues to dramatically impact demand for corn, affecting all feed grains, beef production will continue to shift more towards forage-based production systems. Sustainable beef systems will require animals that grow and gain well on either grazed forage or roughage-based diets. Selecting seedstock animals that gain efficiently on high forage diets is one of the first steps.

Approximately two years ago, the Wyoming Hereford Association, with the help of Scott Keith of the Wyoming Business Council, began planning a forage-based bull test at the James C. Hageman Sustainable Agriculture Research and Extension Center utilizing the GrowSafe feeding system, which allows for individual animal feed intake and feed efficiency to be calculated. The ultimate goal was to produce performance and RFI (residual feed intake) values for a cross-section of bulls, helping seedstock producers investigate and better understand feed efficiency traits to aid in breeding and selection decisions.

Objectives

The objective is to evaluate 40 Hereford bulls in a 90-day performance and feed efficiency test, producing individual performance, feed efficiency, and RFI rankings.

Materials and Methods

Five Wyoming seedstock producers participated in the project. One Kansas Hereford and Angus producer who has used RFI data for 7 years was also included for reference herd data.

Results and Discussion

Data were collected on a total of 51 bulls. Health and performance were excellent, despite cold weather during the final 30 days.

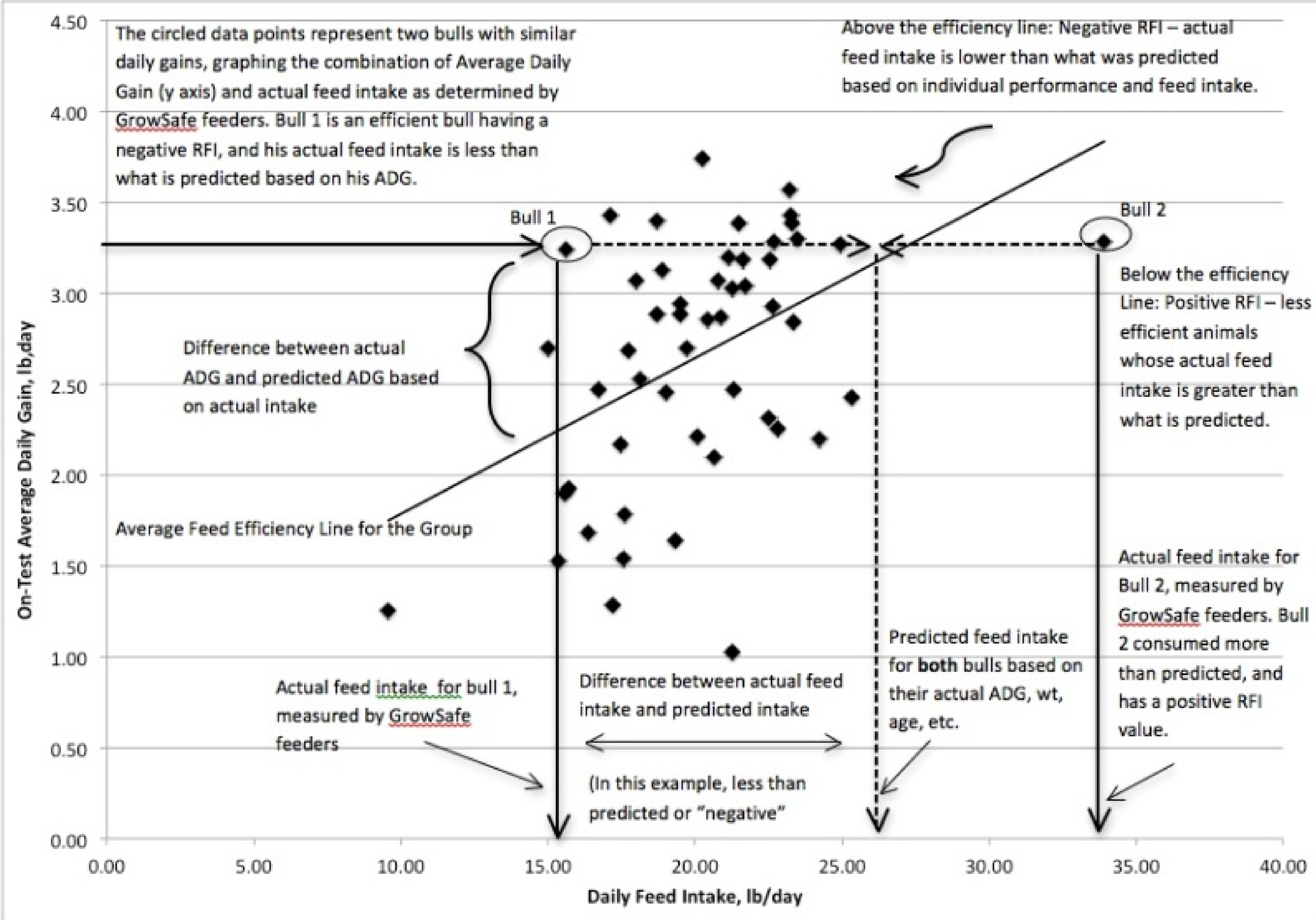

Figure 1. Actual ADG and feed intake data from the 2010-2011 Wyoming Hereford Association forage-based bull test at SAREC.

Assessment of Greenhouse Gas Emissions, Soil and Residue Carbon, and Nitrogen from Soils Beneath Irrigated and Dryland Alfalfa/Grass Hay Crops

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Project funded by a USDA National Institute of Food and Agriculture-Agriculture and Food Research Initiative grant.

Introduction

Alfalfa (*Medicago sativa)* mixed with perennial grass hay production in the Northern High Plains depends on seasonal precipitation. Irrigation is often the only alternative to obtain reliable hay harvest in this region. Legumes fix considerable amounts of atmospheric dinitrogen (N_2) but also, through plant residue decomposition, can contribute significant quantities of nitrogen (N) and carbon (C) to potent greenhouse gas (GHG) species such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), responsible for climate forcing. However, little is known about the impact of dryland or irrigated legume hay production on seasonal soil and plant nutrient cycling, and consequently, estimates of GHG emissions. Here we report the preliminary data of spring GHG emission estimates and soil and plant biomass characteristics for dryland and irrigated alfalfa/grass hay production before the irrigation begins. We hypothesize that in the spring, the legume/grass hay production generates significant amounts of GHG. The magnitude of the emissions depends on soil N, water content and legume contributions to the overall hay mix.

Objectives

The objectives of this research are to: (1) assess seasonal GHG emissions from dryland and irrigated legume hay production, and (2) characterize N contributions from irrigated and dryland alfalfa hay to soil and plant biomass.

Materials and Methods

Research is established at the James C. Hageman Research and Extension Center. Biweekly collection of trace gases is performed using an enclosure technique for determination of CO_2, CH_4, and N_2O concentrations. Biological N fixation will be assessed using total plant biomass N. Additional soil measurements of microbial biomass C and N, seasonal changes in labile N, net rates of N mineralization (buried resin capsules) under both alfalfa and grass plants, and gross N mineralization rates using ^{15}N enrichment technique are performed through the season.

Results and Discussion

In 2011, irrigated and dryland systems produced comparable amounts of early spring hay biomass (**Table 1**). This production was supported by efficient plant uptake of inorganic N demonstrated as low soil NH_4 levels, sufficient amounts of plant-available N (measured as potentially mineralizable N), and sufficient soil moisture content (**Table 2**); however, soils from the irrigated system were cooler, had significantly greater soil NO_3 concentrations, and produced more N_2O at the end of May when compared to the dryland system (**Table 3**). This suggests the presence of soil inorganic N in excess of plant demand and potential N losses to leaching (NO_3) and GHG emissions (N_2O). The source of N in the irrigated system originates from N-rich residue biomass left in soil from the year before. This residue is predominantly alfalfa-dominated. Conversely, the dryland system is grass-dominated and produces more CO_2 compared to the irrigated system. Both stands appear to be effective sinks for atmospheric CH_4 in early spring.

Table 1. Average soil moisture content, soil temperature, and biomass from irrigated and dryland alfalfa/grass plots.

Plot	Average Soil Moisture 5/10/2011	Average Soil Moisture 5/31/2011	Average Soil Temp °F 5/10/2011	Average Soil Temp °F 5/31/2011	lbs/ac of Biomass
Irrigated	13.90%	24.33%	38.50	47.00	4589.29
Dryland	12.02%	24.29%	38.50	44.00	4714.29
SE	*0.94%*	*0.02%*	*0.00*	*1.50*	*62.5*

Table 2. Potentially mineralizable N (soil labile N) and soil nitrate (NO_3^-) and ammonia (NH_4^+) concentrations from irrigated and dryland alfalfa/grass stands.

	Plant Available		Potentially Mineralizable N
	NO_3 (mg/Kg)	NH_4 (mg/Kg)	(mg/Kg)
Irrigated	7.50	0.01	165.43
Dryland	0.13	0.01	165.36

	Irrigated		Dryland	
Gas	***5/10/2011***	***5/31/2011***	***5/10/2011***	***5/31/2011***
CO2	13.19	9.93	5.44	70.94
CH4	-8.98	-1.77	-9.14	-3.25
N2O	9.85	71.78	23.96	42.27

Table 3. Spring GHG emissions from dryland and irrigated (before irrigation started) alfalfa/grass plots. CO_2 and CH_4 are reported in mg C $m^{-2}hr^{-1}$, and N_2O is reported in µg N m^{-2} hr^{-1}.

Further research is planned to assess biomass N fixation potential using ^{15}N natural abundance in legume/grass biomass; seasonal inventories of GHG and soil labile N; net rates of N mineralization (buried resin capsules); winter N mineralization processes using ^{15}N Gross N mineralization estimates , GHG, and residue decomposition.

Acknowledgments

We would like to recognize the hard work of our SAREC field crew, technical personnel in the Urszula Norton lab (Sarah, Bayasaa and Erin), and fellow graduate students of the lab.

Contact Information

For additional information, contact the principal investigators, Brekke Peterson, at bpeter28@uwyo.edu, or Urszula Norton at 307-766-5196 or unorton@uwyo.edu.

Supplemental Rumen-Protected Fish Oil Increases Concentrations of *Omega*-3 Fatty Acids in Tissues of Grass-Fed Beef

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Project funded by the Wyoming Agricultural Experiment Station.

Introduction

Grass-fed beef offers consumers a lean product with a fatty acid profile that generally reflects that of forage consumed. Grass-fed beef producers market this product, in part, on the contents of *omega*-3 fatty acids. Although concentrations of *omega*-3 fatty acids are higher in meat of grass-fed beef than in feedlot finished beef, the concentrations reported in scientific literature do not suggest that grass-fed beef is a particularly rich source of these fatty acids. The more important *omega*-3 fatty acids are the ones found in fish oil, namely EPA and DHA. Attempts to increase the tissue concentration of EPA and DHA by fish oil supplementation have shown mixed results, largely because of their conversion to saturated fatty acids while in the rumen. By using a by-pass source of EPA and DHA, the concentration of these fatty acids could be increased in beef; however, the extent to which supplemental *omega*-3 fatty acids can be increased in tissues of grass-fed beef has, to our knowledge, not been reported. Calcium salts of unsaturated fatty acids may provide limited ruminal by-pass characteristics.

Objectives

The objective of this study was to supplement calcium salts of fish oil fatty acids to half-blood LowLine Angus steers grazing irrigated pasture to determine extent of deposition of EPA and DHA in liver, muscle, and serum lipids.

Materials and Methods

Forty half-blood LowLine Angus steers (initial body weight 640 ± 15 lb) were allotted to either a control (**CON**; no supplemental fat), a palm oil-based saturated fatty acid calcium salt (**SAT**), or a fish oil-based fatty acid calcium salt (**N3**). Calcium salts of fatty acids were provided by Virtus Nutrition™ (Corcoran, California). Supplements were beet pulp-based and contained 7.6 percent molasses, 18.2 percent fatty acid calcium salts, 4.0 percent $CaCO_3$ for CON (to balance for calcium in SAT and N3), 4.4 percent mineral mix, and 1.8 percent poloxalene. Supplements were fed at 0.25 percent of body weight and formulated to limit supplemental fat to 2.0 percent for SAT and N3. Supplements were offered to individual steers on alternate days such that supplement intake could be recorded. Steers were raised on irrigated pasture of 25 percent bromegrass, 25 percent wheatgrass, and 50 percent alfalfa (crude protein = 20.9 percent; available forage was 81 lb dry matter per head daily). Steers were weighed monthly and blood sampled at 45 and 93 days to obtain serum. Pasture was rotated weekly over a period beginning June 1, 2008, and ending October 15, 2008; steers were fed forage harvested from the same pastures until December 8 when steers were shipped 85 miles for harvest at a commercial slaughter plant. Liver was sampled at slaughter. Muscle was sampled 12 days post mortem from the rib eye.

