FIELD DAYS BULLETIN

2012

2012 Field Days Bulletin

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

B.W. Hess[1]

[1]Director, Wyoming Agricultural Experiment Station.*

Introduction

Justin Smith Morrill of Vermont wrote legislation that provided grants of federal lands to states for the establishment of public universities and colleges. The Morrill Land Grant Act was signed into law July 2, 1862, by President Abraham Lincoln.

The Morrill Act of 1862 stipulated that the curriculum of land-grant colleges would focus on "scientific agriculture" and the mechanical arts (engineering). Land-grant institutions have since been the backbone of advanced agricultural education and research in the United States. The sesquicentennial anniversary of the Morrill Act is a time to celebrate the many accomplishments of land-grant universities, including the University of Wyoming (UW).

In addition to being instrumental in the establishment of UW, the Morrill Act served as the preamble to the Hatch Act of 1887, which led to subsequent establishment of the Wyoming Agricultural Experiment Station (WAES) and its affiliated research and extension (R&E) centers. Since its beginning in 1891, WAES has conducted applied and basic research to help solve problems that affect the agricultural sector of our state, region, and nation. With R&E centers in Laramie (LREC), near Lingle (James C. Hageman Sustainable Agriculture Research and Extension Center, or SAREC), near Powell (PREC), and near Sheridan (ShREC), WAES provides research and outreach that are responsive to the needs of stakeholders throughout Wyoming. For example, the R&E centers host annual field days to provide the public with an update on activities of each center 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 by WAES and at the R&E centers. The bulletin provides a forum for researchers and educators affiliated with WAES to publish results of their activities or to introduce new projects in a standardized, simple format that is reader-friendly. The objective of this report is to describe a new process by which WAES will utilize input from stakeholders throughout the state.

Development of the Production Agriculture Research Priorities Document

WAES embarked on a new process of gathering and documenting stakeholder input in an attempt to align strategic issues facing Wyoming with long-term national priorities outlined by the U.S. Department of Agriculture's National Institute of Food and Agriculture (NIFA). WAES created a list of applied research priorities that were gleaned from past listening sessions with each R&E center's advisory group. This list evolved into the *Production Agriculture Research Priorities* document that places emerging issues identified by Wyoming producers in context with national priorities.

The next step was to ask agricultural industry interest groups and UW Extension educators throughout Wyoming to submit names of five producers willing to provide input on the list of applied research needs. A member of the SAREC Citizens' Focus Group volunteered to contact these individuals to invite them to review the document and comment on our proposed research focus areas.

In addition to targeted input, WAES has invited public comments on the draft document that was posted on our website in April. Appropriate comments have been incorporated into the draft of the *Production Agriculture Research Priorities* document. This working draft is on the WAES website (www.uwyo.edu/uwexpstn "Important Links"). Comments are welcome and encouraged.

The process will be refined and regularly repeated based upon the volume of comments received and to address emerging trends and specific needs. For example, several stakeholders have identified a similar need to document research priorities for specialty crops and other agricultural products suitable for niche markets. Thus, WAES is planning to develop a similar document to address these specific areas.

The WAES research priorities document will increase researcher awareness of topics identified by stakeholders. In addition, documentation of stakeholder research needs is important as NIFA and other federal granting agencies call for research that is stakeholder-driven.

Acknowledgments

Thank you to all of the researchers, educators, faculty and staff members, students, stakeholders, and volunteers for their contributions to WAES and the *Field Days Bulletin*. Very special thanks to the Editorial and Review Board and bulletin editors Robert Waggener and Joanne Newcomb. Joanne's superb effort ensured that the bulletin was ready for distribution at the field days. Thanks also to Tana Stith for this year's bulletin cover.

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2012 Laramie Research and Extension Center Field Day

D. Zalesky[1]

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Introduction

The Laramie Research and Extension Center (LREC) comprises various units providing a wide range of facilities and animals for use by a large number of disciplines. These units include the LREC greenhouse complex at the corner of Harney and N. 30th streets, the animal laboratory facilities at the Wyoming State Veterinary Laboratory at 1174 Snowy Range Road, and the LREC Livestock Farm two miles west of Laramie on Highway 230. Included in the Livestock Farm complex are the Swine, Sheep, and Beef units. Also located at the Livestock Farm is the Cliff and Martha Hansen Livestock Teaching Arena. The mission of LREC is to provide opportunities in research, extension, and teaching for University of Wyoming (UW) faculty members, staff members, and students as well as the people of Wyoming and others. Facilities and animals at LREC are utilized by numerous individuals to meet the mission of the College of Agriculture and Natural Resources and UW. Departments and UW programs that utilize the facilities and animals include: Animal Science, Microbiology, Molecular Biology, Plant Sciences, Ecosystem Science and Management, Veterinary Sciences, Agricultural and Applied Economics, Family and Consumer Sciences, and UW Extension.

LREC Accomplishments

The LREC greenhouse complex continues to see unprecedented utilization with space both inside and outside the facility completely occupied and used for research, teaching, and outreach. Improvements include installation of new LED lighting systems in some of the greenhouse units, new growth chambers, and updated audio-visual equipment in the classroom. The new lighting systems will allow us to provide improved lighting to the greenhouse units and at lower energy costs.

After a long and distinguished career at UW, Kelli Belden, the soils lab and greenhouse manager, will retire this summer. Kelli has faithfully served UW and the people of Wyoming for many years, and her expertise and service will be sorely missed. We wish her the best.

Remodel work on LREC's animal laboratory facilities will be completed by summer's end, including installation of a new heating/ventilation/air conditioning system. During the past year, the LREC Sheep Unit became home for a flock of Targhee sheep. It is one of the premier Targhee flocks in Wyoming and the United States. Acquisition of the flock was the result of a cooperative agreement between UW and the Wyoming Wool Growers Association. Through the agreement, the Targhee flock, which was developed by the Von Krosick family in Riverton, was kept in the state and will continue to be available to the sheep industry in Wyoming. The flock will also be utilized by UW for teaching and research purposes. Another major accomplishment this year was the development and implementation of management teams for each of the units within LREC. Teams will assist in development of both short- and long-term goals for each unit. Input will be utilized to develop a long-range strategic plan for LREC. The Swine and Beef units continue to be busy with research projects and providing resources for teaching. Personnel at the two units are always working to improve facilities. The Hansen Livestock arena continues to be a hub of activity. The facility is home to the UW Rodeo Team and provides a place for numerous other UW teams and clubs to practice throughout the year.

Acknowledgments

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

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50 Years of the Wyoming Ram Test: How Have Sheep Changed?

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Introduction

Numbers of sheep in Wyoming have declined steadily since the early 1940s. Although there are only 10 percent as many sheep in Wyoming as there were in 1940, the Wyoming sheep industry is alive and well. Range sheep operations predominate in Wyoming, and for many producers Rambouillet or Rambouillet-cross are preferred. For the past 50 years, production characteristics of white-faced rams have been systematically evaluated in the Wyoming Ram Test with these records representing ideal breed characteristics of the time. Although some changes in the industry over the past 50 years are obvious even to the casual observer, the magnitude of change as well as the production characteristics that remained stagnant within the Rambouillet breed is intriguing.

Objectives

The goal of this research was to document changes that have occurred in the Rambouillet breed over the past 50 years. How market forces may have shaped changes within the industry were also explored.

Materials and Methods

Performance records (n = 3941) from the Wyoming Ram Test from 1961 to 2010 were analyzed to determine how ram size, rate of gain, and fleece characteristics have changed over the past 50 years. This data set is particularly suited for this analysis since the production test has remained relatively stable with predominantly Rambouillet rams from top producers in the region. Although the diet has changed over the years, rams have always been provided an *ad libitum* (at one's pleasure) diet. Historical market prices were used to determine correlations of production characteristics with potential market forces with a time lag of 0, 2, or 5 years.

Results and Discussion

Even to a casual observer, it is obvious that sheep have increased in size over the past 50 years. With age of rams on test remaining relatively stable, ram weights at the end of the test increased approximately 53 pounds from the early 1960s from 192 to 245 pounds (Fig. 1). This increase is a reflection of an increase in growth efficiency with rams almost doubling their average daily gain from approximately 0.5 to 0.9 pound per day (Fig. 2).

Clean fleece weight increased over this period and is likely a reflection of increased ram size with both characteristics increasing about 25 percent.

Even though a clear drive for increased meat production has influenced breed characteristics and production over the past 50 years, spinning count (a measure of wool fiber diameter) has remained relatively stable with an average spinning count of 62.

Rambouillet rams have a more open face as reflected by a decrease in face wool score, but changes in the presence of body wrinkles was not as apparent. However, wrinkle and face scores are a subjective measure and most likely relative to rams present at any given test such that rams presenting with the most wrinkles would always score a 3 even though total wrinkling has declined.

Average daily gain strongly correlated with feeder lamb price, and it had the strongest correlation with a two-year lag time. Sheep inventory correlated negatively with average daily gain but correlated similarly with a 0-, 2- or 5-year lag time indicating an increase in efficiency occurred simultaneously with a decline in total sheep numbers. However, a cause-and-effect is not implied. Wool price was not correlated to spinning count at any of the time lags investigated.

Rambouillet rams have increased in size over the last 50 years with an increase in efficiency of production. Although clean fleece weight has increased proportionally to ram size, fiber diameter has remained unchanged and did not correlate with change in wool price. This suggests that market influences on white-faced ram selection have largely impacted growth traits while avoiding any negative impact on wool quality.

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Key words: sheep, production, ram test

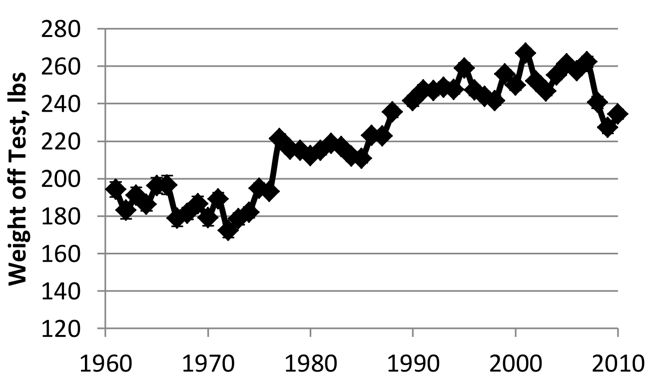

Figure 1. Ram weight (lbs) off test from rams on Ram Test from 1961 through 2010.

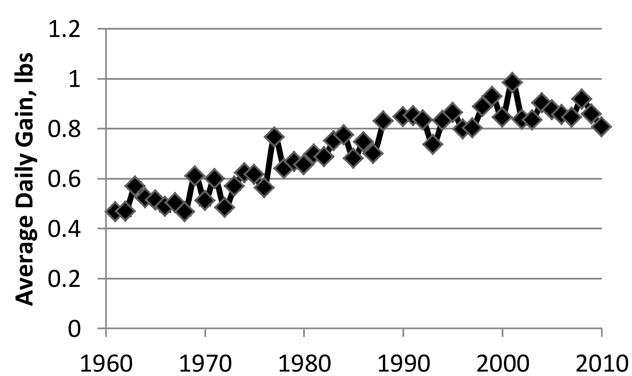

Figure 2. Average daily gain (lbs) from rams on Ram Test from 1961 through 2010.

Identification of Markers Associated with Feed Efficiency in Sheep

R. Cockrum[1], N. Pickering[2], R. Anderson[2], D. Hyndman[2], M. Bixley[2], K. Dodds[2], R. Stobart[1], J. McEwan[2], K. Cammack[1]

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Introduction

For livestock production to remain sustainable and economically efficient, it is imperative that researchers provide genomic tools that target polygenic traits of economic importance. Current selection practices can be improved through the incorporation of marker-assisted selection that target complex traits such as feed efficiency. This can be achieved through the use of high-density genotype chips. Residual feed intake (RFI), the difference between an expected intake and actual intake, has been suggested as an alternative measure for feed efficiency as it is independent of growth and carcass traits. As sheep producers incur feed costs of 50–70 percent of total inputs, feed efficiency parameters should be considered when constructing breeding programs. Increases of 9–33 percent in profitability have been realized in beef cattle when incorporating feed intake into breeding schemes for the selection of RFI. However, obtaining feed intake measurements for RFI is time consuming, expensive, and labor intensive. The combination of the time, labor, and costs associated with collecting individual feed intake measurements and the moderate to high heritability (0.16–0.43) of RFI makes it an ideal trait for marker-assisted selection.

Objectives

The objectives of this research were to determine heritability and identify markers associated with feed efficiency in sheep.

Materials and Methods

Feed intake measurements were collected from 2009–2011 from the University of Wyoming ram dual purpose (DP) and blackface (BF) breed performance tests (n = 330) using GrowSafe technology. Performance tests were composed of 5 groups (fall 2009 = 1; summer 2010 = 2; fall 2010 = 3; summer 2011 = 4; and fall 2011 = 5). Rambouillet, Columbia, Targhee, Suffolk, and Hampshire breeds were used. Body weights were collected weekly for the DP rams and every 25 days for the BF rams. Blood was collected for DNA isolation via the jugular. The majority of DP and BF sheep producers incorporate line breeding in their selection schemes to maintain purebred lines, which explains the average inbreeding coefficient of 9.6 percent (Table 1). Rams used in this study are likely more representative of purebred production populations.

Table 1. Genomic inbreeding coefficients of performance-tested rams for feed efficiency.

Group	Year	Breed Type	n	Mean[1] f_g %
1	Fall 2009	Dual Purpose	60	10.7%
2	Summer 2010	Blackface	77	9.4%
3	Fall 2010	Dual Purpose	75	10.6%
4	Summer 2011	Blackface	70	9.6%
5	Fall 2011	Dual Purpose	48	7.7%
Total			330	

[1]Genomic inbreeding coefficient percentage.

Table 2. Number of candidate genotypes per chromosome associated with feed efficiency.

Chromosome	Candidate genotypes	Chromosome	Candidate genotypes
0	1	13	2
1	10	14	5
2	7	15	3
3	8	16	1
4	1	17	1
5	6	18	7
6	1	20	1
7	6	21	1
8	4	24	2
9	5	25	2
10	8	26	2
12	2	X	4
Total = 90			

Out of 50,896 markers, 90 were determined to be associated with feed efficiency in sheep.

Individual RFI values were calculated by the difference between actual feed intake and estimated feed intake.

Results and Discussion

Genomic heritability (0.14) was much less than estimates from pedigree analyses in our study. Results confirm genomic heritability for this trait in cattle.

Chromosomes 1, 2, 3, 10, and 18 had the highest number of markers (n ≥ 7) associated with feed efficiency (Table 2). The SNP50 chip was designed to target genotypes evenly spaced across the genome, allowing for an unbiased approach. With sparse information available on the sheep genome, previous research in cattle must be drawn upon as a comparison to results found in sheep for feed efficiency.

Marker-assisted selection can be incorporated into breeding schemes to indirectly select against feed efficiency. Selection for feed efficiency will subsequently increase profitability and/or provide producers with the flexibility to increase their operation size.

Acknowledgments

This research was funded by the U.S. Department of Agriculture's National Institute of Food and Agriculture. The authors thank the American Rambouillet Sheep Breeders Association and Wyoming Wool Growers Association for making this research possible. Furthermore, a special thank you to the Laramie Research and Extension Center Sheep Unit farm crew and undergraduate research assistants for assisting in data collection.

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Key words: feed efficiency, genetics, sheep

The Effect of Diet on Feed Intake Traits and Relationships with Carcass Traits in Sheep

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Introduction

Feed for livestock is a substantial portion of production costs and can be included in up to 50–70 percent of total production costs in sheep. It is unlikely that feed costs will soon decrease due to increased competition for feed resources by energy industries and a growing human population. Improving feed efficiency becomes more important as feed costs continue to rise. This can improve performance of animals while decreasing necessary inputs.

Residual feed intake (RFI) is a measurement of feed efficiency defined as the difference between actual and predicted feed intake as it relates to observed. There is a great deal of research related to RFI in cattle; however, little work has been reported on RFI in sheep. Relationships between RFI and meat quality may concern producers who select animals based on efficiency. Therefore, it is important to understand whether selection for improved efficiency, particularly RFI, affects carcass quality. Additionally, little is known about how diet composition affects animal performance and intake during RFI testing, especially in sheep.

Objectives

Objectives were to determine the effects of a concentrate (CONC) versus forage (FOR) diet on feed intake traits and RFI and determine the relationship of RFI with carcass characteristics in lambs fed either a CONC- or FOR-based diet.