Results and Discussion

Steers fed the N3 supplement were the only ones consuming EPA and DHA. Initial body weights, final body weights, and average daily gains were similar for the steers fed all three supplements. Average values for each were 640 lb, 933 lb, and 1.6 lb/day, respectively. During the grazing trial, the temperatures were typically 90 to 100+ degrees, which likely caused intake to decrease. By analyzing blood serum for EPA and DHA, we could determine the change in their digestion compared with the other two treatments (CON and SAT). Total EPA + DHA was similar for CON and SAT at 2.5 mg/100 cc of blood serum, but for the N3 treatment the total was 6.0, which was more than twice as much. In fresh liver samples, the total EPA + DHA was increased from 142 to 265 mg/3.5 oz serving in the N3 group compared with the CON group. In the fresh rib eye meat sample, the total EPA + DHA was increased from 14.3 to 27.5 mg/3.5 oz serving. The increased concentrations of EPA and DHA in the rib eye samples did not affect flavor because off-flavor scores were not different for the CON and N3 groups. A very important observation in this study was the variation in intake of the N3 supplement. This supplement had an intense fishy odor, and some steers did not consume much of their supplement ration, while others consumed all of it resulting in a clear relationship between intake and deposition.

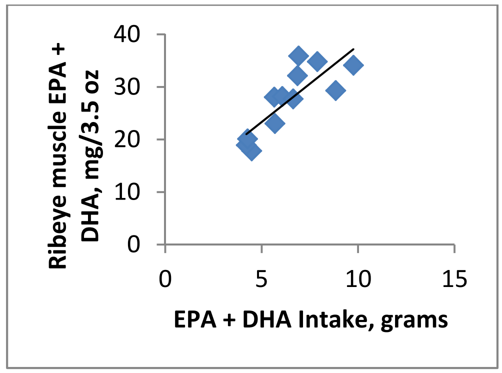

Figure 1. Muscle EPA and DHA as a function of intake; y=2.9x + 8.7; R^2 = 0.67.

Overall, the study revealed that grazing steers consuming a supplement containing calcium salts of the *omega*-3 fatty acids, EPA and DHA, can increase their concentrations in beef. Development of a more palatable fish oil calcium salt supplement is currently underway.

Acknowledgments

The authors wish to thank the James C. Hageman Sustainable Agriculture Research and Extension Center staff and Department of Animal Science laboratory personnel for their hard work and devotion to this project.

Contact Information

For additional information, contact the principle investigator, Dan Rule, at 307-766-3404 or dcrule@uwyo.edu.

Rogers Research Site: A New Addition to the Research and Extension Centers to Address Forest and Wildlife Issues

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Project proposal to the Wyoming Agricultural Experiment Station and the Colonel Rogers University of Wyoming Excellence Fund.

Introduction

The Rogers Research Site (RRS), which is approximately six miles southeast of Laramie Peak in southeastern Wyoming (**Figure 1**), is a new addition to the research and extension center array that provides coverage of the state of Wyoming. The information generated by this work will contribute to baseline weather, plant, and soil information important to the functioning of this station as well as how this particular forest system functions.

The federal government controls approximately half of the surface area of Wyoming. To understand the management of those resources, we must continue to establish research, instructional, and outreach liaisons that connect federal land management agencies to economic and cultural interests of the state. The RRS will also aid in natural resource management between the state and federal forest and wildlife interests.

Figure 1. General map of the property. Red dashed lines indicate section boundaries and scale. This 320-acre parcel shares boundaries with the Medicine Bow National Forest (green shaded zones) and was willed to the University of Wyoming by the late Col. William C. Rogers for use as a site to address issues of forestry and wildlife. Dominant plant species include ponderosa pine, lodgepole pine, and aspen, as well as grass and shrub lands. The site is near Fletcher Park on the Douglas Ranger District of the Medicine Bow National Forest.

Objectives

(1) Establish a weather station at the location, (2) conduct a soil and biological survey [see below] of the area, and (3) determine soil nutrients, especially nitrogen inputs, in representative soils.

Materials and Methods

1. Weather station. Weather records are available from several relatively nearby stations (within 25 miles), but elevation and topography modify weather so much that at least a baseline of weather records is needed for the RRS.

2a. Biological survey. This will include mapping of the soils and vegetation at the RRS as well as identification of nitrogen fixing species and a general identification of major soil microbial systems and microbe-plant symbioses at the RRS. Classical methods of taxonomy as well as new methods (e.g., nucleic acid analysis) will be used to make these identifications.

2b. Soils. This will include excavation of key soil profiles across the RRS, identification of soil horizons as well as chemical and physical properties. The weather data (as well as data from nearby National Weather Service stations) and soils data will provide baselines for identification of soils, completing the biological survey, and evaluating the overall condition of the RRS. This will generate important information for future research and demonstrations.

3. Determine preliminary rates of nitrogen fixation of non-leguminous nitrogen fixers, leguminous nitrogen fixers, and biotic crusts to estimate nutrient (especially nitrogen) levels for the RRS. Further, this information will provide the basis for the master's degree student we propose to work on this project.

All of the above will provide a baseline for further forestry-related as well as wildlife-related projects.

Results and Discussion

Management of mixtures of federal, state, and private lands, which represent the RRS and nearby zones, is complicated. These lands have a diversity of uses such as ranching, farming, recreation, home sites, forestry, and wildlife. This is made even more complex when pine bark beetle and fire impacts are considered. Establishment of an active forestry- and wildlife-focused research station will provide the State of Wyoming with more information on especially wildland management. This information can be shared with private land owners as well as our federal land management partners.

Acknowledgments

The Wyoming Game and Fish Department, Wyoming Office of State Lands and Investments, Medicine Bow National Forest, and Wyoming State Forestry Division have been involved with planning and direction of this effort.

Contact Information

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2011 Laramie Research and Extension Center Field Day

Doug Zalesky[1]

[1]*Director, Laramie Research and Extension Center.*

Introduction

The Laramie Research and Extension Center (LREC) is composed of various units providing a wide range of facilities and animals for use by a large number of disciplines. These units include the Greenhouse Complex at Harney and N. 30th, the lab animal facility at the Wyoming State Veterinary Laboratory (WSVL), and the Livestock Farm two miles west of Laramie. Included in the Livestock Farm are the Swine, Sheep and Beef Units and the Cliff and Martha Hansen Livestock Teaching Arena.

The LREC mission is to provide opportunities in research, extension, and teaching for faculty, staff, students, and the people of Wyoming and beyond. Facilities and animals at the LREC are utilized by numerous individuals to meet the mission of the College of Agriculture and Natural Resources and the University of Wyoming.

Greenhouse Complex

The Greenhouse Complex consists of a 20,000-square-foot main building that contains 10 research laboratories, a classroom, office space, specialized processing areas , and supply areas. There are also six greenhouses as well as field space. Management of the facility is provided by an on-site greenhouse coordinator, greenhouse operations manager, and horticulturist, aided by students. University research, instruction, and extension activities include the fields of agroecology, agronomy, botany, entomology, horticulture, molecular biology, plant pathology, soil science, and weed science.

Field plot elevation is 7,265 feet. Average annual precipitation is 10.7 inches. The average daily mean temperature is 40.5° F, with a record low of -50° F in 1963 and a record high of 95° in 1980. The average number of frost-free days per year is 90 to 100 with an average growing season of 90 to 100 days (dependent on frost tolerance of crops in the 24° to 32° F range).

During the last year, we completed a number of improvements at the facility. The policy manual for the facility was revised and is now available online. We also resided three of the greenhouse ranges and installed larger ventilation fans in those ranges to improve temperature control. The chemical storage building had alarms installed to notify staff of temperature problems. Our new pesticide policy was implemented, and we currently give monthly worker protection classes to ensure compliance with federal and state regulations. We completed our replacement of irrigation lines and valve boxes. We are now integrated into the campus phone and Internet system.

Lab Animal Facility

A lab animal facility (vivarium) is being developed to serve as a central housing facility for laboratory research animals in the college. It will contain three animal rooms, a surgery preparatory area, a surgery suite, as well as a cage washing area and a feed storage and preparation area. This facility will supplement the vivarium in the WSVL. The lab animal facility has a full-time manager and part-time student help. It also houses the office of the LREC director.

Livestock Units

The LREC Swine Unit is a farrow-to-finish facility that farrows about 25 sows twice a year. Animals from the facility are utilized for research, teaching, and extension activities primarily by the Department of Animal Science. The swine unit also participates in an annual feeder pig and lamb sale for area 4-H and FFA youths.

The Sheep Unit has approximately 300 head of ewes. The flock is composed of commercial ewes (n=180) and purebred Columbia, Rambouillet, Suffolk, and Hampshire ewes (n=180). These animals are utilized extensively for teaching, research, and extension activities. The Sheep Unit also houses GrowSafe technology, which is used to measure feed efficiency in individual animals; the unit works with sheep producers in Wyoming and surrounding states to conduct two annual ram tests. The unit is involved with the annual pig and lamb sale for 4-H and FFA members.

The Beef Unit is a commercial cow/calf operation that consists of approximately 220 head of crossbred cows. Similar to the other units, the Beef Unit provides opportunities for research, teaching, and extension activities. Cow/calf pairs from the unit summer at the McGuire Ranch, a 5,000-acre ranch 30 miles northeast of Laramie.

The Hansen Teaching Arena provides numerous opportunities for educational activities throughout the year. Various other types of activities including 4-H, FFA, rodeos, and equine events are held at the arena, which also serves as home for the UW Rodeo Team.

The remainder of the Livestock Farm consists of pasture and cropland. The majority of the cropland is utilized for hay production. Additionally, forage and crop research and demonstration projects are incorporated into the pasture and crop acreage at the farm.

The Livestock Farm has a full-time manager with two additional full-time staff. Each of the individual livestock units has a full-time manager, and they utilize part-time students to supplement labor needs.

Contact Information

For additional information, contact Doug Zalesky at 307-766-3665 or dzalesky@uwyo.edu.

Breeding Performance of Rams in Two Wyoming Producer Flocks

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Project funding support from U.S. Department of Agriculture-National Research Initiative grant 2007-55618-18176.

Introduction

Ram selection is fundamental to the profitability of a flock and is based on desired physical and performance traits. Selection processes, however, rarely include an evaluation of sexual behavior though the ability and desire to mate with ewes in estrus are required for incorporation of superior genetics into a flock. Previous research suggests that as many rams could be culled for poor mating behaviors as are culled for physical limitations or poor semen quality. Low mating behavior results in the need for additional rams, extends the lambing season, and decreases the number of lambs born per ewe lambing.

Objectives

The objective of this study was to determine the incidence of rams with poor-mating behavior in producer flocks. Such information is necessary to evaluate the impact of ram mating behavior on breeding success, genetic progress, and profitability.

Materials and Methods

Rams from two producer flocks in Wyoming were evaluated for breeding soundness. Blood samples from flock sires were collected to identify paternity of offspring. At lambing, blood samples were collected from a subset of the ewes and one of their lambs. Selected flocks used 24 (Flock 1) and 13 (Flock 2) rams to breed 1,200 and 400 ewes, respectively. Assuming each ram had equal opportunity to mate with ewes in estrus, the number of lambs expected to be sired by each ram was established by calculating 99-percent confidence intervals for mean lambs sired in each flock. Rams siring numbers of lambs within the bounds of respective confidence intervals were classified as intermediate-sexually performing rams. Rams siring greater or less than numbers of lambs predicted by the confidence intervals were categorized as high- or poor-sexually performing rams, respectively.

Results and Discussion

Sires for 80 percent (n = 290) and 85 percent (n = 170) of the lamb samples were identified by paternal genotyping in Flocks 1 and 2, respectively. In Flock 1, seven rams (29 percent) sired less and six rams (25 percent) sired more lambs than predicted. Likewise, in Flock 2, 23 percent (n = 3) of the rams sired less and 33 percent of the rams sired more lambs than predicted (**Table 1**). The remaining 11 (46 percent) and 7 (54 percent) rams in Flocks 1 and 2, respectively, sired intermediate numbers as predicted by the 99-percent confidence intervals for each flock. The incidence of poor-, intermediate-, and high-sexually performing rams were similar to values previously reported at the U.S. Sheep Experiment Station.