Materials and Methods

Growing Rambouillet, Hampshire, and Suffolk wethers (castrated male sheep) were randomly allocated by body weight (BW) to receive either a CONC- or FOR-pelleted diet. Individual feed intake was measured using the GrowSafe system for a 49-day trial. Two-day average initial and final BW were obtained to calculate average daily gain (ADG). From this data, RFI was calculated as the deviation of true feed intake from expected feed intake. Expected feed intake was determined by regressing ADG and metabolic mid-weight on actual feed intake. Residual feed intake calculations were used to rank wether efficiency. The 20-percent most and 20-percent least efficient wethers from each diet based on RFI ranking were processed at the University of Wyoming Meat Lab, and carcass data were recorded, including hot carcass weight, dressing percentage, 12th rib fat, body wall thickness, rib-eye area, muscle conformation, U.S. Department of Agriculture (USDA) quality grade, USDA yield grade, and percent boneless retail cuts.

Results and Discussion

Wethers had an average daily intake of 4.80 ± 0.13 lb for CONC and 6.92 ± 0.18 lb for FOR diets, and feed intake was greater in FOR-fed compared to CONC-fed wethers. ADG was greater in FOR-fed (0.60 ± 0.02 lb/d) compared with CONC-fed (0.44 ± 0.02 lb/d) wethers. The gain-to-feed ratio was not affected by diet type. Residual feed intake ranged from -0.47 to 0.69 for wethers fed the CONC diet and from -0.70 to 0.80 for wethers fed the FOR diet. This suggests that a wider range of daily feed intake is associated with a forage-based pelleted diet. Boneless retail cut percentage tended to be greater for carcasses from FOR versus CONC wethers (Table 1). There were no other effects of diet, of RFI selection group, or on their interaction on carcass measures. RFI and USDA quality grade tended to be positively correlated. No other relationships between RFI and carcass measures were found. This suggests that selection for RFI should decrease overall intake while not unfavorably affecting carcass traits in sheep.

Acknowledgments

This research was funded by USDA's National Institute of Food and Agriculture. The authors thank the Laramie Research and Extension Center Sheep Unit farm crew, UW Meat Lab, and undergraduate research assistants for assistance with data collection.

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Key words: carcass, feed efficiency, sheep

Table 1. Effects of diet and residual feed intake (RFI) selection group on lamb carcass traits

	Diet[1]			RFI Selection Group[2]			*P*-values		
Item	CONC	FOR	SEM	Low	High	SEM	Diet	RFI	Diet x RFI[3]
Hot carcass weight, lb	85.90	79.10	7.00	81.90	83.00	6.60	0.31	0.77	0.71
Dressing %	56.50	54.40	1.70	56.50	54.80	1.70	0.39	0.58	0.39
12th rib fat, in	0.23	0.22	0.04	0.23	0.21	0.04	0.89	0.47	0.84
Body wall thickness, in	0.88	0.80	0.09	0.84	0.84	0.10	0.16	0.93	0.90
Rib-eye area, sq in	2.72	2.63	0.26	2.65	2.69	0.25	0.73	0.81	0.13
Muscle conformation	12.10	11.10	1.00	11.50	11.70	0.90	0.23	0.81	0.88
USDA quality grade[4]	12.10	11.60	0.90	12.10	11.60	0.90	0.47	0.39	0.94
USDA yield grade	2.62	2.60	0.40	2.72	2.49	0.41	0.90	0.48	0.82
Boneless retail cuts, %	45.30	46.00	0.60	45.60	45.70	0.60	0.09	0.71	0.24

[1]CONC=pelleted concentrate diet; FOR=pelleted forage diet; [2]Low=20% lowest RFI lambs of each diet (most efficient); High=20% highest RFI lambs of each diet (least efficient); [3]These numbers are the *p*-value for the interaction of diet and RFI; [4]11=average Choice; 12=high Choice.

Maternal Obesity in the Ewe Alters Pituitary Function, Programming Increased Adiposity and Reduced Skeletal Muscle Mass in Adult Male Offspring

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Introduction

The growth hormone (GH)/insulin-like growth factor-1 (IGF-1) axis profoundly influences body composition. GH increases liver synthesis of IGF-1 upon binding to GH receptors (GHR), which in turn stimulates skeletal muscle growth. Therefore, a decrease in the IGF-1 level would result in reduced skeletal muscle mass and increased fat deposition in animals. We have developed and characterized an ovine model of maternal obesity. From 60 days before conception, through parturition, control (C) ewes are fed 100 percent of National Research Council (NRC) recommendations, while obese (OB) ewes are fed 150 percent of NRC. We have previously reported that maternal obesity throughout gestation in the ewe results in decreased GH production by the pituitary, with a resultant decrease in blood levels of IGF-1 and increased adiposity in adult male offspring. These results indicated that reduced circulating IGF-1 is the cause for the increased adiposity and the decrease in lean mass-to-fat ratio seen in OB offspring compared with C offspring. Recent reports in rodents indicate that leptin, a hormone secreted by fat cells, stimulates pituitary secretion of GH through its binding to a receptor (OB-Rb) on GH-secreting cells. Additionally, peroxisome proliferator-activated receptor gamma (PPAR-γ) and the GH secretagogue receptor (GHSR) have also been shown to play important roles in inhibition and stimulation of pituitary GH secretion, respectively.

Objectives

While we have previously reported the negative effects of maternal obesity on reducing pituitary secretion of GH, the goal of this study was to determine which of these factors—leptin, PPAR-γ, or GHSR—mediated this effect.

Materials and Methods

Male singleton offspring born to obese (OB;150 percent of NRC recommendations, n=6) and control (C;100 percent of NRC, n=6) ewes were maintained together and fed to 100 percent NRC from weaning through adulthood (2–3 years of age) and then subjected to a 12-week *ad libitum* feeding challenge before necropsy. Pituitary and liver tissue were collected and snap frozen at -80^{o}C, and pituitary tissue was fixed and paraffin was embedded to evaluate co-localization of pituitary GH and OB-Rb using fluorescence microscopy. Pituitary expression of PPAR-γ and GHSR,

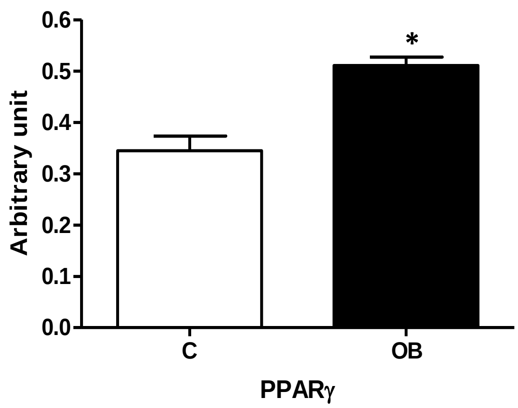

Figure 1. Protein expression of pituitary PPAR-γ in OB and C offspring.

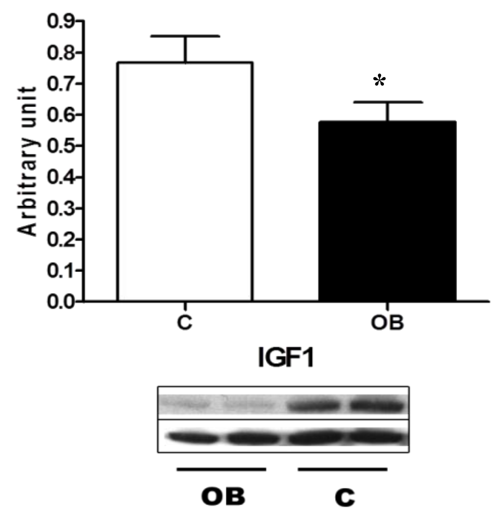

Figure 2. Protein expression of liver IGF-1 in OB and C offspring.

as well as liver expression of GH receptor (GHR) and IGF-1, were determined.

Results and Discussion

OB-Rb receptors were localized to GH-secreting pituitary cells, but they were markedly reduced in number in OB offspring. Further, pituitary protein expression of PPAR-γ was higher ($P<0.05$) in OB offspring than C offspring (Fig. 1), while protein expression of GHSR remained similar between groups. Liver expression of IGF-1 was lower ($P<0.05$) in OB vs. C offspring (Fig. 2), while liver expression of GHR remained similar between groups. These data suggest that the reduced number of leptin receptor sites on GH secreting cells, and their increased exposure to PPAR-γ, resulted in decreased GH secretion with a subsequent decrease in liver secretion of IGF-1. In conclusion, maternal obesity during gestation results in increased adiposity in their offspring by programming decreased pituitary GH secretion, and it results in reduced carcass quality.

Acknowledgments

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Key words: maternal obesity, sheep, fetal programming

Maternal Obesity in the Ewe Programs Increased Adiposity in Granddaughters

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Introduction

The fat cell hormone leptin acts on brain centers controlling appetite to inhibit food intake. Leptin negative feedback is central to maintenance of normal postnatal body weight and composition, while dysregulation leads to obesity. During the early postnatal period, rodent offspring exhibit a blood leptin spike, which programs their appetite in later life by influencing future leptin sensitivity.

We have developed and characterized an ovine model of maternal obesity. From 60 days before conception, through parturition, control (C) ewes are fed 100 percent of National Research Council (NRC) recommendations, while obese (OB) ewes are fed 150 percent of the control diet.

We have recently reported for the first time that a leptin spike also occurs in the early postnatal lamb, and that maternal obesity induces increased newborn adiposity and completely eliminates this leptin spike. Further, when we subjected the adult female F1 offspring from obese mothers (F1OB) to a 12-week *ad libitum* feeding trial, they exhibited markedly increased appetite, glucose and insulin dysregulation, increased adiposity, and increased circulating leptin levels when compared to adult female F1 offspring from control-fed mothers (F1C).

Objectives

This study was conducted to determine if there is a transgenerational effect of maternal obesity on eliminating the postnatal leptin spike and inducing adiposity of their granddaughters (F2 lambs) born to F1OB mothers that were fed only to requirements throughout gestation.

Materials and Methods

Mature F1OB (n=8) and F1C (n=7) female lambs were fed to requirements until maturity, then bred and maintained on 100-percent NRC recommendations throughout a gestation. They were allowed to lamb unassisted to produce F2OB and F2C lambs. F2 lambs were weighed and bled at birth, and body composition was determined by Dual Energy X-ray Absorptiometry (DEXA), then lambs were bled daily from postnatal days 1 to 7, and on postnatal day 9 and 11. Plasma leptin was measured by validated radioimmunoassay (RIA).

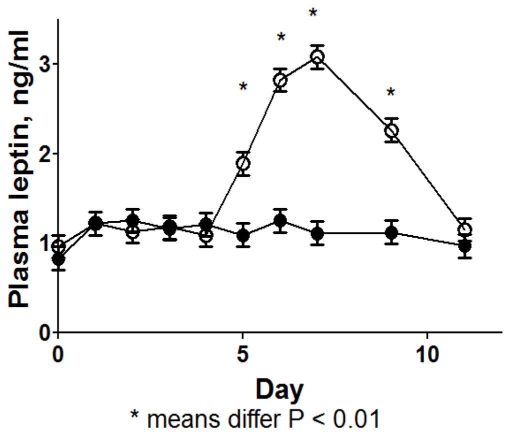

Figure 1. Postnatal leptin spike in F2 offspring born to CF1 mothers (open circles) and OBF1 mothers (closed circles).

Results and Discussion

Gestation length was reduced in OBF1 ($P < 0.05$) ewes compared with C F1 ewes (150.1 ± 0.5 vs. 153.6 ± 0.5 d, respectively). Lamb birth weight was similar for control and obese F1 ewes (11.02±1.10 vs. 11.46±0.44 pounds, respectively), but newborn adiposity as a percent of body weight was markedly increased in lambs born to OB F1 ewes compared to newborns born to C F1 ewes (9.70±0.60 vs. 5.66±0.75 percent, $P<0.01$).

C F2 lambs exhibited an increasing ($P < 0.05$) plasma leptin from postnatal days 4 to 7, which remained elevated from days 5 to 9, before returning to baseline levels by day 11(Fig. 1). No increase in leptin was seen in OBF2 lambs from day 1 through day 11.

We have reported for the first time that diet-induced maternal obesity in a large precocial (gives birth to mature young) species (1) results in increased adiposity, (2) results in the elimination of the neonatal leptin peak in their offspring, and (3) has a transgenerational effect on the F2 generation as well, which is independent of maternal nutrition. Additional studies will be required to ascertain the specific factors influencing newborn adiposity and the postnatal leptin peak. These data have real implications for both livestock and human health and growth efficiency, suggesting transgenerational increases in adiposity, insulin resistance, and cardiovascular disease in offspring.

Acknowledgments

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Key words: maternal obesity, sheep, fetal programming

Effects of Post-AI Nutrition on Growth Performance and Fertility of Yearling Beef Heifers

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Introduction

Approximately 80 percent of the cowherds in the West and Midwest are spring calving, which means that producers are often breeding replacement heifers early in the grazing season. Many of these heifers are developed under a controlled nutritional environment to reach 60–65 percent of their mature weight, artificially inseminated (AI) to maximize productivity, and then typically moved to pasture without supplementation following AI. It is known that transporting females after AI can compromise conception rates. Maternal recognition of pregnancy takes place around days 15–17 post-insemination, and transporting animals near this time compromises conception rates. However, moving heifers within the first five days post-insemination does not appear to cause this reduction in pregnancy success to AI. Nonetheless, research suggests that conception rates are compromised when heifers are moved from a controlled nutritional environment to a pasture without supplementation. These observed low AI conception rates may be due to early embryonic losses—those losses that occur from fertilization until day 28 of pregnancy when differentiation and implantation has occurred. In herds where post-AI movement happens within the first several days after insemination but coincides with early spring forage growth—a time in which forage is typically high in water content and low in nutrient profile—producers have still experienced a reduction in AI conception rates. Our hypothesis is that when heifers are fed under a controlled nutritional environment, synchronized and AI'd, and moved within several days to early spring pasture, conception rates are compromised due to a sudden drop in energy intake during the first 21 days post-insemination.

Objectives

The objectives were to determine the effects of change in nutritional status during the first 21 days post-breeding on body weight, body condition score (BCS), AI conception rates, and, ultimately, reproductive efficiency of yearling beef heifers.

Materials and Methods

Heifers at the Laramie Research and Extension Center (LREC) and Purdue University were assigned to one of three treatments: 1) formulated to meet the growth requirements for heifers to gain at a rate identical to that prior (1.5 lbs/day) to initiation of trial (GAIN); 2) diet formulated to meet nutrient requirements for a maintenance diet (MAINTAIN); and 3) diet formulated to provide 80 percent of the energy requirement for maintenance (LOSE). Estrous synchronization was accomplished using the industry standard 7-day Co-Synch+CIDR® and the MGA®/PGF2α protocols at both locations. All heifers were bred on a timed scheme. Immediately following AI, heifers were returned to dry lots and placed on dietary treatment for the 21-day experimental period. AI pregnancy rates were determined at 35 days after timed-AI via ultrasonography.

Results and Discussion

As expected, heifers on the GAIN treatment had a greater average daily gain (ADG) and increase in BCS compared to heifers on other treatments. First-service conception rate was significantly increased for heifers on the GAIN (76 percent) treatment compared with heifers on either the MAINTAIN (56 percent) or LOSE (60 percent) treatment. Additionally, conception to the second service followed the same trend with the GAIN (58 percent) group having greater second service conception rates compared with MAINTAIN (24 percent) or LOSE (35 percent). These results suggest that the level of nutritional decline post-AI may not be as critical as the reduction itself. Heifers that were maintained with the same level of nutrition post-breeding had significantly greater conception rates for the first two heat cycles.

As exposed by reductions in ADG, and consequently body weight and BCS, heifers in the MAINTAIN and LOSE diet were under nutritional stress, which was reflected on AI and overall conception rates. Results observed in this study are supported by other research evaluating post-AI nutritional management. In every case, heifers moved from feedlot to pasture with no supplementation resulted in lower pregnancy rates than those kept in the feedlot or moved to a pasture and supplemented. On the other hand, pasture-developed heifers that returned to pasture (with or without supplementation) and heifers moved to a feedlot resulted in similar pregnancy rates.

These data suggest that the post-breeding plane of nutrition is critically important and should be considered for heifers fed a high plane of nutrition prior to breeding.

Acknowledgments

We recognize the hard work of Travis Smith, LREC Beef Unit manager.

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Key words: heifer, dietary energy, post-breeding

Correlation of Feed Efficiency and Small Intestinal Growth in Finishing Cattle

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Introduction

As feed and other input costs rise, efficiency of nutrient use becomes more and more important for livestock production. It has been well-established that when other outside factors are similar, feed intake varies between individual animals due to differences in metabolic efficiency. Residual feed intake, also known as RFI, is the difference between an animal's actual measured intake and its predicted intake based on growth rate and body weight, and it is one way to measure feed efficiency.

Much of the physiological basis for differences in feed efficiency among animals being managed similarly remains unknown. The gastrointestinal tract—namely the small intestine—is the main site of nutrient digestion and absorption. It also uses many nutrients and energy that the animal consumes. However, the role of the small intestine in feed efficiency is unclear.

Objectives

We hypothesized that feed efficiency of cattle during the finishing phase would be correlated with small intestinal growth measurements in market weight calves. Our objectives were to investigate the relationship of small intestinal growth with feed efficiency measures during the finishing period.