The small number of high-sexually performing sires in each flock sired nearly as many lambs as the more numerous intermediate performing rams. Less than 10 percent of the ewes conceived to low-sexually performing rams.

In conclusion, proportions of high-, intermediate- and low-sexually performing rams in producer flocks are similar to earlier reports. Methods to eliminate low-sexually performing rams and identify high-sexually performing rams are needed to reduce ram costs, promote the incorporation of desired genetics in a flock, and improve the profitability of sheep producers.

Acknowledgments

This research was supported by a grant from the U.S. Department of Agriculture's National Research Initiative.

Contact Information

For additional information, contact the principal investigator, Brenda Alexander, at 307-766-6278 or balex@uwyo.edu.

Table 1. Proportion of lamb crop sired by poor-, intermediate-, and high-sexually performing rams in two producer flocks.

Performance Category	Flock (n)	Lamb crop % (n)[1]
Poor	**1 (n = 7)**	**6.9 (n = 20)**
	2 (n = 3)	**8.2 (n = 14)**
Intermediate	**1 (n = 11)**	**47.6 (n = 138)**
	2 (n = 7)	**54.4 (n = 89)**
High	**1 (n = 6)**	**45.5 (n = 132)**
	2 (n = 3)	**39.4 (n = 67)**

[1]Total number of lambs sired by rams within flocks for each behavior category.

Estimation of Feed Efficiency in Sheep

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Project funded by Western SARE (Sustainable Agriculture Research and Education).

Introduction

Feed costs represent approximately 50-70 percent of total input costs for sheep producers. Improvements in feed efficiency would allow producers to use less feed without sacrificing production. Residual feed intake (RFI) is an alternative measure of feed efficiency that is of increasing interest to the sheep industry. RFI is the difference between an animal's measured feed intake and its predicted intake based on growth and maintenance. Improvements in RFI should not result in unfavorable increases in mature body size, a distinct advantage over more traditional measures of feed efficiency. While the sheep industry is interested in using the RFI measurement to improve feed utilization efficiency, researchers have yet to fully investigate the impacts of practicing genetic selection on this trait. Past experience has shown that it is important to understand the consequences of genetic selection, as genetic selection to improve one trait can have detrimental effects on other important traits. Before RFI is deemed an appropriate measure of feed efficiency for sheep, it must first be determined that it is not unfavorably related with other important traits. Additionally, RFI is expensive to measure, as it requires collection of individual feed intake data. The University of Wyoming houses a GrowSafe automated feed intake system that collects feed intake data on group-housed individuals; however, the system has limited space and is expensive to maintain. Rams submitted to the annual UW Ram Test are currently measured for RFI in the GrowSafe system for >100 days. Beef cattle data suggests, though, that ~60 days of testing is adequate to measure RFI. An appropriate testing period needs to be determined for sheep.

Objectives

The objectives were to 1) determine if relationships exist between RFI and other traits measured as part of the Ram Test, and 2) determine an appropriate testing period for measuring RFI in sheep.

Materials and Methods

A total of 87 Rambouillet rams (5-8 months old) submitted to the 2010 Ram Test were evaluated for 140 days using the GrowSafe system. After the testing period, rams were shorn for fleece analyses (raw fleece weight). Conformation and growth trait data (ultrasound back fat, ultrasound loin eye area, body condition score, and scrotal circumference) were collected, and RFI was calculated using the feed intake data collected by the GrowSafe system.

Results and Discussion

Table 1 shows the trait averages and correlations with the trait of interest, RFI. Because RFI is defined as the difference between actual and predicted feed intake, animals with a positive RFI consume more feed than expected and are therefore considered less efficient. Conversely, animals with a negative RFI consume less feed than expected and are therefore more efficient. Because animals within the testing group range from positive to negative RFI, the average RFI should be 0 lb/d, as was shown here. There was no relationship between RFI and back fat, loin eye area, body condition score, or raw fleece weight, indicating no adverse effects of RFI selection on these traits. Scrotal circumference, however, had a positive relationship with RFI (> 0.20), indicating that less efficient animals (those with positive RFI values) have greater scrotal circumference measurements. The impact of that relationship will require further study. Weekly analysis of RFI data showed that variation in RFI ranking of rams was substantially reduced after 42 days of data collection, and that the variation was the least after 63 days of collection. This indicates that >100 days of individual feed intake data collection (what is currently done) is not necessary. Instead, < 70 days of collection will provide accurate measurement of RFI while reducing testing costs for producers.

Acknowledgments

We thank the Laramie Research and Extension Center Sheep Unit farm crew, especially Brent Larson, for assistance.

Contact Information

For additional information, contact the principal investigator, Kristi Cammack, at 307-766-6530 or kcammack@uwyo.edu.

Table 1. Trait averages and correlations with RFI.

Trait (units)	**Average**	**Correlation with RFI**
RFI (lb/day)	0	---
Back fat (inches)	0.27	-0.17
Loin eye area (inches^2)	1.48	0.16
Scrotal circumference (inches)	34.46	0.21
Body condition score (1-5)	3.29	-0.04
Raw fleece weight (lb)	3.90	0.10

The Role of the Rumen in Predicting Feed Efficiency

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Project funded by the Wyoming Agricultural Experiment Station.

Introduction

Feed costs represent approximately 50-70 percent of total input costs for ruminant livestock producers. Improvements in feed efficiency facilitate high levels of performance with less feed inputs. Feed efficiency is moderately heritable, exhibiting the variation necessary for genetic selection; however, it is difficult and expensive to measure, requiring collection of individual feed intake data over long periods of time (>60 days). It is thought that much of the variation observed among individuals measured for feed efficiency is due to differences in the rumen. Recent beef cattle research has shown that rumen microflora, which are responsible for the conversion of digested feedstuffs to energy, differ between highly efficient versus lowly efficient grain-fed cattle. These differences suggest that it may be possible to identify feed efficient individuals by analyzing a rumen sample, as compared to testing animals in a controlled environment for >60 days. It is yet unknown if similar differences in rumen microflora populations exist under different feeding conditions (such as grazing) and in other ruminant livestock species (such as sheep).

Objectives

Our objectives are to 1) determine rumen microflora characteristics associated with greater feed efficiency in sheep; 2) determine if rumen microflora characteristics of efficient roughage-fed sheep are similar to those of efficient concentrate-fed sheep; and 3) determine the potential of rumen microflora characteristics to rank sheep for feed efficiency.

Materials and Methods

This research project is scheduled to begin in August 2011. To accomplish these objectives, 80 growing wethers will be fed either a high concentrate diet (>65 percent concentrate; “feedlot diet”) or a high roughage diet (85 percent roughage; “grazing diet”) for a 60-day testing period using the GrowSafe feed intake monitoring system. The GrowSafe system records individual feed intake on group-housed animals, allowing for estimation of feed efficiency. Rumen fluid samples will be collected prior to and after the 60-day testing period for microflora characterization.

To accomplish Objective 1, the 5 percent most efficient wethers and the 5 percent least efficient wethers (determined using the GrowSafe data) on the "feedlot diet" will be selected. DNA analyses will be performed on rumen samples collected after the 60-day trial to determine microflora characteristics that differ between these selected groups (highly efficient versus lowly efficient).

To accomplish Objective 2, rumen samples from the 5 percent most efficient wethers on the "feedlot diet" and from the 5 percent most efficient wethers on the "grazing diet" will be selected. Again, DNA will be performed on rumen samples collected after the 60-day trial to determine microflora characteristics that are similar or different between these selected groups (feedlot versus grazing conditions).

To accomplish Objective 3, the 5 percent most efficient wethers and the 5 percent least efficient wethers from the "grazing diet" will be selected. DNA analyses will be performed on rumen samples collected *prior* to the 60-day trial. Wethers will be ranked on the microflora profiles generated by the DNA analyses. Those rankings will be compared to the feed efficiency rankings determined by the GrowSafe data. Similar rankings would suggest that rumen microflora profiles have potential to predict feed efficiency.

Expected Outcomes

Predicted benefits from improving feed efficiency in ruminant livestock include:

- $0.25 per head per day saved by feeding more efficient animals;
- 10 percent reduction in maintenance costs;
- 25 percent greater potential for improved profitability versus selection on average daily gain;
- Less dependence on outside feed resources;
- 30 percent reduction in methane production;
- 20 percent reduction in manure production.

Contact Information

For additional information, contact the principal investigator, Kristi Cammack, at 307-766-6530 or kcammack@uwyo.edu.

Rearing and Release of an Herbivorous Fly from Uzbekistan for Biological Control of Russian knapweed

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Project funded by the Wyoming Weed and Pest Council.

Introduction

Invasive, exotic plants represent a fundamental threat to the ecological and economic well-being of Western rangelands. Biological control (the use of insect herbivores from the exotic plant's native range to suppress invasive plants) is one of the cornerstones of weed management on rangelands.

This project implements biological control of one of the most problematic weeds in Wyoming: Russian knapweed (*Acroptilon repens*). Russian knapweed is an exotic, deep-rooted perennial, originally from central Asia that displaces desirable- and native-vegetation **(Figure 1)**. The weed is unpalatable and/or poisonous to livestock and wildlife. In horses, feeding on Russian knapweed causes a lethal condition known as nigropallidal encephalomalacia, or "chewing disease." Because of its extensive root system, Russian knapweed is very difficult to manage with herbicides.

Figure 1. Russian knapweed infestation

(Photo: Jeff Littlefield)

In the 1980s, the Wyoming Weed and Pest Council, CABI Europe – Switzerland, and the U.S. Department of Agriculture's (USDA) Agricultural Research Service launched a biological control program for Russian knapweed. In 2009, the USDA permitted the importation of a fly called *Jaapiella ivannikovi* Fedotova, or "Russian knapweed gall midge," from Uzbekistan.

The Russian knapweed gall fly causes the formation of a "rosette" gall (**Figure 2**) on the stem of a knapweed plant, which reduces the plant's size and number of seeds produced per flower. The Russian knapweed gall midge was first released in Wyoming in June 2009 in Fremont and Park counties, where these releases have established reproducing populations. Distribution of the insect to Russian knapweed infestations across the state is now needed.

Figure 2. Gall on Russian knapweed plant formed by the Russian knapweed gall midge (Photo: Urs Schaffner)

Objectives

This project involves the production of Russian knapweed plants, which will be infested by the Russian knapweed gall midge. Galls formed on these plants will be removed and placed in the field at sites in Hot Springs, Laramie, Natrona, Weston, and Washakie counties, among others.

Materials and Methods

Rearing of the Russian knapweed gall midge is ongoing at the greenhouse facility of the Laramie Research and Extension Center. Russian knapweed plants have been grown from seed in 10-liter pots in standard growing media. Russian knapweed gall midges will be obtained from the field, Montana State University, and/or the USDA.

Results and Discussion

Releases of the gall midge are expected to reduce Russian knapweed biomass at existing infestations, as well as reduce the infestation of new sites via reduced seed production. Reduction in the establishment of new Russian knapweed infestations will reduce the costs of identifying, traveling to, and eradicating small, new patches of Russian knapweed. Releases of the gall midge are also expected to have positive effects on desirable and native vegetation.

Contact Information

For additional information, contact the principal investigator, Timothy Collier, at 307-766-2552 or tcollier@uwyo.edu.

Does Diet Reduction in Early Ovine Pregnancy Prevent the Impacts of Maternal Obesity on Offspring Adiposity and Metabolic Disease?

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Project funded in part by the Wyoming Agricultural Experiment Station.

Introduction

Obesity is occurring earlier and earlier in life and is now becoming a significant problem in women of childbearing age. Being overweight is associated with poor maternal health and several chronic conditions, including type II diabetes and cardiovascular disease, including hypertension and stroke. Perhaps more importantly, reports strongly indicate that maternal weight gain prior to and during pregnancy is associated with offspring adiposity and health concerns. There is strong evidence to suggest that the fetal environment associated with maternal obesity leads to increased risk of obesity and metabolic disease in her offspring.

Objectives

The study outlined below is designed to determine if an early pregnancy reduction in maternal nutrition to requirements will reverse or attenuate the observed negative impacts of maternal obesity on fetal growth, adiposity, and organ development, and therefore reduce the incidence of obesity, insulin resistance and other components of the metabolic syndrome observed in their offspring. It is felt that the effects of a simple reduction in dietary intake should be evaluated first, before pharmacologic agents are considered for administration to pregnant women or animals. The fetal sheep has a metabolism similar to the fetal human as shown by the large number of studies conducted worldwide.

Materials and Methods

To determine whether there are negative impacts of maternal obesity on offspring in ruminant livestock species, we developed a model of diet-induced maternal obesity. We fed a highly palatable diet at either 100 percent (control, CTR) or 150 percent (maternal obesity, MO) of National Research Council (NRC) requirements from 60 days before conception through gestation.

Results and Discussion

Using this approach, body weights of MO ewes increased ~30 percent from diet initiation to conception, with an additional 20-30 percent increase in weight from conception to term, while CTR ewes exhibit a normal gestational weight gain of only 10-15 percent. Further, these ewes developed significantly increased insulin resistance and levels of circulating glucose (major fetal energy source), which entered the fetal compartment. Fetuses gestated by MO ewes are ~30 percent heavier than CTR fetuses by midgestation and exhibited markedly altered organ weights, cellular composition and function, as well as increased adiposity when compared to fetuses from CTR ewes. By late gestation, however, fetal weights of MO and CTR ewes were found to be similar, due to a marked decrease in growth rate of MO versus CTR fetuses. This resulted from decreased placental vascularity, which reduced delivery of maternal nutrients to the fetus. While being similar in weight, fetuses from MO ewes continued to exhibit markedly altered organ development, altered circulating hormone and metabolite concentrations, as well as increased perirenal fat depots compared to fetuses from CTR ewes. While lambs born to MO and CTR ewes were found to be similar in bodyweight at birth, lambs born to MO ewes continued to exhibit markedly greater visceral adiposity than lambs from CTR ewes. Further, when male and female offspring born to MO females were subjected to a bout of ad libitum feeding in adulthood, they exhibited increased appetite, altered glucose metabolism, and increased weight gain, in association with increased adiposity and decreased skeletal muscle mass, when compared to offspring from CTR ewes.

Interventions that reduce insulin resistance and thus circulating maternal glucose concentrations in obese pregnancies would be expected to reduce the risk of obesity in the offspring, but no known relevant studies have been conducted in livestock species. Several approaches currently under evaluation to improve pregnancy outcome in obese women may theoretically reduce the risk of obesity and metabolic disease in the offspring of livestock species. These include life style, e.g., diet and physical activity strategies, as well as the use of pharmacological agents to improve glucose tolerance during gestation. Our central hypothesis is that a dietary reduction to requirements during early pregnancy in over-fed obese ewes will return fetal/neonatal growth, adiposity, and organ development and function to that seen in fetuses gestated by ewes fed to requirements, and lead to normal postnatal appetite, growth rate, glucose tolerance, adiposity, and carcass quality. To address this hypothesis, we plan to recuperate the maternal obesity (RMO) challenge by reducing feed intake in pregnant obese sheep from 150 percent to 100 percent of NRC recommendations over a two-week period beginning at 28 days gestation (gestation length is approximately 150 days), which is equivalent to ~7 weeks of human pregnancy. We believe that this dietary recuperation will attenuate the effects of maternal obesity on fetal growth, organ development, and composition, as well as hormone and metabolite concentrations in fetal blood **(Experiment #1)**. Further, we believe that recuperation of the maternal obesity challenge by reducing feed intake in pregnant obese sheep over a two-week period beginning at 28 days of pregnancy will result in a normal postnatal growth rate, appetite, glucose homeostasis, adiposity, and carcass quality of their offspring (**Experiment #2**).

Information obtained from these studies will provide specific information about how maternal overnutrition impacts offspring health and growth efficiency, and whether returning maternal nutrition to requirements in obese female ruminants during early gestation can improve offspring quality.

Acknowledgments

We would like to acknowledge in advance the hard work of the personnel of the Center for the Study of Fetal Programming for their integral roles in conducting these studies and in the evaluation of results.

Contact Information

For additional information, contact the principal investigator, Stephen Ford, at 307-766-2709 or spford@uwyo.edu.

Selenium Supplementation Provides Protection in a Mouse Model of Huntington's Disease

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Project funded by the Wyoming Agricultural Experiment Station.

Introduction

Huntington's disease (HD) is an autosomal dominant neurodegenerative disorder characterized by progressive motor dysfunction, emotional disturbances, dementia, and weight loss. HD occurs worldwide. Its prevalence is 5-10 cases per 100,000. There are about 30,000 affected individuals in the United States. Disease symptoms typically develop in the 20-40's; however, there is a range from childhood to old age. Once symptomatic, affected individuals show early functional decline, and require increasing care for another 15-25 years before dying from the effects of severe physical and mental debilitation. Compared to other neurodegenerative diseases, HD consumes significantly more medical, social and family resources. Currently, there are no treatments that delay the onset or progression of human HD symptoms.

We have recently found evidence of disrupted selenium metabolism in brains of deceased HD subjects obtained at autopsy. Twenty-four mammalian proteins are known to co-translationally incorporate selenium, in the form of selenocysteine, into their primary sequence. Several of these proteins are ubiquitous anti-oxidants, for example, glutathione peroxidases. Therefore, altered brain selenium metabolism could reflect deficits in a number of anti-oxidant pathways which would contribute to neuronal dysfunction and degeneration in HD. Furthermore, oxidative brain injury is a consistent feature of the HD phenotype. These findings indicate that there are disturbances of Se metabolism in HD and that dietary supplementation may be beneficial to HD patients.

Objectives

The overall goal of the ongoing research project is to use a genetically accurate mouse model of Huntington's disease (HD) to test whether supra-nutritional selenium protects against disease progression. We are in the process of evaluating HD mice fed on normal mouse chow receiving normal water or water supplemented with selenium. The specific aims are outlined below.

Aim 1: Determine if brain changes in brain selenium metabolism found in human HD are recapitulated in mouse HD models. We have obtained base-line information on selenium metabolism in HD mouse brain.
Aim 2: Determine if nutritional supplementation of HD mice with selenium ameliorates the biochemical and behavioral phenotype of HD.

Materials and Methods

Mice: We utilize a transgenic mouse model of HD in these experiments. Mice are bred by crossing HD males with normal females. Selenium interventions began at 6 weeks and continued until age of sacrifice.
Selenium administration: We tested various levels of selenium in water to ensure absence of toxicity in our experiments. Water bottles were adsorbed with selenium prior to study to ensure steady state concentration in liquid phase.
Outcomes: We have evaluated mouse behavior and brain biochemistry to determine the effects of treatments.

Results and Discussion

Data generated so far suggests that high dietary selenium levels provide protection in this line of HD transgenic mice. We have found evidence for beneficial effects on mouse behavior and also biochemical measures of brain oxidative status.

Finding beneficial effects of supra-nutritional selenium supplementation in HD mice suggests that there may be similar benefits in human HD. However, further mouse studies are needed to elucidate effects of high dietary selenium on mouse brain and to better understand mechanisms. Experiments currently in progress will determine if selenium supplementation in these mice decreases the brain shrinkage that occurs in this disease.

Currently, there are no treatments that delay the onset of HD symptoms or slow progression. As no one intervention is likely to provide a complete cure in the next few years it is likely that multiple therapeutic interventions will be required to be used together to provide the greatest possible protective effect. If these studies continue to show promise then high dietary selenium could become one of several approaches used to delay the onset and progression of this disease.

Acknowledgments

Jenna Moline and Megan Stiles bred mice and undertook behavioral experiments. Merl Raisbeck validated selenium delivery system. Irene Volitakis measured mouse brain selenium levels. Additional funding support from UW NIH COBRE center grant (PI: Francis Flynn).

Contact Information

For additional information, contact the principal investigator at aes@uwyo.edu or 307-766-3667.

Interactions between Manganese and Glyphosate in Glyphosate-resistant Soybeans (*Glycine max L.)*

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Introduction

The conversion of weed control methods from conventional herbicide applications to the use of a single herbicide (glyphosate) has created a paradigm shift in both soil and crop science. Concerns have arisen with respect to the soil bioavailability of manganese (Mn) and the effects of Mn deficiency in glyphosate-resistant crops. A greenhouse study was conducted in the spring of 2011 to investigate whether glyphosate reduced soybean uptake of Mn, which could result in crop damage among other physiological detriments. A three-factor factorial arrangement of 5 manganese (as $MnCl_2$) rates, 3 glyphosate rates, and three soybean varieties were grown in a Mollisol collected from the James C. Hageman Sustainable Agriculture and Research Center (SAREC) near Lingle. During the growth process, laboratory experiments were performed to examine the soil solution sorption chemistry of the Mn, glyphosate, and Mn-glyphosate complex. In separate experiments, total soil Mn concentration, bioavailable fraction, and water-soluble concentrations of Mn were determined to evaluate soil dynamics both separately and in conjunction with the herbicide. The Mn concentrations were then analyzed in the below- and above-ground biomass as well as chlorophyll concentration and soybean injury. The greenhouse experiment was also duplicated in field trials at SAREC during the summer of 2011 to confirm correlation.

Objectives

The objectives of the greenhouse experiment were to understand the dynamics of plant secondary micro-nutrient demand and the effect that glyphosate may have on the growth cycle of glyphosate-resistant plants. Identification of Mn concentration in comparing the above- and below-ground biomass would determine whether the herbicide exhibited a treatment effect on the plant and its ability to uptake the nutrient.

During the growth process of the soybeans, soil testing at Wyoming Analytical Laboratories (WAL) in Laramie, Wyoming, identified base soil characteristics of the obtained soil and a separate soil-solution sorption chemistry experiment on the Mn and glyphosate as factors of the project. The sorption experiment identified whether the soil had a greater affinity for binding both Mn and glyphosate or if the interaction was happening in the root zone of the plant.

Materials and Methods

Soil was gathered from SAREC in mid-February and sieved to eliminate residual plant material from the previous growing year. The soil was allowed to dry, sampled for bulk density determination and then split into five portions for Mn amendment according to the following treatments: 0 mg Mn^{2+} * kg $soil^{-1}$, 200 mg Mn^{2+} * kg $soil^{-1}$, 400 mg Mn^{2+} * kg $soil^{-1}$, 800 mg Mn^{2+} * kg $soil^{-1}$, and 1,200 mg Mn^{2+} * kg $soil^{-1}$. A subsample of each treatment was saved for laboratory analysis of Mn.

Three glyphosate-resistant soybean varieties were randomly chosen and planted in the amended soils. Three rates of Roundup Weathermax® were applied at 6 weeks, which included: 0 g ae. * ha^{-1} (trt.1), 840 g ae. * ha^{-1} (trt. 2) and 1,640 ae. * ha^{-1} (trt. 3).

Throughout the growth period, the plants were monitored for visual injury due to Mn uptake, and chlorophyll levels were measured by a Konica-Minolta chlorophyll meter. At the end of the 10-week growth period, plants were harvested. The roots were gently washed with deionized water. The plants were dried in an air-dry loss oven at 90ºC for 48 hours and the above- and below-ground biomass weights were recorded.

Finally, plants were subjected to a nitric acid-hydrogen peroxide digestion and submitted for analysis of Mn by Inductively Coupled Plasma-Mass Spectroscopy.

Results and Discussion

Some conclusions are apparent even though analysis is not complete. From the initial soil characteristics (**Table 1**), the soil pool reserve of water soluble Mn is low with total Mn concentrations being average in a Wyoming Mollisol:

The growth study revealed that two varieties did best in the soil, while the third had severe dwarfing. The highest treatment of Mn caused severe leaf chlorosis and plant necrosis in all treatments of Mn and soybean varieties, which implicates that the glyphosate did not hinder uptake of the micro-nutrient.

Sample	pH	Bulk Density (kg* m^{-3})	EC (dS* m^{-1})	CEC (mEq* 100 g^{-1})	O.M. (%)	SAR	Sand (%)	Silt (%)	Clay (%)	Soluble Mn (µg * kg^{-1})	Total Mn (mg * kg-1)
Lingle soil	8.0	1.3	1.1	10.8	1.74	1.7	15-20	45-55	20-30	96	223

Table 1. Initial conditions of the target soil.

Acknowledgments

Special thanks to the LREC and SAREC staff as well as the employees at WAL.