Materials and Methods

Crossbred calves (n = 17 steers, n = 14 heifers) born at the Laramie Research and Extension Center (LREC) Beef Unit were managed similarly pre- and post-weaning. Individual feed intake of calves was measured with the GrowSafe® Feed Intake System at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle during the finishing period. From this data, both residual feed intake and gain:feed were calculated. At slaughter in the University of Wyoming Meat Lab, the small intestine was dissected and sampled for determination of weight and growth characteristics.

Results and Discussion

Correlation coefficients of small intestinal growth measures with RFI and gain:feed are shown in Table 1. All correlations were statistically significant at $P < 0.10$.

Correlation does not imply cause-and-effect but shows relationships between two given measures. A positive correlation coefficient means that the two measures move in a similar fashion (both increase or decrease together), whereas a negative correlation coefficient means that the two measures move in an opposite direction (as one increases, the other decreases). To interpret this data, it must be noted that a negative RFI value indicates a more efficient animal, although a greater gain:feed value indicates a more efficient animal.

The correlation data from this study demonstrate that more efficient calves had less small intestinal mass but more dense mucosal tissue. Intestinal mucosal is the main part of the tissue that acts in digesting and absorbing nutrients, thus small intestines with more mucosa and less support tissue (e.g., muscle and connective tissue) may be able to aid in digestion and absorption of more nutrients while using less nutrients. Additionally, the small intestine of more efficient animals had more cells that were smaller, indicating more cell replication than cell growth.

These data demonstrate that small intestinal size and growth measurements explain some of the variation in efficiency of nutrient use in feedlot cattle. Because the small intestine appears to contribute to feed efficiency, it is a potential target for feedlot management strategies to improve efficiency. Further research is necessary to better understand this relationship.

Table 1: Correlation coefficients of feed efficiency and small intestinal growth traits

	Residual feed intake	**Gain: Feed**
Jejunal Weight	0.35	--
Small Intestinal Weight	0.33	--
Jejunal Mucosal Density	-0.33	0.42
Jejunal DNA Concentration	-0.34	0.32
Jejunal RNA Concentration	--	-0.44
Jejunal Protein Concentration	--	0.40
Jejunal RNA:DNA	--	-0.52
Total Jejunal DNA	--	0.34
Total Jejunal RNA	0.33	-0.37
Total Jejunal Protein	--	0.39
Total Jejunal Cells	--	0.34

Acknowledgments

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Key words*:* beef cattle, feed efficiency, residual feed intake

Effects of Supplementation with a Pressed Dried Distillers Grain Block on Beef Cow Performance and Hay Intake During Late Gestation

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Introduction

Feed costs represent the majority of operating costs for beef cow-calf producers. Compounding this issue, protein and/or energy supplementation is often needed for optimal production of cattle grazing low-quality forages. Supplementation can be both expensive and labor intensive; therefore, implementing a supplementation program that minimizes labor and still offers adequate nutrients is essential.

The ethanol industry and resulting high corn prices have increased the prevalence and use of co-product feeds such as dried distillers grains with solubles (DDGS). DDGS has greater protein (and increased ruminally undegradable protein), fat, and fiber content than many traditional supplements such as corn. The nutrient content of DDGS thus gives the potential to supplement both ruminally undegraded protein and fat to beef cows consuming low-quality forages. Use of these co-products may be limited in the range setting, however, because of the increased labor of daily or alternate-day feeding of range cube or loose DDGS-based supplements.

Objectives

Our objectives were to evaluate effects of supplementation with a self-limiting pressed DDGS-based block, SweetPro® 16, on cow body weight (BW), body condition score (BCS), ultrasonic body composition, and hay intake in late gestation.

Materials and Methods

Seventy-two mature crossbred beef cows during late gestation were blocked by expected calving date and randomly allocated by BW to one of three treatments. The study took place at the Laramie Research and Extension Center Beef Unit using cows ranging in age from five to nine years (average age = 6.9 years) from December 8, 2011, to February 14, 2012 (March 1 to April 15 calving period). Eighteen pens were used, allowing for six replicates of each treatment (four cows/pen). All treatments had access to *ad libitum* chopped grass hay (8.1% crude protein [CP]; 57.7% neutral detergent fiber) for the duration of the 70-day trial. The control (CON) treatment received only grass hay without any supplementation. The second (BLOCK) treatment had *ad libitum* access to SweetPro® 16 (1.28 to 4.37 $lb \bullet cow^{-1} \bullet d^{-1}$ intake), a pressed DDGS-based block (22.4% CP; 6.9% fat). The positive control (POS) treatment received 1.25 lb•cow^{-1}•d^{-1} (as fed) of supplement (57% corn and 43% DDGS; 19.2% CP; 6.4% fat) to resemble suggested intake and nutrient composition of BLOCK. Hay fed to cows in each pen was measured twice daily and refusals measured once weekly to monitor hay intake per pen.

Cow BW and BCS were monitored during the study. Ultrasonic back-fat thickness, rib-eye depth, and marbling score were also measured at study initiation and conclusion.

Table 1: Effects of supplementation on hay intake and cow performance. ^{abc}Means with different superscripts differ (P < 0.10).

	Treatment			
Item	**CON**	**BLOCK**	**POS**	***P*-value**
Hay intake, lb DM	28.0^{a}	27.3^{b}	27.8^{ab}	0.05
BW change, lb	128.0^{a}	168.7^{b}	168.2^{b}	0.007
BCS change	0.34^{a}	0.53^{b}	0.68^{c}	0.006
Back-fat change, mm	0.053	0.387	0.543	0.57
Marbling score change	29.1	12.8	14.9	0.79
Rib-eye depth change, mm	-1.46	0.39	-2.49	0.35

Results and Discussion

All data discussed are statistically significant ($P \leq 0.05$). Throughout the course of the study, hay dry matter intake was decreased for cows with access to SweetPro® 16 blocks compared to cows receiving only hay (Table 1). The reason for decreased hay intake for the BLOCK treatment is unknown but likely due to a variety of explanations concerning how supplementation affected fiber digestibility, satiety signals, hormonal responses, and/or ruminal fill.

BW increase was greater for cows in the BLOCK and POS treatments compared with CON over the entire study (Table 1). This was likely both a result of the rapid fetal growth during late gestation and the increase in nutritional plane from supplementation.

Cows receiving the POS treatment had the greatest increase in BCS during the study, while the BLOCK treatment was intermediate and CON was least (Table 1). There was no effect of supplementation on ultrasonic back-fat thickness, rib-eye depth, or marbling score.

In conclusion, performance improved while hay intake was decreased in cows allowed *ad libitum* access to SweetPro® 16 pressed DDGS blocks, suggesting that this is a viable supplementation option for beef cows during late gestation. However, cost and intake of the supplemental inputs must be considered to determine feasibility in production systems.

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Key words: beef cows, distillers grains, supplementation

Chemical Castration of the Coyote

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Introduction

Coyotes have been and continue to be significant predators of livestock, mainly domestic sheep. Primary control of depredating coyotes has been by lethal removal. This method has been met with mixed reviews mainly due to both public opposition and limited effectiveness of lethal control.

When depredating adult coyotes are removed from an area, a new pair rapidly moves into the vacant territory and resumes depredations. Research has shown that depredations decrease when pups are removed. Paired coyotes continue to maintain territories even in the absence of pups. Therefore, controlling reproduction may be a more socially acceptable and effective tool for managing predatory behaviors of coyotes. Surgical sterilization has been successful in controlling coyote depredations on sheep and pronghorn antelope; however, implementation costs prevent widespread use.

Chemical castration of coyotes with gonadotropin-releasing hormone (GnRH) agonist provides an alternative option for controlling reproduction. In contrast to surgical castration, which removes the testes, GnRH agonists work in the brain to stop production of reproductive hormones and sperm, resulting in a castration-like effect.

Objectives

The overall goal of this research is to determine if a single treatment of a sustained release, high dose of the GnRH agonist deslorelin can permanently *chemically* castrate coyotes.

Materials and Methods

The study consists of two groups of male coyotes housed at both the Laramie Research and Extension Center (LREC) Beef Unit and University of Wyoming Red Buttes Environmental Biology Laboratory near Laramie. All test coyotes are implanted with 47 milligrams (approximately 0.0017 ounces) deslorelin. Group one coyotes (n=3) were implanted April 2011. Group one also had a control coyote (n=1) until October 2011. Group two consists of test coyotes implanted January 2012 and control coyotes with no implant.

Results and Discussion

Preliminary data from group one indicates full suppression of the reproductive axis as supported by complete absence of sperm as shown in Fig. 1. Fig. 2 shows that testosterone concentrations remain suppressed after one year. The initial "flare" of testosterone in coyotes is a predicted drug-induced response after implant.

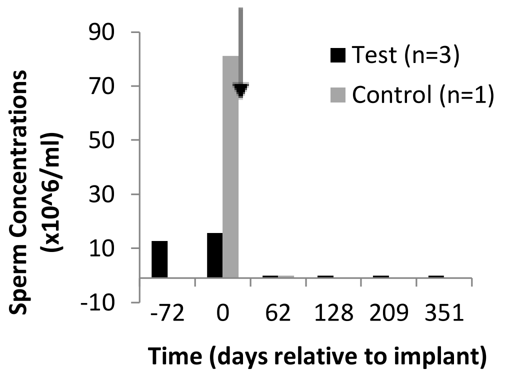

Figure 1. Sperm concentrations (x10^6/ml). Implant day indicated by arrow.

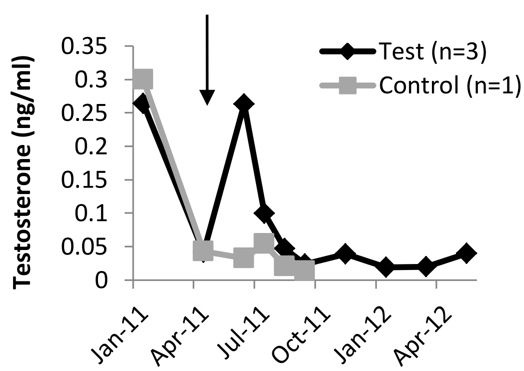

Figure 2. Testosterone concentrations (ng/ml). Implant day indicated by arrow.

Deslorelin does not appear to reduce testosterone levels below the natural seasonal drop in coyotes. The high level of testosterone during the breeding season (January 2011) is necessary for sperm production; however, it is believed only low levels of testosterone may be needed to maintain mating integrity. This was shown experimentally in the rat: minimal testosterone levels (not sperm production) support mating behaviors.

Pending successful castration, we aim to move this to a field study to assess impacts of castration on territory fidelity and affiliated behaviors. To our knowledge, there are no known castration studies involving wild canids. Experimental research in castrated dogs has found that mating behaviors and territorial aggression persist years after castration. More studies are finding that non-migratory animals don't rely on testosterone to drive aggression even during the mating season. This is why caution must be used when applying the role of testosterone and behaviors across non-canid species, including farm animals and other wildlife.

Implications for this research may provide an additional means of selectively managing problem coyotes. The goal is an *effective* management tool that is cost efficient and acceptable to the general public.

Acknowledgments

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Key words: coyote, predation, castration

A New Insect Biocontrol Agent for Russian Knapweed

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Introduction

In 2009, a new insect biocontrol agent from Uzbekistan became available for the management of Russian knapweed, one of the most important, invasive rangeland weeds in Wyoming. The insect, a fly about half the size of a mosquito (Fig. 1) causes the formation of distorted and swollen plant tissue known as a "gall" on the tips of Russian knapweed shoots (Fig. 2). The gall essentially "hijacks" shoot growth to provide food and shelter for the developing fly larvae inside. As a new biocontrol agent, the fly must be reared in a greenhouse and released at multiple "insectary" sites in Wyoming. In addition, the impacts of the insect on Russian knapweed need to be evaluated.

Figure 1. Adult Russian knapweed gall fly, originally from Uzbekistan. Photo: CABI Europe – Switzerland.

Figure 2. Gall on Russian knapweed shoot tip, Fremont County. Photo: T Collier.

Objectives

The first objective is to rear gall flies in the greenhouse for release at field sites across Wyoming. The second objective is to experimentally evaluate the impact of attack by the gall fly on Russian knapweed plants, specifically on root growth and new shoot production from Russian knapweed's creeping root system as well as on flower and seed production.

Materials and Methods

Rearing of the gall fly was conducted in 2011 and continues in 2012. Russian knapweed plants are grown from seed or root pieces in 3- to 5-gallon pots at the Laramie Research and Extension Center (LREC) greenhouse facility (Fig. 3).

Once the knapweed plants reach an appropriate stage, they are infested with gall flies reared in quarantine from parental flies collected in Uzbekistan. Galls appear on the plants approximately 7 days later and are ready for field release after 12 days.

Figure 3. Potted Russian knapweed plants used for gall fly rearing in 2011. Photo: T. Collier.

Experimental assessment of gall fly impact is a new project for 2012. Russian knapweed plants, established from seed, will be grown in “rhizotrons” at the LREC greenhouse facility. A “rhizotron” is an apparatus for visualizing plant root systems without having to destroy the plant. A year after planting, in July 2013, half the knapweed plants in rhizotrons will be exposed to gall fly attack while the other half will be maintained as unattacked “control plants.” Images of roots will be taken every 2 weeks from July–September, and in October, the number of new shoots and flowers per plant will be recorded. Flowers will be dissected to determine seed number. The hypothesis is that attack by the gall fly will reduce shoot, flower, and seed production.

Results and Discussion

Galls reared in the greenhouse in 2011 were released at a field site in Natrona County in August 2011. Whether the population has persisted over the winter at the site will be evaluated in August 2012. The impact assessment is a new experiment for 2012. Results will not be available until late 2013 but are expected to indicate whether the gall fly reduces the creeping spread and seed production of Russian knapweed. Results will suggest whether the gall fly, as a new management tool for Russian knapweed, has the potential to reduce the spread of this important rangeland weed.

Acknowledgments

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Key words: weed management, Russian knapweed, biological control

Investigating Wild-collected and Cultivated Seed Impacts on Grassland Restoration Success

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Introduction

Restoration commonly requires the reintroduction of plants to degraded sites, and long-term vegetation establishment is a critical component of restoration success. Guidelines for seed sourcing recommend the use of local, wild-collected seeds to increase the likelihood that seeds are adapted to site conditions, maintain site biodiversity, and improve the long-term sustainability of restored plant populations. However, native seeds are scarce, and practitioners often purchase commercially produced seeds, or cultivars, to meet native vegetation goals and reduce costs.

Cultivars of native plants are desirable because they are readily available and cost efficient; however, cultivated seed sources generally represent native plant seeds derived from a limited number of sources and at long distances from restoration sites. Non-local seeds may not be suited to novel environmental conditions, such as different climates and soils.

Recommendations to use local seed sources are based on the assumption that the environmental conditions to which plants are adapted remain relatively unchanged. However, some environments are so radically altered by exotic, invasive weeds that original conditions may no longer exist. Under these circumstances, agriculturally selected cultivars of native species may have a competitive advantage at sites that are highly degraded, and the assumption that local seeds are better adapted to site conditions than cultivars may no longer hold. To address questions of appropriate seed sources for restoration, we are establishing a research program between Montana and Wyoming to test wild-collected (local) and cultivated seed sources of Sandberg bluegrass (*Poa secunda*) in different environments.

Figure 1. Bitterroot Valley, Montana (Photo: K.M. Hufford).

Objectives

The primary goal of this project is to test establishment of wild-collected and cultivated seed sources of Sandberg bluegrass in non-invaded and invaded environments in the field. Secondary goals are to understand the extent of the biological differences among seed sources of *P. secunda* and how these differences affect each seed source's ability to survive and grow in controlled greenhouse conditions.

Materials and Methods

To investigate the outcome of Sandberg bluegrass seed introductions at the MPG Ranch in western Montana (Fig. 1), we will compare commercial and local, wild-collected seeds in invaded and non-invaded plots for germination, survival, growth, and reproduction. In addition, we will test for germination and growth differences among cultivated and wild-collected seed sources grown in the greenhouses at the Laramie Research and Extension Center. Seeds of *P. secunda* will be grown individually or competed with each other or the invasive species cheatgrass (*Bromus tectorum*) in pots to test hypotheses that commercially developed seeds are more competitive than wild seed and more likely to establish in invaded conditions. Lastly, we will conduct genetic analyses to test differences among wild and cultivated seed sources of Sandberg bluegrass.

Results and Discussion

The use of local seeds in restoration is key to preserving biodiversity and may be important for restoration success if they are better adapted to site conditions and more likely to establish than cultivars. However, the growing impact of invasive species and high levels of site degradation may require innovative methods for reintroduction of native plants. This study will determine the degree of genetic and adaptive divergence among cultivated and local seed sources, test their ability to establish in highly invaded grasslands, and contribute to our understanding of how seed origin affects competitive interactions of native flora with invasive species. It is critical that we begin to examine the different impacts of cultivated seed sources versus local, wild-collected seeds to determine best practices for their use.