Contact Information

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Growing Algae for Fuel, Food, and Soil Amendment

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This project was supported by a matching grant from the University of Wyoming School of Energy Resources.

Introduction

Lack of water and resulting poor soil quality strongly limit agricultural production in many parts of the world. Adequate fertilizer and irrigation can solve this problem, but these inputs are cost-prohibitive in many production settings. Moreover, the costs of inorganic fertilizers rise with the price of gas and oil and are thus volatile. For these reasons, novel technologies that improve soil quality at low cost using minimal water and energy can lift a major barrier to the success of farms and ranches in arid regions of the western U.S. and around the world.

Objectives

The first objective of the project is to grow large quantities of algae and apply them to soil for study of how soil amendment with algae affects soil properties. The second objective is to acquire preliminary soil metabolite data to determine how treatment of soil with algae alters the structure and function of the soil microbe community.

Materials and Methods

We will grow two commonly occurring algae: the dinitrogen-fixing cyanobacterium *Nostoc* and the green alga *Chlorella*. Polyethyene utility tanks will be modified to grow the algae outdoors in closed systems that recirculate air and retain both water vapor and carbon dioxide added to stimulate algal growth.

The algae will be applied to field plots of bare soil or forage grass. No-algae control plots will be included in the design. Soil samples from these plots will be collected for detailed analysis using standard agronomic research protocols.

For field plots, liquid treatments will be sprayed on small plots (1.5 m× 6 m) established in the spring. Weed control and mowing will be done as needed. Algal and control treatments will be applied as liquid suspensions adjusted for application of 10 liters of water per m^2 of soil. Treatments will be applied using a small sprayer every month except during times when the soil is snow-covered.

Replicated soil cores will be collected from the experimental plots at 0-20 cm depth for initial soil fertility tests. The soil properties tested will include pH, electrical conductivity of soil paste, organic matter (loss on ignition), phosphate-phosphorus (Olsen Method), available nitrate-nitrogen (chromotropic acid method), and potassium (ammonium acetate extraction). Soil tests will be performed in the University of Wyoming Soil Testing Laboratory. Profiling of soil metabolites will be performed by GC-MS analysis of methanol extracts from the soil samples.

Results and Discussion

A first-generation closed photobioreactor has been designed and is in use producing algal biomass for application to field plots. No soil applications or analyses have been performed yet.

Production of algal biomass may be a very efficient method of making organic matter for soil improvement. Sunlight is the primary energy requirement, and water can be conserved and recycled if the algae are grown in closed photobioreactors, which limit evaporation. In addition, algal biomass can be used as food for fish, cattle, and humans, to make biodiesel, and to produce high value chemicals of many kinds, including oral vaccines. Growing algae for soil improvement would address the immediate need for improved soil fertility in many parts of the world. It would also establish an algal production infrastructure with the potential to develop into a small-scale algal biotechnology that integrates naturally with existing agricultural activities.

Acknowledgments

The authors are grateful for the assistance of the Laramie Research and Extension Center staff: K. Belden, R. Pendleton, and C. Seals.

Contact Information

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Fatty Acid Status of Developing Replacement Beef Heifers Fed Camelina Co-Products

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Project funded by Western SARE (Sustainable Agriculture Research and Education) Grant No.SW07-049.

Introduction

Two co-products are generated when camelina seeds are used for biodiesel production. Camelina meal (mechanically extracted) contains roughly 10 percent oil with approximately 70 percent polyunsaturated fatty acids. A very small percentage of these fatty acids also remain within the crude glycerin; however, the oil in these camelina co-products consists of 2 to 5 percent erucic acid. Feeding erucic acid to beef cattle could be a concern because lab animals fed this fatty acid had fat accumulate in their heart muscle. Increasing polyunsaturated fatty acid status of developing beef females has been associated with an increase in first-calf pregnancy rates. It was hypothesized that camelina co-products could be used as substitutes for a conventional corn-soybean meal supplement to effectively increase the developing beef heifer's fatty acid status.

Objectives

Our objective was to determine the effect of replacing supplemental corn and soybean meal with camelina co-products (meal and crude glycerin) on plasma concentrations of fatty acids of developing replacement beef heifers.

Materials and Methods

Two hundred and four Angus × Gelbvieh rotationally crossed heifers were stratified by initial body weight (year 1, n = 99 heifers; 662 pounds; year 2, n = 105 heifers; 648 pounds) to randomly receive one of three treatments: a control supplement consisting of 50 percent finely ground corn and 50 percent soybean meal; 100 percent mechanically extracted camelina meal; or a crude glycerin supplement consisting of 50 percent soybean meal, 33 percent finely ground corn, 15 percent crude glycerin, and 2 percent corn gluten meal. Supplements were offered daily at 2 pounds per heifer. Free choice bromegrass hay was offered immediately after supplements were consumed. Blood samples were taken before the heifers were fed on 60, 30, and 0 days preceding synchronizing them for estrus.

Results and Discussion

Blood plasma concentrations of fatty acids (**Figure 1**), including polyunsaturated fatty acids, were greater in heifers fed camelina meal than in heifers fed control and crude glycerin supplements. This response was expected because heifers fed camelina meal consumed more polyunsaturated fatty acids than heifers fed control and crude glycerin. Fatty acid concentration of the crude glycerin co-product was only 0.26 percent, which resulted in similar plasma fatty acid concentrations between heifers fed the control and crude glycerin supplements.

The camelina meal used in this experiment contained 2.58 percent of total fatty acid as erucic acid. Heifers fed camelina meal had a trace of erucic acid in their blood plasma (0.01 milligrams per gram of freeze-dried plasma). Erucic acid represented only 0.04 percent of total fatty acids found in plasma of heifers fed camelina meal, which was 50 times below the level recommended to be safe. Erucic acid was not detected in the blood plasma of heifers fed the control or glycerin supplements; this was expected because the control and glycerin supplements did not contain any erucic acid.

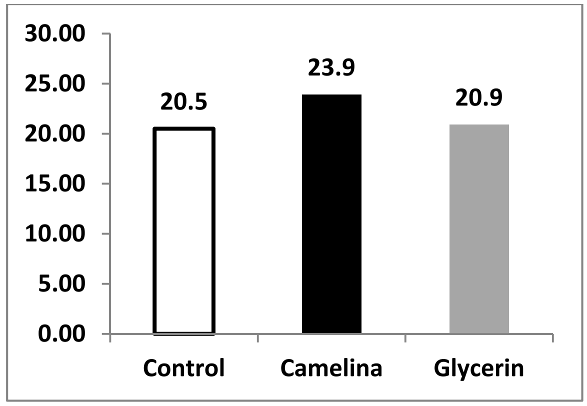

Figure 1. Concentration of fatty acids (parts per thousand parts of freeze dried sample) in plasma of heifers fed the control, camelina meal, or crude glycerin supplements for 60 days before estrous synchronization.

In conclusion, feeding camelina meal as a substitute for a conventional corn-soybean meal supplement is an effective strategy to alter plasma fatty acid profile of developing beef heifers. Only traces of erucic acid were detected in plasma of heifers fed camelina meal. Replacing supplemental corn with 15 percent of crude glycerin, however, did not affect plasma fatty acid profile of developing replacement beef heifers.

Acknowledgments

The authors thank all graduate students, postdoctoral fellows, laboratory technicians, and farm crew members who assisted throughout the study.

Contact Information

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Growth and Reproductive Performance of Developing Replacement Beef Heifers Fed Camelina Co-Products

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Project funded by Western SARE (Sustainable Agriculture Research and Education) Grant No.SW07-049.

Introduction

Two feed ingredients are generated when camelina seeds are used for biodiesel production: meal and crude glycerin. Camelina meal is the co-product resulting from pressing the seeds for oil extraction, whereas crude glycerin is the co-product remaining after the extracted oil is used for biodiesel production. Camelina meal is similar to other oilseed meals and contains about 30 percent crude protein. Glycerin is a colorless, odorless, sweet tasting liquid with similar energy value as corn. We hypothesized that biodiesel co-products (camelina meal and crude glycerin) could replace corn and soybean meal in the diet of beef heifers.

Objectives

Our objectives were to evaluate the effects of replacing corn and soybean meal with camelina meal and replacing corn with crude glycerin on growth and reproductive performance of developing replacement beef heifers.

Materials and Methods

Two hundred and four Angus × Gelbvieh rotationally crossed heifers were stratified by initial body weight (year 1, n = 99 heifers; 662 pounds; year 2, n = 105 heifers; 648 pounds) to randomly receive one of three supplements that were formulated to provide equal amounts of dietary crude protein for 60 days before estrous synchronization. Supplements included a control supplement consisting of 50 percent finely ground corn and 50 percent soybean meal; 100 percent mechanically extracted camelina meal; or a crude glycerin supplement consisting of 50 percent soybean meal, 33 percent finely ground corn, 15 percent crude glycerin, and 2 percent corn gluten meal. Supplements were offered daily at 2 pounds per heifer. Free choice bromegrass hay was offered immediately after supplements were consumed. Heifers were synchronized for estrus and artificially inseminated 12 hours after exhibiting estrus. Heifers not showing estrus within 66 hours after the end of the estrous synchronization protocol were also artificially inseminated. Heifers showing estrus after first service artificial insemination were again bred by artificial insemination or by a clean-up bull.

Results and Discussion

Dietary treatment did not affect forage or total dry matter intake, body weight, or average daily gain of heifers. The lack of differences in forage and total dry matter intake and growth performance among heifers fed control, camelina meal, and crude glycerin supplements suggests that, in addition to being formulated to provide equal amounts of protein, the supplements provided the same amount of energy. The number of heifers detected in estrus before timed artificial insemination, pregnancy rate of heifers bred by heat, overall pregnancy rate to artificial insemination, and final pregnancy rate did not differ among the various dietary treatments. Although not statistically significant, a 17-percent improvement in final pregnancy rate observed for heifers fed camelina meal versus heifers fed the control supplement was consistent with literature results demonstrating that supplemental fat improves reproductive success of beef heifers. The magnitude of difference in overall pregnancy rates can be attributed to the greater percentage of heifers fed camelina meal that settle after being artificially inseminated 66 hours following the estrous synchronization protocol (**Figure 1**).

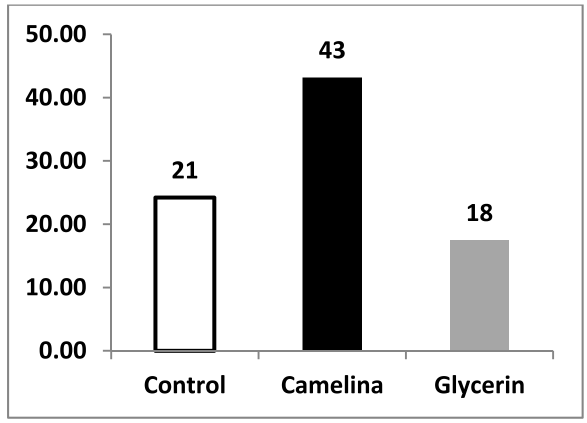

Figure 1. Pregnancy rates of beef heifers 66 hours following estrous synchronization.

Feeding camelina meal at 2 pounds per heifer – or an average of 5.25 ounces per day – of crude glycerin did not affect growth or overall reproductive performance of peripubertal beef heifers. Therefore, camelina co-products (meal and crude glycerin) are suitable replacements for conventional corn-soybean meal supplements when offered to replacement beef heifers for 60 days before estrous synchronization.

Acknowledgments

We thank the graduate students, research technicians, and farm crew members who assisted.

Contact Information

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Thyroid Hormone Concentrations in Developing Replacement Beef Heifers Fed Camelina Co-Products

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Project funded by Western SARE (Sustainable Agriculture Research and Education) Grant No.SW07-049.

Introduction

Two co-products are generated when camelina seeds are used for biodiesel production: meal and crude glycerin. Camelina meal is the co-product resulting from pressing the seeds for oil extraction, whereas crude glycerin is the co-product remaining after the extracted oil is used for biodiesel production. There has been concern about feeding camelina co-products to cattle because the seeds also contain compounds that can decrease the synthesis of thyroxine (T_4) by the thyroid gland. As a result, animals consuming these compounds, known as glucosinolates, could experience less than expected growth performance.

We hypothesized that camelina meal could replace corn and soybean meal without impairing thyroid gland activity of beef heifers.