Acknowledgments

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Key words: adaptation, cultivars, restoration, seeds

An Evaluation of Desirable Species' Relative Competitive Abilities Against Downy Brome

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Introduction

Downy brome, or cheatgrass, is a winter annual grass that has become one of the most widespread, problematic weeds on Western rangelands. Downy brome is estimated to occupy more than 54 million acres in the western United States and is continuing to spread at an average rate of 14 percent annually.

As with many other invasive rangeland weeds, challenges to downy brome management include vast areas infested, a high cost-to-monetary-benefit ratio associated with control, and difficulty in achieving successful long-term control. The ability to compete with desired species for early spring moisture and nutrients, prolific seed production, and effect on wildfire cycle, make downy brome a challenging and troublesome weed to control on Western rangelands.

On drastically disturbed sites, such as a natural resource extraction site, annual weeds such as downy brome and Russian thistle may compete with desired vegetation during establishment. Where restoration of an invaded site is needed, or in the situation where annual weeds impede establishment of desired vegetation, an integrated approach to weed control is needed.

Objectives

A greenhouse study was performed to evaluate several desirable species' relative competitive ability when grown in competition with downy brome.

Materials and Methods

A phytometer, or target species, approach was used to assess competitive effect of desirable species on the target species downy brome. On May 10, 2011, three individuals of each species of interest were planted in a 15 cm diameter pot equidistant from one downy brome plant in the center. Downy brome was also grown alone for comparison. The experiment was conducted in the Laramie Research and Extension Center greenhouse complex. Downy brome biomass was measured four months after planting, and the deviation from downy brome grown alone was used to calculate relative competitive performance of the neighboring species (competitor).

Results and Discussion

Of the species studied, muttongrass and Salina wildrye were the only species to significantly reduce downy brome aboveground growth (Table 1). Downy brome biomass was most reduced when grown with other downy brome neighbors, suggesting strong intra-specific competition. These results suggest that none of the species used in this study would be very successful competitors with downy brome in the seedling stage, although we did not evaluate the competitive effect of downy brome on desirable species' growth.

Acknowledgments

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Key words: restoration, seedling competition, invasive species

Table 1. Aboveground relative competitive performance means against downy brome phytometer with 8 neighboring species after 4 months growth in a greenhouse. Number of replicate pots (n) and lower (LCL) and upper 95% confidence level (UCL) are also included. Mean values above 0 indicate an increase in downy brome biomass grown with corresponding neighbor, and values below zero indicate competitive suppression of downy brome by the species. Species where the range between LCL and UCL do not overlap may be interpreted to have statistically different relative competitive performance.

		Aboveground RCP		
	N	mean	LCL	UCL
Phytometer alone	8	0	-0.14	0.14
Wyoming big sagebrush	2	-0.138	-0.25	-0.03
BLM CO western wheatgrass	5	-0.129	-0.31	0.05
'Piceance' bluebunch wheatgrass	10	-0.192	-0.29	-0.10
Blue flax	4	-0.297	-0.54	-0.05
Muttongrass	**8**	**-0.293**	**-0.42**	**-0.17**
Crested wheatgrass	7	-0.295	-0.51	-0.08
'Salina' wildrye	**10**	**-0.291**	**-0.40**	**-0.19**
Downy brome	**9**	**-0.697**	**-0.82**	**-0.57**

Desirable Reclamation and Restoration Species Seedling Response to Aminocyclopyrachlor

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Introduction

Establishment of desirable plants on disturbed sites is critical to successful reclamation. Competition from weedy species may impede establishment and growth of desirable seeded species, and herbicides are often used to reduce weed competition. Herbicides used in reclamation should cause limited damage to desirable species in addition to controlling weeds. A new synthetic auxin herbicide, aminocyclopyrachlor, effectively controls many broadleaf weed species commonly found on disturbed sites, but little is known about its effects on desirable species at early growth stages.

Objectives

This study investigated the seedling response of 17 desirable species (composed of 27 unique germplasm sources) and two exotic weeds to aminocyclopyrachlor.

Materials and Methods

A greenhouse study was conducted in 2010 and repeated in 2011 at the Laramie Research and Extension Center. Twenty-seven different accessions of 17 desirable species and two invasive weeds were planted individually in pots in fall 2010 and repeated in spring 2011 (Table 1). Aminocyclopyrachlor was applied to seedlings at rates from 0.14 to 4.5 oz/acre 30 days after planting. Plants were harvested and weighed 30 days after herbicide treatment.

Results and Discussion

Downy brome (cheatgrass) was one of the more tolerant grasses to aminocyclopyrachlor. At a rate that would reduce downy brome growth, other desirable perennial grasses would likely be equally or more damaged at seedling stage. Most seedling grasses were fairly tolerant to aminocyclopyrachlor. We observed differences among accessions within a species in response to aminocyclopyrachlor, suggesting genetic variability within species for susceptibility to this herbicide.

If aminocyclopyrachlor was used to control prickly Russian thistle (*Salsola tragus* L.), grass injury would be minimal with an early postemergence timing. With increased environmental stressors expected under field conditions, it is more difficult to predict the long-term effects of this herbicide on these species, especially in arid and semiarid environments.

Aminocyclopyrachlor substantially injured all forbs and shrubs evaluated in this experiment at rates that would control Russian thistle. If aminocyclopyrachlor were to be used in a reclamation setting, careful attention to the desirable plant component, including forbs, will be necessary.

Acknowledgments

This project was supported by a Wyoming Agricultural Experiment Station competitive grant, DuPont, and the Department of Plant Sciences. Special thanks to the Natural Resources Conservation Service's Plant Materials Program for supplying seed for the research.

Contact Information

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Key words: reclamation, restoration, herbicide tolerance

Table 1. Selected plant materials and growth reduction resulting from aminocyclopyrachlor applied 30 days after planting estimated from log-logistic regression.

Common name	Germplasm	Growth Reduction*
Crested wheatgrass	Common	16
Bottlebrush squirreltail	BLM CO	34
Bottlebrush squirreltail	Baggs	18
Slender wheatgrass	Common	28
Slender wheatgrass	'Pryor'	34
Junegrass	Common	20
Basin wildrye	'Trailhead'	0
Basin wildrye	Common	30
Salina wildrye	Common	25
Western wheatgrass	'Rosana'	43
Russian wildrye	'Bozoisky'	11
Bluebunch wheatgrass	'Anatone'	30
Bluebunch wheatgrass	'Piceance'	42
Bluebunch wheatgrass	BLM CO	19
Fringed sage	Common	97
Wyoming big sagebrush	Common	89
Silver sagebrush	'Cedar springs'	74
Prairie flax	'Maple grove'	92
Blue flax	Common	87
Downy brome	Common	6
Russian thistle	Common	90

* % reduction in growth compared to untreated plant means resulting from 105 grams aminocyclopyrachlor/ha

Forage Legumes Establishment through Seed Scarification and Companion Crop

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[1]Plant Sciences Department.

Introduction

There is increasing interest among livestock producers in the West to grow forage legumes such as cicer milkvetch, sainfoin, and medic as alternatives to alfalfa. However, establishment of these legumes is difficult because of low germination, hard seed coat or content (a protective outer layer of seed), low seedling vigor, high weed competition, and disease problems. One of the major causes for poor establishment is associated with the hard seed of legumes. Many seeds are very hard and require artificial scarification to enhance germination and eventual establishment.

Seed scarification (breaking the hard seed coat without lowering the quality of seeds), use of companion crops, and seed inoculation may enhance establishment. Using companion crops (e.g., oat) in establishing alfalfa is a common practice, but information is lacking whether the same technique can be used to establish other forage legumes.

Objectives

Objectives are to determine appropriate methods for seed scarification, apply the 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 Laramie Research and Extension Center (LREC) greenhouse. Treatments included were heat, freeze–

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 (00.0)	1.0 (1.4)	0.0 (0.0)	0.2 (0.4)	1.8 (0.8)
	Vernal	6.0 (02.8)	2.2 (1.3)	0.0 (0.0)	0.0 (0.0)	1.6 (0.9)
	Ladak	6.0 (05.7)	3.0 (1.9)	1.0 (1.0)	0.0 (0.0)	3.4 (2.2)
	Falcata	7.0 (01.4)	12.0 (2.2)	0.6 (1.3)	1.2 (0.4)	2.6 (1.1)
Sainfoin	Shoshone	5.0 (01.4)	3.2 (2.8)	3.6 (2.4)	8.0 (1.9)	5.4 (3.6)
	Eski	2.0 (00.0)	1.2 (1.3)	1.0 (0.7)	2.2 (1.8)	1.2 (0.8)
	Remont	1.0 (01.4)	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 (09.9)	68.4 (9.3)	61.0 (4.1)	47.2 (6.7)	59.4 (5.4)
	Lutana	63.0 (09.9)	65.8 (5.2)	57.6 (9.2)	54.4 (7.9)	63.6 (7.6)
Medic	Laramie	23.0 (07.1)	26.2 (5.4)	3.0 (2.2)	4.2 (1.9)	1.2 (2.2)

thaw, mechanical, and acid scarification with five replications. A number of varieties from four legume species were used. The field study was conducted at the LREC and 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), and thus enhanced germination of some of the varieties used. Oat, as a companion crop, has the potential to suppress weed infestation (Fig. 1) and enhance establishment of different forage legumes.

Acknowledgments

We thank SAREC and LREC field crews for assistance in plot establishment and harvesting. The study is supported by departmental funding.

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Key words*:* alfalfa, oats, alternative crops

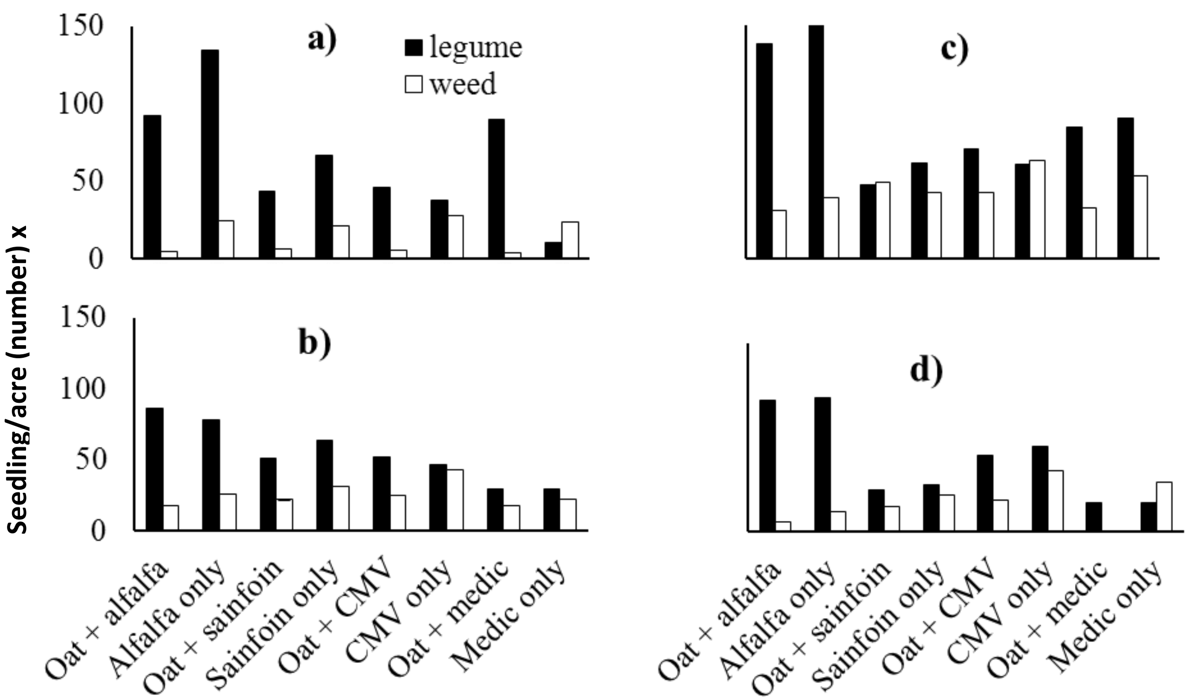

Figure 1. Legume and weed seedling count at first harvest (a) and second harvest (b) at SAREC; and first harvest (c) and second harvest (d) at LREC. The first and second harvests were July 14 and September 8, 2009 at SAREC, and July 30 and September 25, 2009 at LREC.

Forage and Biofuel Potential of Tall Fescue Germplasms

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Introduction

Drought stress is one of the most important constraints on agricultural profitability and sustainability worldwide. Crops with high-use efficiency for all types of limiting resources, including water, are critical to producer success. Forage crops can produce very high levels of net biomass per unit area because of very low requirements of fertilizers, herbicides, and soil preparation. Forages allow producers to harvest important commodities, like fiber and animal feed, from marginal lands that would otherwise be incapable of high productivity. It is important to note, however, that even alfalfa, the most cultivated forage in the West, requires copious amounts of water to be most productive. This reduces efficiency and limits profitability for producers. The tall fescue *Schedonorus arundinaceus* (Schreb.) Dumort—formerly *Festuca arundinacea* Schreb.—is a forage grass that has been selected as a test species based on cold and drought hardiness in a preliminary study. Our data indicates a capability for vigorous growth in harsh Wyoming environments, and it is anticipated that tall fescue can be highly productive with very low costs to local producers. Using forage grasses could save producers money and increase overall profitability across the region.

This project has the potential to directly benefit Wyoming because of application in the cattle industry. We are working to illustrate tall fescue's ability to produce a variety of desirable products, including high quality animal feed and cellulosic ethanol.

Objectives

The goal of this project is to measure the production potential of tall fescue lines and identify those capable of producing high biomass with low management inputs. The project will also examine other applications including forage use as hay or pasture and as a biofuel crop for cellulosic ethanol production.

Materials and Methods

At the Laramie Research and Extension Center, 252 lines of tall fescue from The Samuel Roberts Noble Foundation were planted in three replicated plots under both irrigated and dryland conditions in 2008. The following data are being collected each year of the study: plant vigor, plant height, leaf length and width, tiller number, plant girth, seed head, and canopy temperature. Fresh weights and dry weights of harvested plants are recorded, and water content is

Figure 1. Field measurements on irrigated tall fescue plots.

calculated on a dry weight basis. Plant samples from individual lines are ground and used to determine sugar/starch content, crude protein, neutral detergent fiber, acid detergent fiber, total digestible nutrient, and relative feed value using near-infrared reflectance spectroscopy.

Results and Discussion

This is an ongoing study, and data is being collected, compiled, and analyzed. Preliminary data indicates that there is large variation between treatments (irrigated vs. dryland) and among the 252 tall fescue lines for several desirable forage traits (data not shown). Water content of some of the highly productive lines in dryland was similar to some of the highly productive lines under irrigation, which indicates their high drought tolerance (Table 1 shows some example lines). On average, the most productive lines (some examples are in the bottom three rows in Table 1) had about 12-fold higher dry matter (DM) yield than low-yielding lines (upper three rows) in dryland and about 8-fold higher DM yield in irrigated conditions. In general, irrigated plots had much higher biomass than dryland plots.

It is anticipated that selecting highly productive and high quality lines will help in developing new cultivars that will be specifically suitable for Wyoming's conditions. These lines will help to decipher the genetic effects on complex traits such as drought tolerance, biomass production, and forage quality. These results could increase the effectiveness of future breeding programs and cultivar development. Modern breeding technology can be employed in the future for marker-assisted breeding programs to select for even more effective combinations of traits in breeding lines.

Table 1. Water content and dry matter (DM) production of some comparison lines of tall fescue

Dryland				Irrigated			
Line	Water %	Line	DM (lb/plant)	Line	Water %	Line	DM (lb/plant)
86	56.0	166	0.007	17	67.4	152	0.031
145	57.5	101	0.011	163	67.9	187	0.050
45	59.5	187	0.022	1	68.6	145	0.055
85	74.9	50	0.146	97	80.6	50	0.315
196	75.8	151	0.155	13	81.2	159	0.369
25	77.0	26	0.172	48	81.6	42	0.373

Acknowledgments

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

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Key words: forage, genetics, tall fescue

Forage Kochia on Wyoming Rangelands

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Introduction

Wyoming has a valuable history of energy production as well as livestock and wildlife management. Areas disturbed by human activities often require extensive reclamation efforts to return the lands to pre-disturbance values. Wyoming's arid climate and challenging weed species, including cheatgrass (*Bromus tectorum*) and halogeton, also called saltlover (*Halogeton glomeratus*), create barriers to the success of reclamation. Disturbed sites may remain without plant cover for a quarter century or longer despite revegetation efforts. These problematic areas are unsuitable for ungulate grazing, subject to erosion and loss of organic material, and prone to noxious weed invasions.