Objectives

Our objectives were to: a) evaluate the effects of replacing corn and soybean meal with camelina meal and b) replacing corn with crude glycerin on thyroid hormone concentrations in the blood plasma of developing replacement beef heifers.

Materials and Methods

Two hundred and four Angus × Gelbvieh rotationally crossed heifers were stratified by initial body weight (year 1, n = 99 heifers; 662 pounds; year 2, n = 105 heifers; 648 pounds) to randomly receive one of three supplements: a control supplement consisting of 50 percent finely ground corn and 50 percent soybean meal; 100 percent mechanically extracted camelina meal; or a crude glycerin supplement consisting of 50 percent soybean meal, 33 percent finely ground corn, 15 percent crude glycerin, and 2 percent corn gluten meal. Supplements were offered daily at 2 pounds per heifer. Free choice bromegrass hay was offered immediately after supplements were consumed.

Blood samples were taken before the heifers were offered feed on 60, 30, and 0 days before estrous synchronization.

Results and Discussion

Glucosinolates are polar compounds present in camelina. The derivative products of glucosinolates (thiocyanate and isothiocyantes) are released after breakdown by the microflora inhabiting an animal's stomach. These compounds prevented the iodination of thyroid hormones, resulting in inactive hormones when released into the blood stream. Consistent with our hypothesis, dietary treatment did not affect serum concentrations of T_4. This result was expected because the concentration of glucosinolates in camelina is about five times less than glucosinolate concentrations of rapeseeds.

Heifers fed camelina meal had greater average concentrations of triiodothyronine (T_3) in blood serum than heifers fed either the control or glycerin supplement; serum concentrations of T_3 did not differ between the control and glycerin treatments (**Figure 1**). These results are consistent with others reporting greater concentrations of T_3 in calves supplemented with fat.

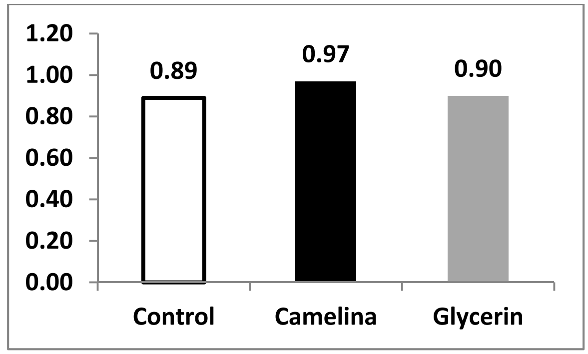

Figure 1. Concentrations of T_3 (ng/mL) in blood serum of heifers fed the control, camelina, or glycerin supplements for 60 days.

Feeding camelina co-products did not impair thyroid gland activity of developing beef heifers. Therefore, camelina co-products (meal and crude glycerin) are suitable replacements for conventional corn-soybean meal supplements when offered to replacement beef heifers for 60 days before estrous synchronization.

Acknowledgments

The authors thank the graduate students, postdoctoral fellows, research technicians, and farm crew members who assisted throughout the study.

Contact Information

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Improving Marginal Habitat Restoration in Western Rangelands: Spatial Variation in Seed Germination of Target Species

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Project funded by the U.S. Bureau of Land Management and the University of Wyoming.

Introduction

Ecological restoration commonly requires the reintroduction of plants to degraded sites, and long-term vegetation establishment is a critical component of reclamation success. In recent years, restoration protocols have experienced a shift in emphasis from non-native to native seed sources (National Native Plant Materials Development Program; http://www.blm.gov/wo/st/en/prog/more/fish__wildlife_and/plants/1.html). However, native plant seeds are scarce, and when supplies are available, seeds are often derived from populations either hundreds of miles distant or with unknown origin. Non-local seeds may not be suited to site conditions due to adaptive variation among populations within a plant species. As a result, the geographic origin of selected seed sources can have significant consequences for restoration outcomes.

Propagation requirements can differ among seed sources of a single plant species, with significant consequences for recruitment success. For example, in a recent study of true mountain mahogany (*Cercocarpus montanus*), researchers at New Mexico State University and the U.S. Department of Agriculture's Natural Resources Conservation Service determined that requirements for cold stratification, or pre-chilling, varied with the latitude and the altitude at which seeds were collected. As a result, it is unlikely that use of northern seed sources that require a long period of cold stratification for germination would result in successful revegetation of mountain mahogany at warmer, southern sites. Given the widespread differentiation in adaptive traits among populations of native plants, knowledge of species-level germination requirements across altitudinal and latitudinal gradients will improve seed selection and vegetation success at reclamation sites.

Objectives

My objectives for this study are to:

1. Collect 20 population samples of >10,000 seeds representing five or more plant species targeted for reclamation along a north–south transect of their geographic range.

2. Characterize propagation requirements for each species based on latitude and altitude of origin to establish effective germination protocols for reclamation.

Materials and Methods

Under an assistance agreement with the U.S. Bureau of Land Management (BLM) in Wyoming to collect native seeds according to the Seeds of Success protocol, seed collections made during summer 2011 will be sent to the U.S. Forest Service's Bend Seed Extractory in Oregon, where 10,000 seeds of each species will be processed and archived in the Agricultural Research Service's Germplasm Resources Information Network for genetic preservation as well as additional research and development. Remaining seeds of each species will be incorporated into germination studies.

Germination studies will be completed at the University of Wyoming (UW) Laramie Research and Extension Center (LREC). Namely, samples of 100 seeds representing each population and each species will be tested for germination potential in trials of different cold stratification periods (e.g., 0, 10, 30, and 60 days) and incubation temperatures. Data will be analyzed for significant differences in germination percentages among populations within species. Analyses will determine spatial patterns of variation in germination requirements and also the range of temperatures within which populations of each species can establish successfully.

Results will be published and made available through UW's Wyoming Reclamation and Restoration Center.

Discussion

Given the widespread differences in adaptive traits among populations of native plants, knowledge of germination requirements across altitudinal and latitudinal gradients will not only improve revegetation success but also contribute to conservation of plant communities in changing climates. An upslope and pole-ward shift in the range of North American species is likely a result of increasing temperatures. The ability of plant species to germinate and establish in warming climates may therefore be key for survival in their present range, and data to describe germination differences among populations are needed to assist both present-day and future reclamation and restoration programs.

Acknowledgments

Thanks to Adrienne Pilmanis at the Cheyenne office of the BLM, the BLM's National Plant Conservation Program and specifically the Native Plant Materials Development Program, and staff at the LREC research greenhouse complex for support and assistance with this research program.

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Agronomic Traits in Tall Fescue Populations

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Project funded partially by The Samuel Roberts Noble Foundation.

Introduction

Drought stress remains one of the most important constraints to agricultural production worldwide. The advent of genomic tools such as statistical techniques, software, and sequence databases has brought new tools to the science of breeding. This study employs these tools in tall fescue [*Schedonorus arundinaceus* (Schreb.) Dumort; (formerly *Festuca arundinacea* Schreb.)], a temperate grass species that is distributed up to areas experiencing hot and dry summers. Drought stress tolerance is a complex trait controlled by many genes.

Tall fescue is an important cool-season perennial hay and pasture grass grown in more than 35 million acres in the United States. Apart from being a cattle feed, its uses extend to lawns, turf (e.g., golf courses), and conservation purposes. The challenge facing the molecular-breeder/agronomist is to understand the genetic basis of stress tolerance (e.g., drought) mechanisms, identify simple means of selection for superior traits for trait integration into breeding populations, and, ultimately, develop and release of superior drought-tolerant cultivars to producers. Both forage yield and drought tolerance are difficult to select for because of low heritability occasioned by non-uniform testing conditions and large genotype-by-environment interactions.

Objectives

The objectives of the study are to identify contrasting genotypes, construct mapping populations, collect phenotype data, construct genetic maps and map candidate genes, and identify quantitative trait loci (QTL) and the markers for marker-assisted selection (MAS).

Materials and Methods

To accomplish the objectives, we have constructed two mapping populations (252 lines); both populations were planted in three sites (two field sites and one greenhouse site) in Oklahoma. One of the populations was also planted in Logan, Utah, and at the Laramie Research and Extension Center (LREC) under irrigated and dryland conditions. In LREC, each line was planted three feet apart and replicated three times in August, 2008. Thus, the total number of lines in each condition is 756. The population planted at the LREC is the verification population that will give us an indication of the utility of discovered markers for MAS. Data collected at the LREC include biomass production, visual vigor score, other agronomic parameters, relative water content, canopy temperature depression, and forage quality. Starting in 2009, two to three harvests were made each year depending on weather conditions.

Results and Discussion

This is an ongoing study, and data are being collected and analyzed. The complex set of data from each year are being compiled and analyzed. Preliminary data show promising results with variations among lines. For example, visual vigor scores (0-9 scales, where 0 = dead and 9 = highest vigor) were, on average, much higher in irrigated conditions (vigor 6-8) compared to rain-fed conditions (vigor 3-6) (**Photos 1** and **2**). There are variations for traits between lines within the same condition.

In 2011, first harvest and data collection were started in mid-June and are continuing. It is expected that selection of well-adapted, high-performing tall fescue lines may result in development of cultivars that will be specifically suitable for Wyoming and neighboring states.

Photo 1. Tall fescue lines under irrigated conditions. Top highlighted = vigor 9.

Photo 2. Tall fescue lines under rain-fed conditions. Top highlighted = vigor 6.

Acknowledgments

The Samuel Roberts Noble Foundation for partial funding and providing the tall fescue genotypes.

Contact Information

For additional information, contact the principal investigator, Anowar Islam, at 307-766-4151 or mislam@uwyo.edu.

Preemergence Ethofumesate Increases Postemergence Spray Retention on Common Lambsquarters

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Financial support for this research was provided by Hatch Act funds through a competitive grant from the Wyoming Agricultural Experiment Station (WYO-427-08).

Introduction

Ethofumesate is a herbicide registered for use either preemergence (PRE) or postemergence (POST) in sugarbeet (sold as Nortron, and other trade names). Recommended field use rates of ethofumesate for PRE application in sugarbeet typically range from 2 to 7 pints per acre (1 to 3.5 lbs/A) depending on soil type. Previous research has demonatrated that ethofumesate reduces leaf wax formation at far less than the field use rate, and therefore sub-lethal rates of ethofumesate may be sufficient to disrupt leaf waxes that represent a significant impediment to POST herbicide retention and absorption.

Common lambsquarters is one of the most economically damaging weeds in sugarbeet production, and has been previously recognized as being difficult to control with glyphosate. A low wettability of the leaf surface may lead to poor herbicide efficacy due to reduced spray retention and herbicide absorption. It is likely that reduced spray retention contributes to variable control of this weed with glyphosate.

Use of glyphosate for weed control in glyphosate-resistant sugarbeet increases sucrose yield and net economic returns compared to conventional sugarbeet herbicides used in conventional sugarbeet. Economic benefits of the glyphosate resistant system are derived from increased weed control and decreased crop injury, which both contribute to increased sucrose yield. Additionally, PRE ethofumesate can result in over $80/A greater net economic return when used in conventional sugarbeet compared to no PRE treatment. However, growers may be hesitant to use ethofumesate in glyphosate resistant sugarbeet due to its potential for crop injury.

Objectives

The objective of this study was to determine if sublethal rates of ethofumesate applied PRE increases POST spray retention on common lambsquarters.

Materials and Methods

Greenhouse experiments were conducted at the University of Wyoming Agricultural Experiment Station in Laramie in May, 2010. The experimental design was a completely randomized design with six replicates. PRE ethofumesate was applied at rates ranging from 0 to 0.2 lbs/A, and then sprayed POST with either water or glyphosate. All POST treatments included red dye. Immediately after POST application, each plant was clipped at the soil surface and placed with forceps in a beaker containing 10 ml of water, and vigorously shaken for approximately 20 s to wash off the dye. Plants were removed from the beaker and the total leaf area was measured. The amount of red color in the wash solution was measured, and the amount of spray solution retained by the plant was then calculated using a standard curve that had been generated previously. Spray retention was then divided by the leaf area of the plant and is presented as μL of spray solution per cm^2 of common lambsquarters leaf area ($\mu L/cm^2$).

Results and Discussion

Common lambsquarters retained more glyphosate compared to water regardless of PRE ethofumesate treatment (Figure 1). PRE application of ethofumesate increased retention of water (114%) and glyphosate (19%).