Forage kochia (*Bassia prostrata*), a semi-shrub evergreen species native to central Asia, has the ability to provide much needed feed for cattle, sheep, and wildlife during fall and winter when most native rangeland grasses are dry and senescent. The species has the ability to establish in harsh environments that lack vegetation. Forage kochia's life cycle allows it to compete successfully with annual weeds while not encroaching on established perennial grass communities. The species should not be confused with its distantly related cousin but similarly named weed kochia, commonly called burningbush (*Kochia scoparia*), a toxic annual found throughout the Intermountain West.

To date, two cultivars of forage kochia have been authorized for release in the United States ('Snowstorm' and 'Immigrant') and have been used for multiple purposes on private and public lands throughout the West. The species could serve as an additional tool for reclamation land managers dealing with sites that are difficult to revegetate.

Objectives

Goals are to determine the potential of forage kochia to reclaim and revegetate areas disturbed by energy production that have low reclamation potential, determine the level at which forage kochia is competitive with multiple common species, and develop an establishment and management plan to reclaim and revegetate areas of low reclamation potential.

Materials and Methods

Experiments consist of a field study at the Laramie Research and Extension Center (LREC) and three competition trials in a greenhouse at the LREC. The field study consists of 19 treatments of different mixtures of commonly used perennial grasses for reclamation placed on a disturbed site. The treatments are duplicated using municipal waste compost. A spring planting of this design took place April 6, 2012, and a fall planting will occur in early November this year. On March 14, 2012, a greenhouse pilot study began; four seeding rates of forage kochia are being compared to four rates of halogeton. This summer, plantings of the two forage kochia cultivars will be compared to cheatgrass and western wheatgrass plantings.

Results and Discussion

The field study is ongoing, and growth monitoring and data collection will start this summer. The pilot study in the greenhouse has shown differences in emergence and plant biomass production between Immigrant and Snowstorm cultivars of forage kochia (Table 1). Snowstorm produced higher seedling emergence compared to Immigrant; however, Immigrant produced slightly higher seedling dry matter (DM) per plant.

Immigrant forage kochia grown in Gillette by the University of Wyoming Extension and analyzed in our lab showed that forage quality and yields increased throughout August–October (Table 2). Forage kochia yield was 2–3 times higher than adjacent crested wheatgrass in September and October (Table 2).

Through this study, we will develop establishment and management strategies of forage kochia and learn if the two cultivars are acceptable for reclamation seed mixtures and animal feed, especially in the cooler months.

Acknowledgments

The study was funded by the Wyoming Reclamation and Restoration Center.

Contact Information

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Key words: reclamation, forage kochia, cheatgrass

Table 1. Emergence and dry matter (DM) of forage kochia cultivars planted in pots in the greenhouse.

Cultivar	Emergence	DM (g/plant)
Immigrant	8%	0.15
Snowstorm	13%	0.12

Table 2. Quality and dry matter (DM) yield of forage kochia. FK=forage kochia (Immigrant); CWG=crested wheatgrass; ADF=acid detergent fiber; NDF=neutral detergent fiber; RFV=relative feed value.

August	Protein	ADF	NDF	RFV	lbs DM/a
FK	18.5	32.4	46.4	127.8	1050
CWG	5.2	42.2	57.6	87.5	1250
September	Protein	ADF	NDF	RFV	lbs DM/a
FK	16.3	35	48.8	115.8	2010
CWG	6.2	43.3	56.4	89.5	750
October	Protein	ADF	NDF	RFV	lbs DM/a
FK	15.1	35.1	38.1	147.3	2185
CWG	5.5	52.7	60.2	63.4	1231

Utilizing Shade Avoidance Responses to Increase Sugarbeet Yield

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Introduction

The relationship between sugarbeet yield and time of weed removal is usually presented as a simple, inverse relationship: the longer the crop has been exposed to competition with weeds, the lower the yield will be. In recent field experiments conducted over different environments and years, however, sugarbeet yield was consistently lower when weeds were removed early in the season and increased when weed control was delayed until the four to six true-leaf sugarbeet growth stage. These results were unexpected but consistent among different studies and therefore warrant additional research.

Objectives

The overall objective of this research is to determine the mechanism responsible for increased sugarbeet yield in response to delaying initial weed control. There are three hypotheses that could explain this unexpected pattern of sugarbeet yield in relation to time of weed removal:
(1) herbicides used to remove weeds early in the season cause crop injury and decrease yield; (2) herbicides applied at the 4- to 6-leaf stage of sugarbeet stimulates sugarbeet growth and increases yield; and (3) before competition for resources occurs, sugarbeet senses the impending competitive environment, and a shade avoidance response is triggered that increases sugarbeet yield.

Materials and Methods

Greenhouse and field studies are underway at the Laramie Research and Extension Center (LREC) and James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle that will test these hypotheses to isolate the cause of this response. Studies in large pots are being carried out at LREC and SAREC. Sugarbeet will be planted into five-gallon buckets filled with potting soil. In each bucket, three plastic cups will be placed at the outer edge and filled with the same growth media. Sugarbeet will then be planted at the center of the bucket. Weeds will be grown in separate plastic cups and not be allowed to directly compete for resources. Weeds will be seeded the same day as sugarbeet. This experimental arrangement will prevent direct competition for light or other resources.

Data collection for the field study will include root yield and sucrose content of each sugarbeet. To characterize the shade avoidance response in detail, a wide range of additional response variables will be measured, including root length, root diameter, leaf number, leaf chlorophyll content, leaf angle, petiole length, leaf length, total leaf area, and aboveground biomass. Leaf measurements will be collected weekly and will allow us to document any herbicide or shade avoidance effects that may be caused by the treatments. Light quantity and quality will also be measured in each treatment to determine the effect of weed presence on the light available to the sugarbeet plant. It is expected that weeds alter the red to far-red ratio, which may subsequently trigger changes in sugarbeet morphology similar to responses found in other crop and weed species.

A second field trial will be conducted at SAREC. Treatments in this trial will contain a range of light quality treatments in larger field plots as well as two different sugarbeet varieties. The objective of the SAREC field trial will be to confirm any shade avoidance responses observed in the large pot study. The various light quality treatments will be established by placing different colored plastic mulch next to the sugarbeet rows. The colored mulch will reflect different wavelengths of light back to the sugarbeet plants.

Results and Discussion

The research is currently being conducted, and therefore results are not yet available. Shade avoidance responses similar to the third hypothesis have been previously documented in other plant species, but very little is known about shade avoidance in sugarbeet. This research will represent the first known quantification of shade avoidance responses in sugarbeet, a biennial crop. Results from this research are expected to have an immediate impact on boosting yield in sugarbeet. These results will: 1) provide information that is useful to a wide audience ranging from crop breeders to crop producers and 2) be the first step in a line of research that could lead to significant further discovery and technological advances in crop science.

Acknowledgments

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Key words: weeds, sugarbeet, shade avoidance, competition

Growing Algae for Fuel, Food, and Soil Amendment

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Introduction

Earth will ultimately be home to nearly 10 billion people. Most experts agree that current agricultural technologies are inadequate to allow a good quality of life for this population over the long term. But future needs for food, fuel, waste processing, and management of global climate can be met if new forms of agriculture are developed. These must support and integrate with existing agricultural activities. The goal of our project is to develop technologies for large-scale algae farms. Algae farms can operate on land unsuitable for other forms of agriculture and can be designed to consume a minimum of water. Pilot studies have shown that algae farms can produce many useful materials, including animal feed supplements and fuels needed by conventional agriculture. The present challenge is to reduce costs of production such that algae-derived feed supplements and fuels can compete with less sustainable alternatives.

Objectives

One objective of our project is to make single-celled algae stick together on command. If successful, this will save much energy in the harvesting of single-celled algae from farm-sized cultures. In the best scenario, a small amount of triggering chemical would be added to the algae pond, the cells would form clumps and settle to the bottom, water would be drained for recycling, and the green algal slime would be scooped up for refining into feed supplements or fuels. To test this technology, we are genetically modifying the single-celled green alga *Chlamydomonas* using genes from a close relative, the amazing multicellular green alga known as *Volvox*. *Volvox* is a colony of many *Chlamydomonas*-like cells held together by a transparent matrix of proteins. We have put one of the *Volvox* genes for these proteins into *Chlamydomonas* and have been gratified to see that the *Chlamydomonas* cells now tend to stick together in clumps and settle out of solution. Tests to confirm that the *Volvox* protein is made in *Chlamydomonas* and is responsible for making *Chlamydomonas* cells stick together are in progress.

A second objective is to determine how chemical algicides can be used to prevent "weed" algae and algae-eating pest microbes from infesting large-scale algal cultures. We are testing established algicides for their relative effectiveness against weed algae and algae-eating microbes like *Paramecium*. In the longer term, we hope to develop algicide-resistant cultivars of algae, comparable to Roundup Ready® crop plants. Algicide-resistant cultivars would allow for very effective pest control in algae farm ponds.

Materials and Methods

For expressing *Volvox* genes in *Chlamydomonas,* standard methods of genetic modification were used (Fig. 1). In brief, the polymerase chain reaction was used to make usable amounts of DNA encoding the *Volvox* gene for the protein known as algal CAM. The algal CAM gene was inserted in a small circle of DNA, and the circle was replicated many times by putting it into bacterial cells and allowing them to divide. The many DNA circles were then harvested from the bacteria and mixed with *Chlamydomonas* cells, some of which took up the algal-CAM gene in a functional form.

For algicide sensitivity, non-linear regression analysis is being applied to data for algal growth at various algicide concentrations. Algicide concentrations that inhibit growth by 50 percent are being determined from the regressions for each algal strain.

Results and Discussion

Volvox genes were proven to make RNA in the *Chlamydomonas* cells, but the presence of *Volvox* protein has not yet been confirmed. Determination of algicide sensitivities is still in progress.

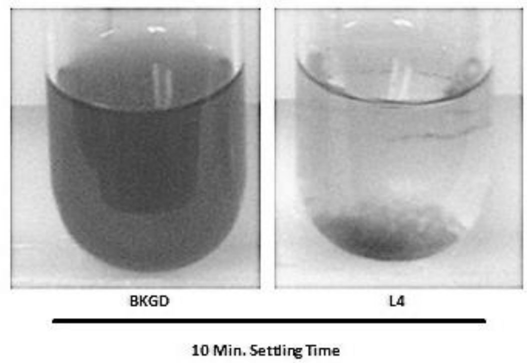

Figure 1. Normal *Chlamydomonas* cells (left) and genetically modified *Chlamydomonas* cells that express a *Volvox* cell adhesion gene (right). The genetically-modified cells have settled rapidly out of solution because they adhere into multi-cellular clumps.

Acknowledgments

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

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Key words: algae farming, genetic engineering, algicides

Wyoming Brown and Gold Fresh Cut Sunflowers

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Introduction

This project builds on a previous Specialty Crop Block Grant obtained in 2010 specifically for purchase and construction of two 12- by 16-foot high tunnels; these tunnels are being used in this project.

Interest in local production of agricultural commodities is increasing in Wyoming. Much of the discussion centers on edible crops but should include ornamentals as well.

One purpose of this project is to successfully grow fresh brown and gold cut sunflowers for local market. Another purpose is to make available to Wyoming growers the methods used. And, using University of Wyoming brown and gold colors may increase the attractiveness of the flowers for consumers.

Objectives

This project has the main goal of adding a niche specialty cut flower for Wyoming growers who use high tunnels or greenhouses. The purpose is to add a quick turnaround specialty crop that can be grown in Wyoming for sales at local venues such as retail florists, farmers' markets, etc. This will hopefully encourage expansion of specialty crop production in Wyoming.

Figure 1. 'Dafna' fresh cut sunflower.

Materials and Methods

Three cultivars of sunflowers, *Helianthus annuus*, are being grown in a greenhouse and two high tunnels at the Laramie Research and Extension Center greenhouse complex. The current project began in November 2011 and will continue through April 2013. Cultivars are 'Dafna' (Fig. 1), 'Pro Cut Bicolor' (Fig. 2), and 'Sunbright Supreme' (Fig. 3).

Seeds are sown every two weeks in the greenhouse, enough for at least 20 plants per cultivar for continuous production (one seed equals one harvestable stem). The first crop of high tunnel seedlings was transplanted into the tunnels May 17, 2012. Another crop will be planted in the tunnels in July 2012.

Table 1. Average stem lengths and days to harvest of fresh cut sunflowers grown in the greenhouse from November 2010 through November 2011.

Cultivar	Stem Length (in)	Days to Harvest
Dafna	25	73
Pro Cut Bicolor	37	87
Sunbright Supreme	29	75

Data are being collected on days to emergence from sowing, days to harvest, and stem lengths. Experimental design is a randomized complete block with four replications. All data will be analyzed using analysis of variance and mean separations. Stems are harvested when all outer (ray) petals have opened and are placed immediately in warm water.

Results and Discussion

A pilot study from November 2010 to November 2011 showed that at least 12 stems per square foot of greenhouse bench space can be produced in one year. In the pilot study, cut flower stem lengths varied by cultivar (Table 1).

Acknowledgments

Funds for this project were provided through the Wyoming Department of Agriculture and the U.S. Department of Agriculture's Specialty Crop Block Grant Program.

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Key words: flowers, greenhouse, high tunnel

Figure 2. 'Pro Cut Bicolor' fresh cut sunflower.

Figure 3. 'Sunbright Supreme' fresh cut sunflower.

Controlling Corn Leaf Angle to Optimize Growth

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Introduction

Corn yields have increased significantly over the last century due to selective breeding and improved farming practices. During this time, breeding for leaf shape has been an important part of crop improvement. Corn plants have been selected for exceptionally large leaves that optimize energy captured from sunlight, which in turn positively impacts yield through increased biomass production. Modern corn plants thus have large flattened leaf blades that project at 45 degrees from the stalk by a joint-like leaf structure called the ligular region (Fig. 1). Changing the shape of this region can alter not only the angle of blade projection but also the width of the blade (Fig. 2). If leaf blades are narrow and more upright, more plants can be grown in less space. Our research focuses on studying how the leaf angle is generated with a long-term goal of manipulating plant leaf shape for optimal growth.

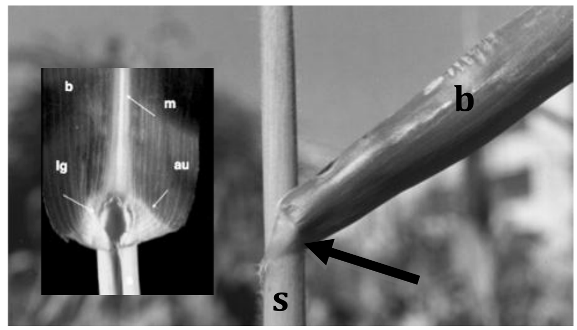

Figure 1. The maize leaf is divided into upper blade (b) and sheath (s) divided at the ligular joint (arrow). Inset: face-on view of inner leaf surface showing ligular joint.

Objectives

The purpose of the research is to identify factors that control leaf angle in corn, study their role in leaf development, and use these factors to manipulate leaf shape to optimize growth.

Materials and Methods

Single gene mutations are identified that alter the ligular region and, in turn, affect leaf shape. Breeding stock is being generated, and the proteins encoded by the selected genes are being studied to understand when and where they are expressed and required during development. Experimental lines are being produced that change the timing of expression to test if shape can be manipulated directly. Plants are grown at the Laramie Research and Extension Center (LREC) greenhouse complex and studied at a genetic, cellular, and molecular level in the Department of Molecular Biology. Seeds are stored at the LREC and tested in fields in Wyoming, California, New York, Colorado, and Hawaii.

Results and Discussion

We have identified three genes of interest including *liguleless1* (*lg1*), *liguleless2* (*lg2*), and *Liguleless3* (*Lg3*). Each gene affects blade width differently: *lg1* narrows the blade significantly; *lg2* alters the midrib region of the blade without affecting width; *Lg3* produces upright blades and increases blade width-to-length ratio (Fig. 2).

Developmental study shows the ligular region is determined early in development at a confined location that precisely separates blade from sheath. The genes have been tagged with fluorescent markers to identify when and where the protein is functioning. Other interacting genes that are required for establishing the leaf angle are being identified by genomic methods. The mutants have also been crossed to a full set of inbred lines to test for genetic background effects and to identify breeding stock with improved growth habit.

The ability to grow more corn per acre is desirable as current land use is changing and environmental pressures are increasing. Consequently, the manipulation of leaf and plant shape is increasingly important. This ongoing research will identify the mechanism of blade projection and will provide breeding lines for crop improvement.

Figure 2. Genetic control of blade angle. In wild-type corn plants, the blade projects at approximately 45 degrees (plant at far left) compared with narrow upright blades of lg1 mutants (middle plant) or broad upright leaves of Lg3 mutants (far right).

Acknowledgments

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Key words: crop improvement, corn genetics, leaf development

The Genetic Architecture of Ecophysiological and Circadian Traits in *Brassica rapa* (field mustard, turnip)

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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.