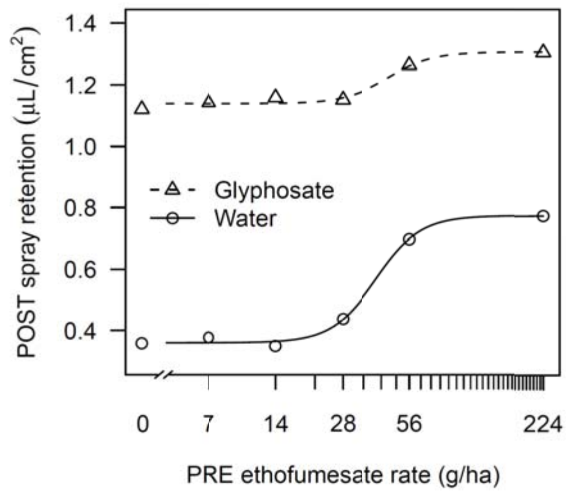

Figure 1. Postemergence spray retention of water and glyphosate on common lambsquarters as influenced by preemergence ethofumesate.

Although intentional application of sublethal rates of ethofumesate is not recommended, the residual properties of ethofumesate will necessarily result in a sublethal concentration of the herbicide in the soil at some point after application. Use of ethofumesate in glyphosate resistant sugarbeet could be viewed, at least in part, as a way to increase the efficacy of POST applications, particularly on weed species that are difficult to control with glyphosate such as common lambsquarters. The rate of ethofumesate could be reduced to the point that crop injury potential is minimized, while still providing weed control benefit.

Contact Information

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Berry Conservation Center Green Roof Native Plants

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Funded by support dollars made available through the Department of Plant Sciences.

Introduction

The newest building to open on the University of Wyoming campus is the Robert and Carol Berry Biodiversity Conservation Center at 10th and Lewis. Part of the building houses a green roof, or, in this case, a roof-top garden planted entirely with Rocky Mountain native plants. Some of these plants could not be found in the nursery trade, but seeds were available. I was asked in early 2011 if I would grow 27 species of native plants from seeds for the green roof. Commercial nurseries grew the majority of the plants, which were purchased and brought in specifically for this project.

Objectives

The main goal of this project was to produce seedlings of 27 native plant species for planting on the new green roof.

Materials and Methods

Seeds of the 27 species not available in nurseries were sown starting in February 2011. The 27 species were:

Aquilegia laramiensis (Laramie columbine)
Arctostaphylos coloradensis (Colorado Manzanita)
Arenaria hookeri v. *desertorum* (Hooker's desert sandwort)
Artemisia nova (black sagebrush)
Artemisia pedatifida (birdfoot sagebrush)
Artemisia spinescens (bud sagebrush)
Astragalus saurinus (dinosaur milkvetch)
Calochortus nuttallii (mariposa lily)
Dodecatheon jeffreyi (Sierra shooting star)
Draba oligosperma (fewseed draba)
Erigeron pinnatisectus (featherleaf fleabane)
Eriogonum ovalifolium (buckwheat variety)
Hymenoxys acaulis v. *caespitosa* (Caespitosa four-nerve daisy)
Hymenoxys torreyana (Torrey's four-nerve daisy)
Leucocrinum montanum (common starlily)
Lupinus lepidus v. *aridus* (lupine variety)
Mertensia lanceolata (prairie bluebells)
Oxytropis lambertii (purple locoweed)
Oxytropis nana (Wyoming locoweed)
Pediocactus simpsonii (mountain ball cactus)
Penstemon eriantherus (fuzzytongue penstemon)
Phlox hoodii ssp. *canescens* (carpet phlox)
Physaria eburnifolia (Devil's Gate twinpod)
Silene acaulis ssp. *acaulescens* (moss campion)
Sphaeralcea coccinea (scarlet globemallow)
Townsendia hookeri (Hooker's Townsend daisy)
Trifolium dasyphyllum v. *anemophilum* (alpine clover)

Results and Discussion

About half of the plants were planted on the green roof the week of June 27; the remaining plants were not large enough and will be planted later this summer. The green roof on the Berry building is open to the public.

Acknowledgments

I would like to thank Mark Bede and Charlotte Belton for their assistance and expertise in planning and planting the Berry building green roof.

Contact Information

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Fresh Cut Brown and Gold Sunflowers

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[1]Extension Horticulture Specialist, Department of Plant Sciences.

Funded by support dollars made available through the Department of Plant Sciences.

Introduction

Initially, this project was designed to grow brown and gold fresh cut flowers for the Wyoming Agricultural Experiment Station banquet at the end of February 2011. Sunflowers were chosen as the seeds germinate quickly and easily, the crop can be finished in two to three months, and many of the varieties available are UW brown and gold. The project has evolved into a year-long study to demonstrate to potential Wyoming growers the viability of this crop.

Objectives

The main goal of this project is to determine if cut sunflowers can be successfully grown in Wyoming year-round, both in the greenhouse and in high tunnels.

Materials and Methods

Three varieties of sunflowers (*Helianthus annuus*) have been grown in a Laramie Research and Extension Center greenhouse since November 2010. Seeds are sown every two weeks, resulting in an almost continuous harvest of brown and gold flowers. The three varieties are 'Dafna', 'Sunbright Supreme', and 'Premier Lemon'. The first two are true brown and gold while the latter is yellow and brown. Seeds are sown in seeding trays; seedlings emerge after eight days. Transplanting into four-inch pots occurs after about 15 days.

Results and Discussion

From seeding to harvest generally takes about 60 to 70 days, depending on variety; however, this summer an increase in time to harvest has been noted, largely due to warmer temperatures and water stress. Stem lengths vary with variety and have increased during summer months as well. Vase life is generally about 10 days.

The project will continue at least through fall 2011.

Acknowledgments

I would like to thank Jae Ho Lee, an undergraduate researcher, for his assistance this spring in collecting data on the sunflowers.

Contact Information

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Green Roof Module Demonstration

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Funded by support dollars made available through the Department of Plant Sciences.

Introduction

In the spring of 2008, I was contacted by an undergraduate honors student, Thomas Gregory, about carrying out his research project on green roof technology. Modules and growing medium were obtained from Colorado Green Roofs and Walls, LLC, in Fort Collins. Plant material was purchased from several different retail garden centers. The project was initially planted in May 2008.

Objectives

The objective of the project was to determine, using several different sizes and shapes of green roof modules, the optimum configuration. We also wanted to determine how long it might take for plant material to establish in each of the modules.

Materials and Methods

Four different sizes and shapes of green roof modules were obtained: 11 inches wide x 22 inches long x 3 inches deep, 12 x 24 x 4, 18 x 18 x 4, and 18 x 18 x 6. Each was filled with an expanded shale growing medium into which six different species and varieties of *Sedum* (stonecrop) were planted. Sedum is a perennial succulent, heavily used in green roof systems. They have been watered as needed during the growing season and have been monitored for overwintering plant survival.

Results and Discussion

Overwintering success has been mixed, depending on module size. The hardest modules in which to establish the sedum plants have been the smallest, shallowest ones. Plants have not survived the winter in these modules simply because of the small volume of medium available for the root systems. The small volume also means these modules change temperature very quickly and also dry out quickly, making plant survival tricky.

This is likely the last growing season for this demonstration project.

Contact Information

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Season-Extending High Tunnels

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Funded by the Wyoming Department of Agriculture Specialty Crops Block Grant program.

Introduction

Interest in season-extending, low-cost systems for growing horticultural crops in Wyoming is steadily increasing. To help meet the demand for information on crop production and management in these systems, two high tunnels were purchased and built at the Laramie Research and Extension Center during the summer of 2010. The tunnels are not heated and have roll-up sides to allow cooling during warm summer months.

Objectives

The two tunnels are identical, each 12 feet x 16 feet x 8 feet. They are oriented perpendicular to one another to determine differences in air temperatures, soil temperatures, and plant growth inside them.

Materials and Methods

The two structures were purchased as kits and were constructed using volunteer labor in the summer of 2010; they were completed in late July. Air temperatures and light levels are being monitored in the center of each tunnel using temperature and light data loggers. Soil temperatures are also being monitored by data loggers buried about four inches deep, two per tunnel, at the centers of the 16-foot sides. Various plant materials have been planted inside the tunnels. The 2010 crops did not produce well as they were not planted until mid-July; they did not have a chance to flower before frost set in. This season (2011), there are tomatoes, peppers, basil, brown-eyed susans, sunflowers, strawflowers, and iris. Data are being recorded on days to harvest (tomatoes, peppers, basil) and days to flower as well as stem length on brown-eyed susans, iris, and sunflowers.

Results and Discussion

The environments in the two tunnels are somewhat different in that the east one (oriented north–south) tends to warm up faster in the morning and stay warmer in the evening. The west tunnel (oriented east–west) is slower to warm in the morning but cools down a bit faster in the evening. For example, on May 18, 2011, temperatures recorded were:

Time of day	E–W tunnel (°F)	N–S tunnel (°F)
5 a.m.	34	34
6 a.m.	36	37
7 a.m.	51	54
8 a.m.	64	62
9 a.m.	78	78
5 p.m.	49	50
6 p.m.	51	52
7 p.m.	46	46
8 p.m.	43	44
9 p.m.	41	42

It remains to be seen whether these phenomena will translate into differences in plant growth and development.

Acknowledgments

I would like to thank all the dozen or so people who assisted last summer in building the two tunnels.

Contact Information

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Chemical Castration of the Coyote

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Project funded by the Wyoming Animal Damage Management Board.

Introduction

Coyotes have and continue to be significant predators of domestic livestock. In addition, they may impact pronghorn antelope and Rocky Mountain bighorn sheep. Primary control of predating coyotes has been by lethal removal of depredating pairs. This method has been met with mixed reviews, mainly public opinion and overall effectiveness. Research has shown that after removing offending pairs, within three months a new pair moves into the vacant territory and resumes depredation. Research has also shown that depredations, on average, decrease when pups are removed and paired coyotes continue to maintain territories even in the absence of pups. Therefore, controlling reproduction of the species may be a socially acceptable and an effective tool for managing predatory behaviors of coyotes.

Surgical sterilization has been successful in controlling coyote depredations on sheep and pronghorn; however, implementation cost may prevent widespread use.

Chemical castration of male coyotes with gonadotropin-releasing hormone (GnRH) agonists may provide an alternative option for controlling reproduction. In contrast to surgical castration, which removes the testes, GnRH agonists work at the level of the hypothalamic pituitary gonadal axis (brain) to shut down production of reproductive hormones and sperm. Administration is via an under-the-skin shoulder implant and requires no anesthesia. In small doses, this is successfully used as a form of reversible contraception for wildlife and dogs. In large doses, this may suffice to permanently alter reproductive function.

Objectives

The overall goal of this research is to develop a non-lethal, cost-effective tool for managing coyote predation. Specifically, we aim to investigate if a single treatment of a sustained release high dose GnRH agonist, deslorelin, can permanently chemically neuter coyotes.

Materials and Methods

Two groups of male coyotes are housed at the Laramie Research and Extension Center's (LREC) Beef Unit coyote facility. The test group consists of coyotes implanted with 47.0 milligrams (approximately 0.0017 ounces) deslorelin. Routine procedures include physical examinations, blood draws (reproductive hormones), electro-ejaculation (sperm count), and testicular measurements.

Results and Discussion

Testosterone levels in the coyote naturally decrease in May followed by undetectable sperm counts. Our data shows the seasonal decrease in testosterone followed by an acute response to deslorelin (**Figure 1**). The following breeding season, we predict chronic suppression of testosterone in experimental coyotes. Pending successful castration, we aim to move this to a field study to assess impacts of castration on territory fidelity and affiliate pack behaviors. To our knowledge, there are no known castration studies involving wild canids. Little is known about the interplay between hormones and learned behaviors in coyotes. Data on castration of domestic dogs has been variable with castration only impacting behaviors if done early on.

Acknowledgments

The UW Department of Animal Science, LREC Beef Unit, and the U.S. Department of Agriculture-Animal and Plant Health Inspection Service's Millville Predator Research Facility. Those who assisted are Dave Moore, Travis Smith, Carole Hertz, W. Andrew Taylor, Ashlee Humphrey, Elsey Perkins, and Mariel Pfeifer.

Contact Information

For additional information, contact the principal investigator, Donal Skinner, at 307-766-4922 or dcs@uwyo.edu.