The question arises as to how plants may evaluate their environment (e.g., using proteins known as "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. (The phenomenon of jet lag illustrates some effects of the circadian clock in humans; that is, our circadian rhythms are "set" to the time of sunrise/sunset in the departure city, and the clock fails to immediately reset to times in the arrival city, meaning that we're tired or hungry at inappropriate times. As noted above, the circadian clock in plants likewise regulates many physiological processes.)

Objectives

The overarching objective of this research is to understand the genetic underpinnings of plant evolution during domestication and plant responses to stressful settings, including water stress.

Specific goals were to investigate: 1) How the expression of gas-exchange traits (e.g., photosynthesis) is affected by the history of selection during domestication, and 2) What the relationship is between the circadian clock and the expression of gas-exchange traits.

Materials and Methods

We studied gas-exchange parameters in diverse cultivars of *Brassica rapa* (common mustard), which has been domesticated as turnip, diverse leaf crops such as pak choi, the flower crop brocoletto, and the original canola oilseed crop. Plants were evaluated for a range of ecophysiological traits, such as photosynthesis, stomatal conductance, and water-use efficiency (i.e., amount of water expended per unit of carbon that the plant can take up out of the air). Our collaborators at Dartmouth College evaluated the same lines for the expression of circadian rhythms.

Results and Discussion

Preliminarily, we find that both photosynthesis and stomatal conductance are related to the history of domestication. Genotypes domesticated for seed oil production have higher gas-exchange rates than either the turnip or cabbage varieties.

Further, history of domestication appears to affect the evolution of the circadian clock; genotypes domesticated for seed oil have shorter circadian cycles than do either turnip or cabbage types.

Potentially, the comparatively high metabolic expense of seed oil production (relative to vegetable production) results in selection for plants to expend their water supply in order to take up carbon.

In prior research in experimental genetic lines (also performed at the Wyoming Agricultural Experiment Station field site in Laramie), we observed that quantitative variation in the clock was correlated with gas-exchange traits, such that shorter circadian cycles were associated with higher photosynthesis and stomatal conductance.

In sum, the results raise the interesting hypothesis that selection for increased gas exchange during the history of domestication has evolved via shifts in circadian clock function.

We are currently testing these causal associations in follow-up experiments as well as the causal basis of differences in stomatal conductance.

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

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Key words: canola, water-use efficiency, photosynthesis

2012 James C. Hageman Sustainable Agriculture Research and Extension Center Field Day

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Introduction

The James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle began with the purchase of the first property in 2002. UW employees from Torrington and Archer moved to SAREC in 2006 and began research in earnest. SAREC is unique among agricultural research centers 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 rain-fed cropland, and more than 2,000 acres of native range and improved pasture along with a feedlot capable of handling both cattle and sheep.

The employees at SAREC are dedicated to completing relevant research to benefit the agricultural community in southeast Wyoming and the U.S. There is one tenure-track faculty member along with two research scientists, a research associate, a project manager, and an operations staff of up to nine supporting the approximately 75 research projects completed each year.

SAREC PRECIPITATION 2008–2012

Month	2008 Precipitation	2009 Precipitation	2010 Precipitation	2011 Precipitation	2012 Precipitation	30-Year Average Precipitation
January	0.10	0.46	Trace	0.18	0.10	0.31
February	0.18	0.15	0.92	0.18	0.21	0.40
March	0.25	0.66	1.04	0.99	0.00	0.70
April	0.42	2.57	3.38	2.37	0.30	1.68
May	1.91	0.91	2.62	4.57	0.05 as of 5-2-12	2.54
June	2.43	3.27	4.31	1.97		2.09
July	1.40	0.86	1.01	1.08		1.78
August	2.44	3.45	0.85	1.11		1.19
September	1.04	0.65	0.00	0.13		1.27
October	0.55	1.64	0.95	1.84		0.95
November	0.34	0.12	0.55	0.43		0.57
December	0.04	0.37	0.59	0.25		0.36
Total	11.10	15.11	16.22	15.10	0.66 as of 5-2-12	13.84

Research projects range from long-term systems projects funded from U.S. Department of Agriculture National Institute of Food and Agriculture grants to small projects completed at the suggestion of SAREC focus group leaders.

Background Information

The weather at SAREC has been highly varied the past few years. Precipitation in 2008 was below normal; however, 2009, 2010, and 2011 precipitation was above normal. The spring of 2011 was significantly above normal for rain and snow, and serious flooding occurred. The winter of 2011-2012 was very mild, and both snow and rain through the winter and spring have been far below normal, with record high temperatures.

Facility Improvements and Activities

SAREC has matured as a research center, and fewer improvements have been made in recent years. A new twin screw farm truck, which has two rear axles that are both driven by the engine, was purchased in 2011, and the corn header for the combine was rebuilt. A new UTV (utility vehicle) and mower were acquired in early 2012.

Educational programs, such as the ongoing High Plains Ranch Practicum, are held at SAREC. A diverse range of groups including the Wyoming Bankers Association, Goshen County Stock Growers Association, Goshen County CattleWomen, school groups, Wyoming Youth ChalleNGe, international exchanges, local conservation districts, and others used SAREC as a meeting and educational site in the past year.

Acknowledgments

The project was funded by the Wyoming Agricultural Experiment Station. 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.

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Volunteer Roundup Ready Corn Interference and Control in Roundup Ready® Sugarbeet

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Introduction

Shortly after its commercial introduction in 2007, adoption of Roundup Ready® (RR) sugarbeet became widespread, reaching more than 95 percent of U.S. sugarbeet production by 2010. Approximately 70 percent of corn production in the United States is also RR, and it is now common for RR sugarbeet to follow RR corn in the crop rotation. Sugarbeet yield is reduced by many broadleaf weed species including tall-statured weeds such as kochia, common lambsquarters, and pigweed, as well as low-statured weeds such as Venice mallow, wild buckwheat, lanceleaf sage, and redstem filaree. Grass weeds are generally considered less competitive with sugarbeet compared with broadleaf weeds. However, volunteer corn has much broader leaves and a taller growth habit compared with annual grass weeds such as wild oat and green foxtail; therefore, it is unclear how competitive volunteer corn will be with the sugarbeet crop on the basis of data published on other weed species.

Objectives

The objectives of this research were to (1) quantify sugarbeet yield loss in response to volunteer corn density and duration of interference; and (2) determine appropriate control practices for use in RR sugarbeet.

Materials and Methods

Field studies were conducted at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle and the University of Nebraska's Panhandle Research and Extension Center near Scottsbluff, Nebraska, in 2009 and repeated in 2010. Volunteer corn was planted next to the sugarbeet row shortly after sugarbeet planting. A range of volunteer corn densities were used to determine the density at which sugarbeet yield loss occurred. Volunteer corn was removed at various times after sugarbeet emergence to determine how long volunteer corn had to compete with sugarbeet before yield losses occurred. Finally, studies were conducted to determine the best herbicides and adjuvants to use to control volunteer RR corn in the RR sugarbeet crop.

Results and Discussion

At volunteer corn densities of five plants per 100 feet of sugarbeet row, an 8 percent loss in sugarbeet yield was observed. When volunteer corn density increased to nine plants per 100 feet of row, yield loss increased to 14 percent. As a general rule, the number of volunteer corn plants per 100 feet of row can be multiplied by 1.5 to estimate the approximate yield loss that will be observed if left uncontrolled. So if there are two volunteer corn plants per 100 feet of row, yield loss would be 3 percent (2x1.5=3).

If volunteer corn is removed before harvest, yield losses will be reduced. However, when volunteer corn density is very high (20 volunteer corn plants per 100 feet of sugarbeet row), a 5-percent yield loss can be observed after only three weeks of sugarbeet growth. This density of volunteer corn would be unlikely unless there were corn harvest issues the previous year. At a more typical volunteer corn density, corn should be removed by the four to six true leaf stage of sugarbeet, or approximately four weeks after sugarbeet emergence.

Many herbicide options are available to control volunteer RR corn in RR sugarbeet. Select Max® and Assure® II both provided excellent control of volunteer RR corn when tank-mixed with Roundup®. Poast® herbicide provided less control. Most of the grass herbicides plus the necessary adjuvants will cost approximately $15/acre or less. If a grower assumes a yield goal of 22 tons per acre and a $38 per ton payment, it would only take a 1.8-percent sugarbeet yield loss to cost the grower $15/acre in revenue. The volunteer corn density required to cause 1.8-percent yield loss is only 1.2 plants per 100 feet of sugarbeet row. In this scenario, volunteer corn densities of greater than one plant per 100 feet of row warrant treatment with a grass herbicide. If yield goals are greater than 22 tons/acre or payments are expected to exceed $38/ton, then the volunteer corn density that warrants control would be even less than one plant per 100 feet of row.

In summary, volunteer corn can be extremely competitive with sugarbeet, and densities as low as one plant per 100 feet of row cause economic loss. If a grower was to implement a volunteer corn control practice approximately four weeks after sugarbeet emergence, economic sugarbeet yield loss would be avoided. In eastern Wyoming and western Nebraska, the sugarbeet crop will typically have between four to eight true leaves at four weeks after emergence.

Acknowledgments

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Key words: sugarbeet, volunteer corn control, yield loss

Rhizoctonia Seedling Decay Management in Sugarbeet with In-Furrow Fungicides

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Introduction

Seedling establishment is essential for crop development and achieving economic yields. Sugarbeets are especially vulnerable to soil-borne pathogens like *Rhizoctonia solani*, which can cause extensive seedling loss and can also cause extensive crop loss through infection of beets later in the growing season. Increased seedling disease loss is associated with cool, wet soil conditions after planting as well as the planting of susceptible cultivars. This research was initiated because we lacked information pertaining to seedling loss and the potential for protecting seedlings grown under Wyoming environmental conditions.

Objectives

Objectives were to determine the potential for: 1) Roundup Ready® sugarbeet seedling loss due to infection by *R. solani*, and 2) seedling and/or mature plant protection following the application of in-furrow fungicides. Two rates of a numbered compound were compared to a standard fungicide (Quadris®) for sugarbeet protection (Table 1).

Materials and Methods

Plots were at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle. Plots were planted on April 29, 2011, in a randomized complete block design with four replicates. Fungicide was applied in a 5-inch band to open furrows over planted seed on April 29 (see Table 1 for details). *R. solani* inoculum was then introduced into the furrow to ensure disease development. Furrows were covered and the seedbeds firmed with foot pressure.

Rhizoctonia seedling decay was measured indirectly as seedling stand counts and compared to the non-inoculated check (Table 1). Stand counts were determined May 26 and June 7 and 30 for the two middle rows in a fixed 10-ft length (average reported). Rhizoctonia root and crown rot (RRCR) incidence was rated for mature plants August 17. Infected beets were those that had rapidly wilting leaves, darkened petioles, and/or decayed crowns evident with necrotic leaves present. All data were analyzed via ANOVA (ANalysis Of VAriance). On October 4, one of the two treated rows (20 ft) was lifted, and beet root yields were determined.

Results and Discussion

Fungicide treatments significantly reduced seedling decay compared to the non-treated inoculated check on all evaluation dates (Table 1: $P \leq 0.05$). The GWN-9935 (0.75 lb ai [active ingredient]) treatment had significantly less stand loss than the Quadris standard on all evaluation dates ($P \leq 0.05$). Plants were all dead by June 30 for inoculated plots where no fungicide was applied. In contrast, Quadris disease ratings were similar to the non-inoculated check, indicating plant protection throughout the growing season. Therefore, data reveal that GWN-9935 was more effective for reducing Rhizoctonia seedling decay early in the growing season and that Quadris was more effective for disease suppression later in the growing season. All fungicide treatments resulted in yields greater than the non-treated inoculated check ($P \leq 0.05$). Because beets were planted in open furrows and covered by hand, final yields were reduced.

Data reveal that in-furrow fungicide treatments were highly effective for reducing losses due to Rhizoctonia in sugarbeet. Although low rates of fungicide were applied, disease suppression persisted season-long for some fungicide treatments.

Contact Information

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Key words: sugarbeet, Rhizoctonia, fungicide

Table 1. Effects of in-furrow fungicide application to sugarbeet on Rhizoctonia disease suppression.

Treatment and rate (ai as indicated)[Z]	Beet stand counts (10 row ft)			RRCR incidence (17 Aug)	Beet yield (tons/A)
	26 May	7 Jun	30 Jun		
Non-treated non-inoculated check	25.9 a[Y]	27.8 a	27.0 a	1.3 c	13.3 a
Non-treated inoculated check	4.0 d	0.5 d	0.0 d	0.0 c	0.0 c
Quadris 2.08SC (0.15 oz/1000 ft)	12.8 c	13.9 c	13.9 c	4.5 bc	10.7 ab
GWN-9935 (0.75 lb/A concentrated in furrow)	18.5 b	20.9 b	20.8 b	13.0 a	8.0 b
GWN-9935 (1.0 lb/A concentrated in furrow)	15.5 bc	16.9 bc	16.5 bc	8.6 ab	11.8 ab

[Z] Applications were made April 29 in a 5-inch in-furrow band in 1.13 gal/1000 row ft (45 psi boom pressure). Inoculation with *Rhizoctonia solani* AG2-2 was April 29 after fungicide application. Disease was measured as seedling decay (stand loss) and Rhizoctonia root and crown rot (RRCR).

[Y] Treatment means followed by different letters differ significantly (Fisher's protected LSD, $P \leq 0.05$).

Micronutrient Fertilization of Edible Dry Beans and Sugarbeet in Calcareous Soils of Wyoming

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Introduction

Dry edible beans (*Phaseolus vulgaris* L.) are grown throughout the western United States. In 2010, an average of 49,000 acres of dry beans was grown in Wyoming and had a market value of $30.4 million. The crop value of 30,500 acres of sugarbeet in 2010 was $44.3 million, making it the second most valuable crop after hay (Wyoming Agricultural Statistics Service, 2011). Sound soil fertility and nutrient management is a valuable component to profitable dry bean and sugarbeet crops. Production of dry beans in alkaline or calcareous soils is frequently affected by iron (Fe) and zinc (Zn) chlorosis. Soil conditions such as high pH, high free calcium carbonate (lime), and low organic matter favor development of Zn and Fe deficiencies, which can reduce yields and delay crop maturity. Management practices to alleviate micronutrient deficiencies will help prevent yield losses and improve income for producers. Chelated forms of micronutrient fertilizers are considered one of the best management options because they are soluble and readily available to plants than inorganic forms. Soygreen® (West Central, Inc., Willmar, Minnesota), a dry, water-soluble powder containing 6-percent ortho-ortho Fe-EDDHA is reported to prevent iron deficiency in soybeans grown in soils where Fe uptake may be limited (Ferguson and Slater, 2010). Soygreen® and Redline®, a liquid fertilizer formulation (6% N, 12% P, 3% K, 1% Zn, and 0.03% Fe), also from West Central, Inc., are also reported by the manufacturer to improve sugarbeet yields.

Objectives

The overall objective of this study is to evaluate the potential usage of the chelated micronutrient fertilizers Soygreen® and Redline® for managing Fe chlorosis in dry beans grown under irrigated conditions in southeastern Wyoming. The study will also determine the effectiveness of Soygreen® and Redline® on sugarbeet productivity and yield.

Materials and Methods

Two separate experiments were initiated in 2012 at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC).

Sugarbeet study: Treatments in this study consist of a control, three application rates of Soygreen® (1, 2, and 3 lbs/ac) and two application rates of Redline® (2 and 3 gal/ac). All treatments were applied in-furrow on May 3, 2012, after sugarbeet planting. Treatments were arranged in a randomized complete block with four replications.

Dry bean study: This study consists of a control, three Soygreen® application rates (1, 2, and 3 lbs/ac), and Redline® applied at 3 gal/ac. The micronutrient products will be applied in-furrow at planting or post-emergence application (Table 1). There will be four replicates of each treatment in a randomized complete block design. All experimental plots will be fertilized with nitrogen and phosphorus; rates will be based on soil test recommendations.

Table 1. Treatments in dry bean trial.

Treatment	Product	Rate/ac	App. Method
1	Soygreen®	1 lb	In-furrow
2	Soygreen®	1 lb	Postemergence
3	Soygreen®	2 lbs	In-furrow
4	Soygreen®	2 lbs	Postemergence
5	Soygreen®	3 lbs	In-furrow
6	Soygreen®	3 lbs	Postemergence
7	Redline®	3 gal	In-furrow
8	Redline®	3 gal	Postemergence
9	Control	-	

Results and Discussion

Data collection will include scoring for Fe chlorosis in dry beans, plant vigor ratings, and yields of dry beans and sugarbeet. The effects of micronutrients on sugar content in sugarbeet will also be determined. Soil samples will be collected and analyzed for available iron content. Results from the study will provide information on alternative micronutrient fertilizer management in dry beans and sugarbeet.

Acknowledgments

The project was funded by the Department of Plant Sciences and West Central, Inc. We acknowledge SAREC staff for their assistance.