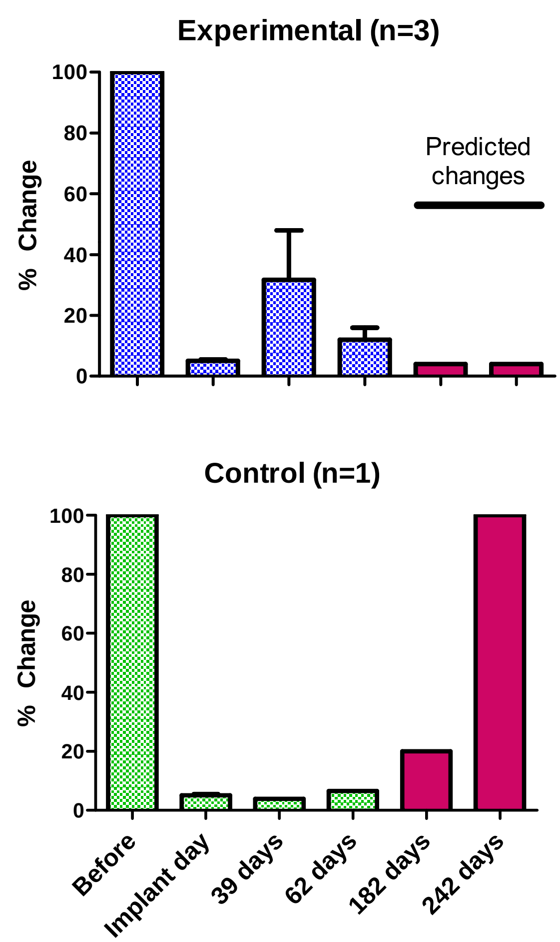

Figure 1. Testosterone concentrations.

Corn Cell Genomics: Developing Visual Marker Lines for Fundamental Research and Crop Improvement

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Project funded by the National Science Foundation, Plant Genome Research Program.

Introduction

Corn has been cultivated to be one of the most productive grain crops, providing much of the world's feed, fiber, and other commodities. In 2010, Wyoming produced 6.05 million bushels of corn on 50,000 acres.[1] Worldwide, corn yield has increased significantly over the last century due in large part to selective breeding and through improved agricultural technology. In the current century and into the future, however, new demands are being placed on crop production as global population, environmental pressures, and commodity needs increase. It is now critical that we identify new ways to improve the crop to fulfill local and global needs. The recent sequencing of the corn genome[2,3] offers unprecedented promise to discover new traits for molecular and selective breeding. By understanding the function of more than 2 billion base pairs of the corn genome, we can isolate and study the factors that improve plant function. New tools that leverage the genome sequence are needed to accomplish this goal. Our project focuses on generating new breeding lines that are part of the toolkit for corn researchers, geneticists, and breeders.

Objectives

The goal of the Corn Cell Genomics project is to generate new corn breeding lines that each harbor a visually tagged corn protein. These marker lines are used to study protein function in the plant at a subcellular level and in response to treatment. Stable lines are propagated and are available to the public and private sectors for agricultural and fundamental research.

Materials and Methods

Genes to be tagged are selected based on their potential to understand or improve crop productivity. Our project focuses on factors that control cell growth and plant development. The corn genome is mined using computational methods for specific gene sequences that encode proteins of relevance to crop improvement. Once identified, the full genomic sequence is isolated, and the sequence for a visual marker, derived from jellyfish, is inserted into the corn gene using cloning, PCR, and other molecular methods. This new “tagged” gene is then genetically engineered into a corn plant. The new line is studied for successful incorporation and expression of the marker protein. Breeding stock is developed by testing the line and by controlled crossing into diverse inbred and mutant stocks at the Laramie Research and Extension Center (LREC) Greenhouse Complex. Seeds are stored at the center. All materials are available and distributed through the project website.[4]

Results and Discussion

The project has generated more than 105 independent lines of corn that express visually marked proteins, with 95 percent of the lines stable over multiple generations. New methods for tagging proteins efficiently were developed. The marked proteins are being studied within the plant and within individual cells (**Figure 1**). Seeds for these lines, and other materials, are publically available and freely distributed nationally and internationally.

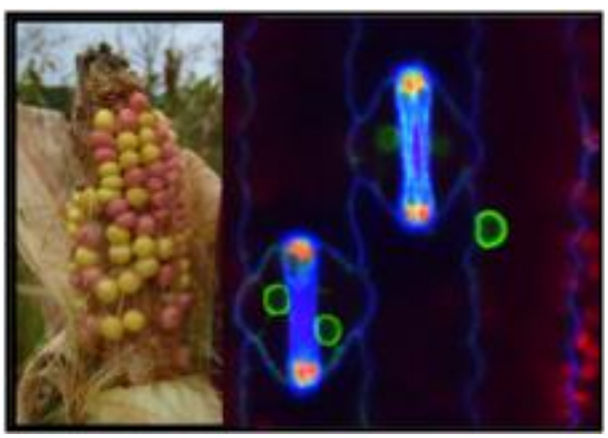

Figure 1. Visually marked seed proteins visible in corn kernels (left, pink seeds, photo by Jackson) or in cells (right, green and blue color in cells, photo by Sylvester).

These marker lines can now be used to test protein function and to develop breeding stock. Direct application and ongoing work is to test the lines for response of the visually marked protein to specific treatments and growth conditions. Proteins that show measurable change due to growth conditions or treatments become candidates for molecular breeding.

Acknowledgments

We appreciate the assistance of members of the Sylvester lab in the greenhouse and field, including graduate student Dan Kirienko, research assistant Gail Stakes, and undergraduate students Laurel Felker and Audrey Plenty Hoops. We thank the staff of the LREC Greenhouse Complex – Kelli Belden, Casey Seals, and Ryan Pendleton – for growing corn successfully and providing support to our project. This research is part of a larger collaborative project with Professor Dave Jackson (Cold Spring Harbor Laboratory, New York) and Assistant Professor Agnes Chan (J. Craig Venter Institute, Maryland).

Contact Information

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1. http://www.nass.usda.gov/Statistics_by_State/Wyoming/
2. http://maizesequence.org/index.html
3. http://www.maizegdb.org/
4. http://maize.jcvi.org/cellgenomics/index.shtml

Genetic Architecture of Ecophysiological and Circadian Traits in *Brassica rapa*

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The research was supported by National Science Foundation grant DBI 0605736 to Associate Professor Cynthia Weinig.

Introduction

Developmental mechanisms that enable perception of and response to the environment may enhance plant performance. Ecophysiological traits, such as photosynthesis levels, typically vary depending on local conditions and contribute to resource acquisition and allocation. Yet correlations between traits may limit optimal trait expression. The question arises as to how plants may evaluate their environment (e.g., using photoreceptors to assess light quality) and how physiological traits may respond adaptively. Notably, photosynthesis and stomatal conductance vary diurnally, and the circadian clock, which is an internal estimate of time that anticipates diurnal light/dark cycles, may synchronize physiological behaviors with environmental conditions.

Objectives

The overarching objective of this research is to understand the genetic underpinnings of plant responses to stressful settings, including water stress.

Our specific goals were to investigate: 1) the patterns of covariation among ecophysiological traits and between ecophysiological and lifecycle traits (such as flowering time), 2) whether specific genetic lines possess combinations of ecophysiological traits that may be targeted for crop improvement (or by natural selection), 3) the association between circadian traits and ecophysiological traits measured here, and 4) whether the genetic architecture of these traits is affected by variable abiotic conditions (i.e., factors such as light, water, temperature, etc., rather than living organisms).

Materials and Methods

We raised six replicates of each of 130 unique genetic lines of *Brassica rapa* (common mustard, which is cultivated as turnip as was the original canola oil species) in drought and well-watered conditions at the Laramie Research and Extension Center (LREC) field site. Plants were then evaluated for a range of ecophysiological traits, such as photosynthesis, stomatal conductance, and water-use efficiency (i.e., amount of water expended per unit carbon fixed). Our collaborators at Dartmouth College evaluated the same lines for the expression of circadian rhythms.

Results and Discussion

Many ecophysiological traits were correlated, and some correlations were consistent with expected biophysical constraints; for example, stomata jointly regulate photosynthesis and transpiration by affecting carbon dioxide and water vapor diffusion across leaf surfaces, and these traits were correlated.

Interestingly, some genetic lines had unusual combinations of ecophysiological traits, such as high photosynthesis in combination with low stomatal conductance or leaf nitrogen, and selection on these lines could provide a mechanism for crop improvement.

At the level of genomic regions, circadian period was correlated with leaf nitrogen, instantaneous measures of photosynthesis, and stomatal conductance as well as with a long-term proxy for gas-exchange, suggesting that gas exchange is partly regulated by the clock and thus synchronized with daily light cycles.

The strong association between circadian rhythms and ecophysiological traits is relevant to crop improvement and adaptive evolution. Moreover, because of limited water availability, selection and development of genetic lines with improved efficiency in water use are highly desirable.

Acknowledgments

The authors are grateful for field assistance from M. T. Brock and M. Rubin and for the work of the LREC staff – K. Belden, R. Pendleton, and C. Seals – in maintaining and establishing greenhouse and field conditions.

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Arthritis and Agriculture

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Wyoming AgrAbility: Cultivating Accessible Agriculture is funded by the U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture under agreement No. 2010-41590-20741.

Introduction

The term arthritis refers to an inflammation of a joint. There are more than 100 types of arthritis or chronic joint symptoms that impact 46 million (nearly one in five) Americans. It is second only to heart disease as a cause of work disability and costs the U.S. economy $128 billion annually.

Arthritis affects approximately one-third of all ranch and farm operators and is considered one of the leading causes of disability by agriculturists in the USDA AgrAbility Project. Arthritis can cause significant impairments to one's mobility, dexterity, capacity to lift heavy objects, and emotional well-being due to unmanaged pain and other factors.

Arthritis is especially detrimental to ranchers and farmers due to the nature of the work. Mounting or dismounting tractors or horses, feeding livestock, baling hay, harvesting crops, and using heavy tools all require strength and mobility, which is lessened by the affects of arthritis.

Trauma to joints often occurs in agricultural settings, such as the impact on joints when jumping off tractors or combines, being kicked by large animals, locking knees when riding in vibrating machinery, or stress from constant bending.

With the average age of American ranchers and farmers climbing above 57, increasingly more operators will find tasks difficult to complete. Tasks such as lifting objects, operating machinery, and working with livestock will become harder to complete as arthritis affects agriculturists. However, removing these tasks from everyday work is not an option for most ranchers and farmers.

Objectives

Participants at the Wyoming Agricultural Experiment Station's Research and Extension (R&E) Center field days will:

- Understand the types of arthritis prevalent in agriculture,
- Learn strategies to manage arthritis in daily living and work tasks,

- View assistive technology devices and work tools that can lessen the pain of arthritis, and
- Receive resource materials that help agriculturists work and live with arthritis.

Materials and Methods

A brief presentation will be given on ranching or farming with arthritis. A display on ergonomic work tools and agricultural equipment modification will be included. In addition, written information and a DVD from the Arthritis Foundation, the National AgrAbility Project, and Wyoming AgrAbility will be available for participants.

Results and Discussion

Since there is no known cure for arthritis, education and awareness of pain management techniques are considered best practices for treating the condition. This includes joint protection, work simplification, and physical stress reduction. Encouraging weight loss, promoting behaviors that reduce joint shock, and modifying work sites to eliminate high-risk tasks are significant to preventing joint damage. It is important that agriculturists keep abreast of the latest education and research-based information on arthritis management to help ensure good health and well-being.

Solutions can be implemented to help control joint stress and pain in ranching and farming operations:

- Wear quality, non-slip footwear
- Use appropriate assistive aids
- Maintain proper posture when sitting for long periods
- Use the largest joint possible to complete a task
- Avoid gripping and grasping for long periods of time
- Simplify jobs and tasks
- Pace oneself throughout the work load

Ranchers, farmers, and farm workers may continue to live productive lives in agriculture if they are willing to commit to controlling their arthritis by diet, exercise, modifying work, and respecting the physical limitations of their bodies.

Acknowledgments

Information in this bulletin comes from *Arthritis and Agriculture: Gaining Ground.*

http://www.arthritis-ag.org/arthritis-and-you/agriculture-and-arthritis.aspx

Contact Information

For additional information on Wyoming AgrAbility or ranching and farming with injury or limitation leading to disability, call 866-395-4986 (toll-free), email agrability@uwyo.edu, or visit the website www.uwyo.edu/agrability.