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Key words: micronutrients, sugarbeet, dry beans

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Composted Cattle Manure and Inorganic Nitrogen Fertilization Effects on Bell Pepper Yield

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Introduction

The increase in demand and consumption of locally grown food has necessitated a corresponding increase in locally produced vegetables for local markets. High tunnel vegetable production is an option many producers are considering to increase the value of their production. High tunnels extend the growing season, which is critical in Wyoming where shorter growing seasons and cooler temperatures limit the production of many warm-season vegetables. Due to higher productivity, nutrient requirements of high tunnel-produced crops are greater than those produced in the field. Thus, development of nutrient management strategies that supply adequate nutrients to meet crop demands while maintaining biological, physical, and chemical properties of soil is critical for long-term sustainability of a high tunnel production system. While applying inorganic fertilizers will increase soil nutrient supply, it does not improve physical and biological properties of the soil. Nutrient management strategies that combine organic and inorganic sources of plant nutrients will increase crop productivity, prevent soil fertility depletion, and maintain soil quality.

Objectives

Our objectives were to investigate the effectiveness of composted cattle manure and inorganic nitrogen fertilization on growth and yield of bell peppers grown under high tunnels.

Materials and Methods

In summer 2011, we investigated using organic and inorganic nutrient sources to improve soil fertility and bell pepper productivity under a high tunnel at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. We compared cattle manure compost (CM), NPK fertilizers, and their combination effects on bell pepper yields. Treatments consisted of a control, CM alone, NPK fertilizer, and substituting 75, 50, and 25 percent of the N requirement of bell pepper with CM. The NPK fertilizer application rates were 200, 100, and 150 lbs/ac of N, P, and K, respectively. Nutrient requirements of treatments receiving only CM applications were supplied by compost alone. However, treatments with supplemental N fertilizer, P, and K requirements were supplied from the compost. Bell pepper seedlings were transplanted into raised beds (8 x 4 feet) in the high tunnel on May 16. Raised beds were used because the soil under the high tunnel is too shallow and gravely. Plots consisted of seedlings planted in two rows 24 inches apart and 24 inches within rows (i.e., plants were 24 inches apart). There were a total of four pepper plants in each plot of 4 ft by 4 ft (plot area is 16 square ft.). Mature pepper fruits were harvested late July through the second week of October.

Results and Discussion

Results in 2010 show that bell pepper yields were highest for 100-percent NPK and 50-percent compost plus 50-percent inorganic nitrogen treatments during the first harvest. As the season progressed, yields of the compost-treated plots were similar to 100-percent NPK plots (Table 1). Total seasonal pepper fresh weights ranged from 86,460lbs/ac (32 lbs/plot) for 100-percent compost treatments to 53,550 lbs/ac (20 lbs/plot) for the control plots. The performance of all the compost-treated plots, except the 25-percent compost plus 75-percent inorganic nitrogen plots, were similar to plots that received 100-percent NPK fertilization. Our preliminary data indicates that if high tunnel producers want early-season pepper harvest, addition of inorganic nitrogen fertilizer may be necessary to provide some form of readily available nutrients for optimum growth and crop performance. This study is ongoing, and the experiment will be repeated in the 2012 growing season.

Acknowledgments

The project was funded by Department of Plant Sciences allocation and SAREC. We acknowledge contributions of SAREC director of operations, Jim Freeburn, and SAREC staff for their hard work in building the high tunnel at SAREC.

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Key words: high tunnels, compost, bell pepper

Table 1. Bell pepper yield as affected by composted cattle manure and inorganic nitrogen fertilization in summer 2011.

	Bell pepper fresh weight (lbs/ac)				
Treatment	7/29/11	8/12/11	9/9/11	10/11/11	Total
Control	6,630	23,050	18,110	5,760	53,550
100% CM	6,850	36,070	16,110	27,430	86,460
75% CM +25% AN	6,670	28,500	13,570	26,950	75,690
50% CM +50% AN	10,070	31,310	13,020	12,930	67,330
25% CM + 75% AN	4,990	34,890	10,570	5,310	55,760
100% NPK	10,020	41,970	10,030	19,780	81,800
Average	7,538	32,632	13,568	16,360	70,098
SEM	1,930	5,850	3,000	7,670	10,400

CM = cattle manure compost; AN = ammonium nitrate; NPK = nitrogen, phosphorus, and potassium; SEM = standard error for mean comparison

Assessment of Fenugreek for Adaptation to Southeast Wyoming

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Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is a valuable specialty crop in the family of *Fabaceae* (legume), which is used both as an herb and 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 helping to decrease diabetes incidence. Fenugreek has also been reported to be a good breast milk stimulator. In addition, fenugreek has potential as an 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 objectives of the project are 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 and 2011 at two locations: 1) the James C. Hageman Research and Extension Center (SAREC)—irrigated and dryland, and 2) the Laramie Research and Extension Center (LREC)—irrigated only. The seeding rate was 25 pounds pure live seed (PLS)/acre. For forage yield, plots were mechanically harvested in August and September 2010 and 2011. The seeds were harvested using a combine in October 2010 and 2011.

Results and Discussion

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 conditions 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—for example, the range of crude protein was 14–20 percent (complete data not shown). Results in 2011 showed similar trends; however, yields were much higher than 2010 (data not shown). 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. The price of fenugreek seed in a local Wyoming health food store was about $1/oz, which far and away exceeds the price for commodity crop seed. Numerous health conscious consumers of fenugreek greens and seed could benefit from local production delivered into southeast Wyoming and beyond. Perhaps a larger market, however, is forage stock feed as fenugreek cut for hay may substitute alfalfa for those looking for a one-year rotational forage crop.

Acknowledgments

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Key words: fenugreek, specialty crop, adaptation

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

	SAREC		LREC	SAREC		LREC
	Irrigated	Dryland	Irrigated	Irrigated	Dryland	Irrigated
Genotypes/accessions	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

Grass–Legume Mixtures to Minimize Nitrogen Need and Improve Soil Properties

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

[1]Plant Sciences Department.

Introduction

Nitrogen (N) is generally the most limiting nutrient in forage production systems. It typically accounts for 10–30 percent of total forage production costs—figures that will most likely continue to rise. It is common to use synthetic N chemical fertilizer to increase crop yield although it has several adverse effects. The process to manufacture these fertilizers is costly and energy intensive, and it depletes fossil fuels. Moreover, it has environmental effects such as greenhouse gas emissions and ground water pollution, and it can cause blue baby disease in humans and nitrate toxicity in cattle. Furthermore, it deteriorates soil structure, increases soil acidity, and decreases soil microbial activity. Due to problems associated with synthetic chemical fertilizers, it is essential to look at sustainable and environmentally safe alternatives to N supply for forage production.

Utilizing legumes in grass forage systems may be beneficial because legumes can fix atmospheric N, increase productivity, improve forage quality, extend growing periods, improve soil properties, and help improve the environment. Many studies on grass-legume mixtures indicate that there is a problem of persistency for legumes because they tend to disappear from grasslands after a few years of continuous cultivation. Limited research is available on the best ratio of grass and legumes in terms of production and legume persistence. This research aims to increase yield and quality of forage, reduce production costs, and improve the long-term profitability and sustainability of forage production systems by identifying appropriate grass-legume mixtures.

Objectives

Specific objectives are to: 1) compare the performance of different combinations of grass–legume mixes, 2) study the effect of grass–legume mixtures on soil carbon (C) and N status, and 3) estimate and compare the economics and fertilizer N replacement value of legumes when mixed with grass.

Materials and Methods

The research is at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC). Sixteen treatment combinations with two grasses (‘Fleet’ cultivar of meadow brome and ‘Paiute’ cultivar of orchardgrass) and one legume (‘WL 319 HQ’ cultivar of alfalfa) were planted September 20, 2011. The grass–legume seeding ratios (percentages) were 100:0, 75:25, 50:50, 25:75, and 0:100

for both grasses with legume. Both grasses were also planted as 100-percent grass monocultures with and without N fertilizer application. A mixture of three crops as a percentage was also used: 12.5:12.5:75, 25:25:50, and 37.5:37.5:25 for meadow brome, orchardgrass, and alfalfa. Sixteen treatments were replicated three times in a randomized complete block design.

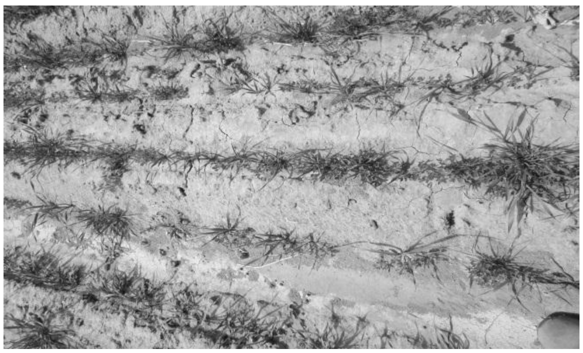

Figure 1. Mixed stand of meadow brome and alfalfa.

Results and Discussion

Preliminary data collected in 2012 include emergence, plant height, leaf number, and crop vigor (Fig. 1; Table 1). Alfalfa and meadow brome had about 80-percent emergence while orchardgrass had about 40 percent. Recent observations indicate that alfalfa and meadow brome are more vigorous than orchardgrass. Soil samples were collected and analyzed for basic properties, C, and N status. Data show that soils are homogenous with pH 8.0, that there are no apparent problems with salinity and sodicity, and that soils have a medium level of N, phosphorus, calcium, and magnesium but a high level of potassium. Crop harvesting started in early June 2012. Phenotypic data and forage quality will be recorded for the next three years. Soils will be sampled from all plots, analyzed, and compared every year during the study period. The study will compare the effects of different combinations of grass–legume mixtures on yield and quality of forage, soil C, and N status, and it will estimate the economics and fertilizer N replacement value of legumes in grass. It is anticipated that the study will provide useful information for producers, scientists, and others.

Acknowledgments

We thank SAREC crews and lab members for their assistance.

Contact Information

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Key words: grass–legume mixture, forage quality, soil N

Table 1. Preliminary forage crop observations recorded at 80 days after sowing.

Crop	Leaf (#/plant)	Plant height (inches)	Plant vigor (scale 1–9*)
Alfalfa	3.0	0.25	3.0
Meadow brome	3.2	2.00	7.0
Orchardgrass	2.9	1.00	3.0

*1=very poor growth, 9=highest growth

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

M.A. Islam[1], *A.R. Kniss*[1]

[1]Plant Sciences Department.

Introduction

Many hay meadows, pastures, and rangelands in the western U.S., including Wyoming, have been invaded by perennial weeds such as field bindweed (*Convolvulus arvensis*), Canada thistle (*Cirsium 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 provides excellent control of 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 feel 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 objectives of this field study are to test the tolerance of tall fescue to aminocyclopyrachlor at various rates and timings. We feel 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 are being used. The study utilized three rates of aminocyclopyrachlor (0, 0.5, and 1.0 ounce 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 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 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 about aminocyclopyrachlor for use in tall fescue.

Acknowledgments

We thank SAREC farm crew members and Wendy Cecil for assistance in data collection and harvesting.

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Key words: tall fescue, weed control, herbicides

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

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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 as 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 yields 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 check (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 November 26, 2008 (both plots), second harvest was May 11, 2009 (forage-only use plots), and third harvest was June 16, 2009 (forage-only use plots). Seed harvest was July 31, 2009 (forage- and grain-use plots).

Results and Discussion

The first harvest indicated a significant difference between lines for forage yield (Fig. 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

Figure 1. Forage harvesting using a harvester.

harvest 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, 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) (Fig. 2). The controls had better seed yield than experimental lines; however, among the lines, NF95134A (wheat), Maton II (rye), and NF96210 (triticale) had the greatest seed yield potential. Higher forage producer lines produced greater seed yield.

The study was repeated during the 2009–10 and 2010–11 growing seasons (data not shown). It is expected that the study will show significant differences between species or lines and provide useful information to producers, scientists, academicians, seed company personnel, and others.

Acknowledgments

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Key words: small grains, forage yield, grain yield

Table 1. Forage yield of different small grains during the 2008–09 growing season.

		Dry matter yield (pounds/acre)			
Species	Line/Variety	First cut 11/26/08	Second cut 5/11/09	Third cut 6/16/09	Total
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

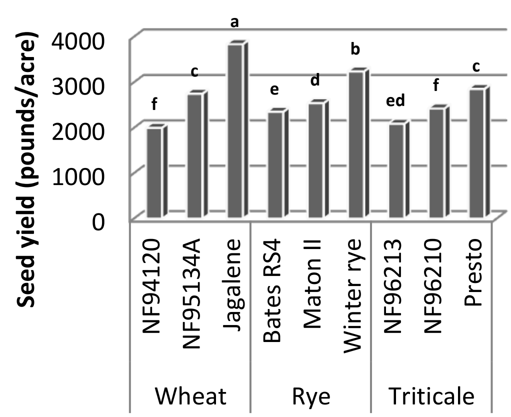

Figure 2. Seed yield of different small grains during the 2008–09 growing season.

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

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Introduction

The cost of nitrogen (N) fertilizer has increased substantially the last few years. This situation is causing a re-evaluation of synthetic N fertilizer 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 N fertilizer costs on agricultural lands and may be a more sustainable option for pasture-based production, not only economically but also in terms of impacts 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 a 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 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 tall fescue grass ('MaxQ') and one legume ('AmeriStand 403T' alfalfa) species planted at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Ten treatments were replicated three times for 30 total plots. Five grass-legume mixtures with no supplemental N were used. The 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 September 10, 2009, and the seeding rate for both tall fescue and alfalfa was 22 pounds PLS (pure live seed)/acre. The first split of N was applied in April 2010 and 2011. 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 and 2011, three harvests were made each year: first in June, second in July, and third in October.

Results and Discussion

The first year's forage yield data showed significant variations among treatments (Table 1). For example, the highest yield (9,168 pounds/acre) was obtained from 0.50:0.50 tall fescue-alfalfa mix treatment followed by 0.25:0.75 tall fescue-alfalfa mix (7,275 pounds/acre) and tall fescue 180 pounds N (7,242 pounds/acre). Interestingly, very little difference was observed between 0.25:0.75 tall fescue-alfalfa mix and tall fescue 180 pounds N. The 0.50:0.50 mix produced more than a 100-percent increase in yield compared to only the tall fescue plot (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 legume mixes and higher N treatments.

This is an ongoing study, and data is still being collected and analyzed. However, data collected in 2011 showed similar trends (data not shown). It is expected that selection of an 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 (Ecophysiological Aspects of Forage Management) states: Maryland, Minnesota, Pennsylvania, Utah, Virginia, Wisconsin, and Wyoming.

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Key words: legume, grass, nitrogen fertilization

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	4617
3	TF-Alf (0.75:0.25)	1302	2587	1726	5615
4	TF-Alf (0.50:0.50)	1342	4529	3297	9168
5	TF-Alf (0.25:0.75)	1197	3826	2252	7275
6	TF 45 lb N	1433	3149	1546	6128
7	TF 90 lb N	1162	2700	1677	5539
8	TF 135 lb N	1092	2860	1911	5863
9	TF 180 lb N	1096	3020	3126	7242
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.

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

M.A. Islam[1], M.C. Saha[2], W.K. Cecil[1], R.E. Baumgartner[3]

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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 generally 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 are to (1) evaluate different advanced lines of C3 (or cool-season) grasses with the inclusion of some local cultivars in relation to their growth, yield, and quality response to irrigation, drought, and planting time, and (2) 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 Canada wildrye (two lines). Fall planting occurred 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, 2010, and 2011 for both plantings are significantly different among species and lines. For example, forage dry matter yield varied significantly among lines and even lines within the same species (Tables 1 and 2). Data will be collected intensively each spring and fall for at least two more years. Data collected in 2011 is being compiled and processed. 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

We thank The Noble Foundation for partial funding.

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Key words: cool-season grass, irrigation, drought

Table 1. Forage yield of different cool-season grasses during the 2009–10 growing season under irrigation at the James C. Hageman Sustainable Agriculture Research and Extension Center (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	3428
	PDF584	3672	1387	5059
	Barolex	2343	1264	3607
	Enforcer	2653	1394	4047
	Fawn	2975	1543	4518
	JesupMax	2931	1230	4161
	TFSoft	2899	1473	4372
Tall wheatgrass	NFTW6001	2967	1439	4406
	NFTW6020	2336	1725	4061
	Jose	2995	1955	4950
Western wheatgrass	NFWW8070	2805	1958	4763
	TCSERD-Select	3375	2689	6064
	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 during the 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	3042
	PDF584	2983	319	3302
	Barolex	2344	470	2814
	Enforcer	1921	486	2407
	Fawn	2553	726	3279
	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	2792
	Rosana	1805	442	2247
LSD (0.05)		784	279	845

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

J.C. Unverzagt[1], A.R. Kniss[1]

[1]Plant Sciences Department.

Introduction

Increasing corn prices and availability of adapted hybrids have consistently increased corn acreage in Big Horn, Park, and Washakie counties. Corn also remains one of the most profitable crops in the rotation for growers in Goshen, Laramie, and Platte counties. Corn herbicide recommendations that are appropriate for the main U.S. corn growing regions are often not applicable to growers in Wyoming, as they are tailored to Midwest states where corn acreage is much greater.

Many corn herbicides used in the Midwest 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 more than 45 herbicides registered for use in corn that 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 allows rotation to either sugarbeet or dry bean the following year.

Objectives

The objective of this research is to provide locally relevant herbicide recommendations for corn growers in Wyoming and the High Plains that will allow for rotation to either sugarbeet or dry bean the following crop season, while utilizing multiple herbicide modes of action to minimize the threat of herbicide-resistant weeds.

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, and PRE/POST combination treatments. All herbicides used in these trials allow sugarbeet or dry bean to be planted in the following year.

Results and Discussion

All PRE followed by POST combination treatments provided good weed control efficacy. Roundup® and Status® provided better broadleaf control when compared to Ignite®, regardless of PRE herbicide. Roundup controlled all species present, while Status worked well only on broadleaf species and had little activity on green foxtail. These results indicate that PRE/POST combinations can be effective weed control options, even if the PRE or POST options are not commercially acceptable on their own. This trial is being repeated in 2012.

Acknowledgments

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Key words: corn, weed control, herbicides

Table 1. Weed control and corn yield from PRE and POST herbicide combinations at SAREC, 2011.

	Weed Control (%)				Yield
Treatment	Common Lambsquarters	Redroot Pigweed	Hairy Nightshade	Green Foxtail	(bu/A)
Verdict PRE / Status POST	99	98	100	100	165
Verdict PRE / Ignite POST	93	94	99	99	142
Verdict PRE / Roundup POST	96	95	96	98	145
Verdict PRE / NO POST	75	89	91	98	138
Harness PRE / Status POST	99	100	100	99	151
Harness PRE / Ignite POST	89	93	91	93	138
Harness PRE / Roundup POST	97	98	98	98	144
Harness PRE / NO POST	91	91	91	98	150
Dual II Magnum PRE / Status POST	100	100	100	100	139
Dual II Magnum PRE / Ignite POST	90	98	99	100	135
Dual II Magnum PRE / Roundup POST	98	100	100	100	139
Dual II Magnum PRE / NO POST	80	97	95	100	125
NO PRE / Status POST	93	76	96	43	142
NO PRE / Ignite POST	46	53	55	79	101
NO PRE / Roundup POST	95	87	92	89	152
Untreated Check	0	0	0	0	56

Turf Grass Variety Trials

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Introduction

Homeowners, agricultural producers, and others in Wyoming face challenges to successfully establish turf grasses because of arid to semiarid climatic conditions, and oftentimes very cold winters. There are a few varieties available, but limited scientific information exists as to whether the varieties are suitable for Wyoming's climate.

Objectives

Objectives are to provide information for various turf grass varieties suitable for Wyoming's climatic conditions.

Materials and Methods

Two identical trials were successfully established at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle 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. As the plots were very dry initially in establishment year, irrigation was added for germination only, but no water was added thereafter.

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 of data, overall ranking was: tall fescue greater than or equal to (≥) 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 collected in 2011 are in the process of being analyzed. Results obtained warrants future detailed study.

Acknowledgments

The Wyoming Department of Agriculture, through the U.S. Department of Agriculture's Specialty Crop Block Grant Program, provided funding. We thank Emi Kimura for assistance in data collection.

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Key words: turf grass variety, establishment, management

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.

Herbicide Options for Glyphosate-Resistant Kochia Control

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Introduction

Kochia is one of the most economically important weeds in both dryland and irrigated production in Wyoming and the High Plains. Kochia is an annual tumbleweed that has evolved resistance to many types of herbicides. Most recently, kochia populations have been found in Kansas, Colorado, Nebraska, and Canada that are resistant to glyphosate, the active ingredient in Roundup® herbicide. Management of glyphosate-resistant kochia will require integration of cultural and chemical weed control practices. In 2010, a regional project was established at sites in Wyoming, Colorado, South Dakota, Nebraska, and Kansas that investigates many aspects of kochia biology, ecology, and control.

Objectives

The overall objective of this series of studies was to develop a set of recommendations for managing glyphosate-resistant kochia proactively (before resistance develops) and reactively (after resistance develops). A specific objective was to determine the best herbicide options for control of kochia in five different cropping systems common in the High Plains.

Materials and Methods

Field studies were established near Lingle, Wyoming; Scottsbluff, Nebraska; Fort Collins, Colorado; Hays, Kansas; and Brookings, South Dakota. At each field site, 17 herbicide treatments were applied to fallow ground with a heavy infestation of kochia. Herbicide treatments included three treatment programs that were thought to provide the best kochia control among potential treatments labeled for each of five different crops (corn, soybean, sugarbeet, wheat, and fallow). The studies also included a non-treated control, and Roundup PowerMax® at 22 fluid oz/A. Corn, soybean, and sugarbeet treatments all consisted of preemergence (PRE) followed by postemergence (POST) herbicide combinations. Fallow and wheat treatments only included POST herbicides. Kochia biomass was clipped from a one square meter area in each plot 30 days following the final herbicide application. Kochia control was also estimated from each plot visually.

Results and Discussion

In general, kochia control was greatest when corn and soybean herbicides were used (Fig. 1). This is at least partially due to corn and soybean treatments including both PRE and POST herbicides. Sugarbeet herbicide treatments also included PRE and POST herbicides, but sugarbeet herbicides are far less effective on kochia than herbicides available in other crops.

If glyphosate-resistant kochia is present, corn would be the preferred crop, as there are many available herbicides that provide excellent control of kochia. If glyphosate-resistant kochia is present in sugarbeet, control will be very difficult with non-glyphosate herbicides. This result is not surprising, as kochia was one of the most difficult to control weeds in conventional sugarbeet before the introduction of Roundup Ready® sugarbeet.

In wheat, Starane® NXT (14 fluid oz/A) or Huskie® (at least 13.5 fluid oz/A) provided very good control of kochia. In the fallow system, Clarity® provided the best and most consistent control of kochia averaged across sites and years. Due to the early and extended germination pattern of kochia in the High Plains, control of kochia should begin early in the spring and will require multiple applications of tillage and/or herbicides.

Acknowledgments

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Key words: herbicide resistance, kochia, crop rotation

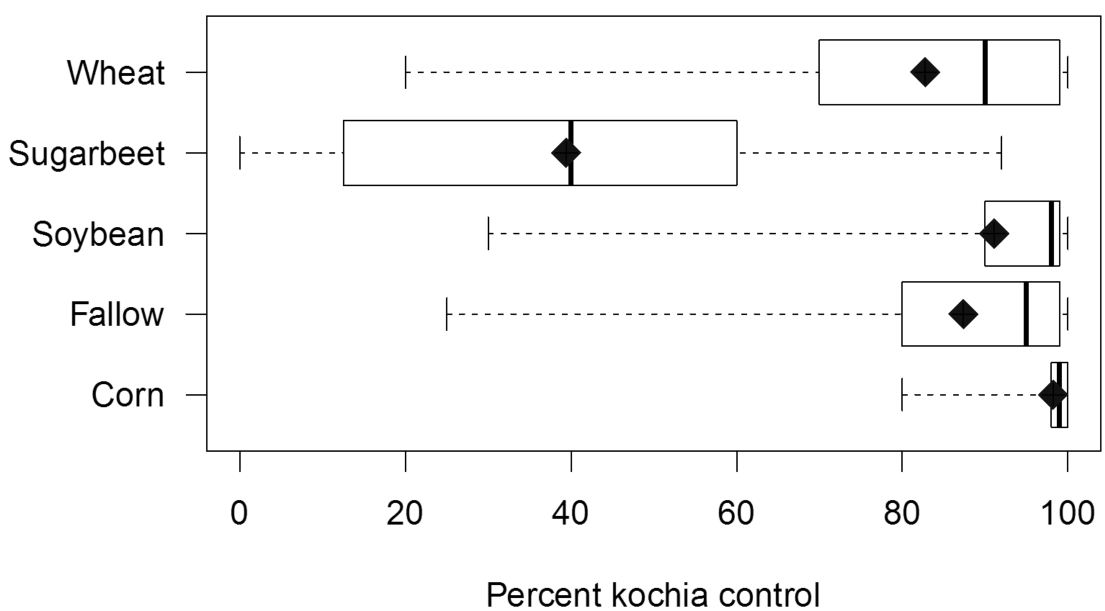

Figure 1. Kochia control from herbicide treatments registered in five different crop systems. Points represent mean kochia control across five states and two years; boxes represent 25th to 75th percentiles; dotted lines extend to minimum and maximum observations.

Effects of Preemergence Application of Matrix®, Plateau®, and Aminocyclopyrachlor on Downy Brome

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[1]Plant Sciences Department.

Introduction

Downy brome (*Bromus tectorum* L.), more commonly known as cheatgrass, is a winter annual grass that has become one of the most widespread, problematic weeds on Western rangelands. Since its introduction to the West, it has invaded numerous ecosystems from deserts of the Southwest to the Rocky Mountains. Cheatgrass has degraded more than 50 million acres in the western United States and is continuing to spread at an average rate of 14 percent annually. Its ability to compete with desired species for early spring moisture and nutrients, prolific seed production, and effect on wildfire cycle make cheatgrass a challenging and troublesome weed to control in Western rangelands.

Objectives

The objectives of this study were to investigate biomass production, vegetative cover, and seed production of downy brome in response to fall-applied aminocyclopyrachlor, Plateau®, and Matrix®.

Materials and Methods

A field study was initiated in fall 2010 at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle. The site was uniformly invaded by downy brome and also had perennial grasses and other desirable vegetation present. Each herbicide was applied at five rates up to the maximum labeled-use rate, plus a non-treated control. Visual inspection for injury on downy brome and native grasses was performed in July 2011, and biomass of plants was collected. Within each plot, two digital photographs were taken at a height of one meter to estimate vegetative cover of downy brome, native grasses, and forbs, as well as the percentage of bare ground. Seed from 25 downy brome panicles was collected from each plot, counted, and tested for germinability.

Results and Discussion

At the respective maximum labeled-use rate for each herbicide, aminocyclopyrachlor increased downy brome biomass and decreased biomass of perennial grass; Plateau decreased biomass of downy brome and perennial grass; and Matrix nearly eliminated biomass of downy brome and increased biomass of perennial grass (Table 1).

Downy brome seeds were visually damaged by aminocyclopyrachlor (Figs. 1 and 2);

however, germination studies indicated that visibly damaged seed germinated at similar rates as non-damaged seed, and, therefore, this treatment is unlikely to reduce the downy brome seed bank.

Acknowledgments

This project was supported by a Wyoming Agricultural Experiment Station competitive grant, DuPont, and the Department of Plant Sciences.

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Key words: cheatgrass, downy brome, restoration, rangeland

Table 1. Response of downy brome and perennial grass biomass to aminocyclopyrachlor, Matrix, and Plateau applied preemergence to rangeland at the maximum-labeled rate.

Herbicide treatment	Change in downy brome biomass	Change in perennial grass biomass
Aminocyclopyrachlor at 4.5 oz/acre	+46%	-18%
Matrix at 4 oz/acre	-97%	+119%
Plateau at 12 oz/A	-50%	-55%

Figure 1. Normal downy brome seed from non-treated control treatment.

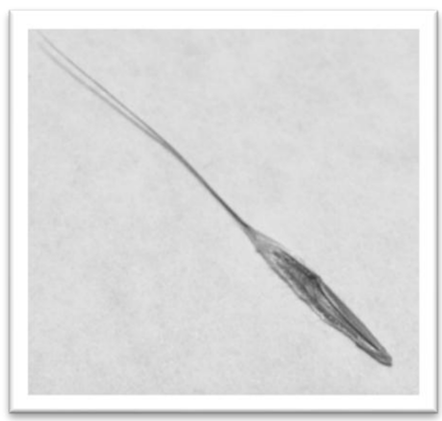

Figure 2. Damaged downy brome seed from aminocyclopyrachlor treatment.

Symbiotic and Non-Symbiotic Biological N_2 Fixation in Dryland and Irrigated Alfalfa/Grass Hay Production

B. Peterson[1], U. Norton[1,2], J.M. Krall[1]

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Introduction

Understanding principles of nutrient inputs and losses is a key component of long-term agroecosystem sustainability. Alfalfa (*Medicago sativa)* mixed with perennial grass is one of the most important cash crops in the High Plains. It is a legume that lives in symbiosis with bacteria capable of fixing considerable amounts of atmospheric dinitrogen (N_2) (up to 300 lbs acre^{-1}).

Additional sources of nutrients in this system are also likely contributed by biological crusts that look like green mats on the surface of the soil and reoccur every fall and winter. Microorganisms that create these biological crusts, such as blue-green algae and *cyanobacteria,* have been well researched in natural ecosystems. These organisms are known to fix atmospheric N_2 through a process that does not involve the presence of legume plants; hence, they are termed "non-symbiotic N_2 fixers".

The seasonal presence of biological crusts in dryland agroecosystems and their contributions to the overall nutrient budgets in dryland farming are not well known. However, it is known that high amounts of N in the soil during fall and winter can be converted by microbial communities to nitrous oxide (N_2O), a potent greenhouse gas (GHG) that remains in the atmosphere for a long time. Here, we report N_2O emissions from May 2011 to April 2012 and describe the ongoing study of N budgeting in dryland and irrigated alfalfa hay production.

Objectives

Our objectives are to compare dryland to irrigated alfalfa grass hay agroecosystems through: (1) seasonal inventories of N_2O emissions; (2) soil, plant, and biological crusts' N contents; and (3) the assessment of N_2 fixation from symbiotic (legume plants) and non-symbiotic (biological crusts) organisms.

Materials and Methods

Research is being conducted at the James C. Hageman Sustainable Research and Extension Center (SAREC). Main treatments include: (1) dryland alfalfa hay dominated by biological crusts in fall and winter, and (2) irrigated alfalfa hay. Plots replicated five times are randomly established in each treatment. To account for spatial heterogeneity, a series of subplots representing different life forms (soil beneath alfalfa plant, perennial grass, and plant interspace) are nested in each plot.

Air samples for N_2O determination are collected biweekly during the growing season and once a month during the non-growing season. Seasonal assessment of soil N is done by analyzing different soil components for organic and inorganic N. Assessment of plant and biological crust N is done by characterizing aboveground and belowground plant biomass, surface residue, and soil cover. Biological N_2 fixation potential is assessed using a series of methods estimating the rate of N_2 disappearance from the air in an enclosed setting. Samples are analyzed in laboratories at the Department of Plant Sciences and at Bangor University, United Kingdom.

Results and Discussion

Preliminary results from air sampling suggest significant differences in the magnitude of N_2O emissions between irrigated and dryland alfalfa hay production. On average, dryland production emits 2.5 times as much N_2O compared to irrigated production. The majority of the emissions in the dryland system are generated by soils beneath grass in fall and winter and beneath alfalfa in summer and early spring. In the irrigated system, soil beneath plant interspaces has consistently higher N_2O emissions compared to the other life forms. However, the same soils under the dryland system produced, on average, 1.6 times more N_2O compared to soils beneath interspaces in the irrigated system. Significant N_2O emissions from soils beneath plant interspaces in both systems can be associated with increased abundance of biological crusts. In conclusion, a dryland hay production system appears to be a large source of N_2O emissions to the atmosphere. Moreover, to assess N_2O emissions from irrigated or dryland hay production systems, spatial variability of the vegetation needs to be considered.

Acknowledgments

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Key words: nitrogen fixation, dryland alfalfa, irrigated alfalfa

Influence of Nitrogen and Phosphorus Fertilization on Dryland *Camelina Sativa* Seed Yield and Oil Content

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Introduction

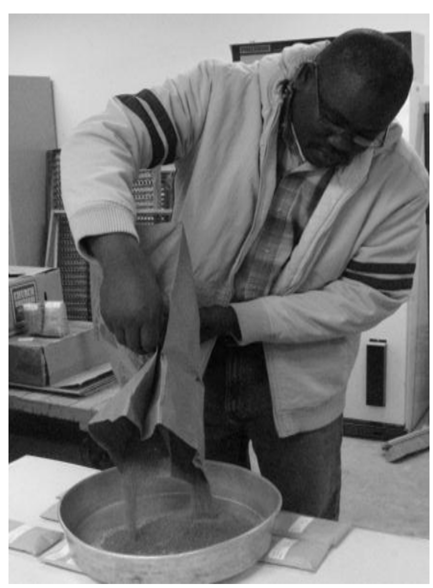
The desire for domestic energy security and a cleaner environment has stimulated public interest in biodiesel as an alternative fuel source. *Camelina sativa* has been reported to be a drought-tolerant oilseed crop adapted to the semiarid environments of the High Plains with oil qualities that make it attractive as a biodiesel crop. Previous studies at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) have shown *C. sativa* to be an alternative dryland crop for partial replacement of summer fallow in wheat production systems in Wyoming. Wheat-camelina rotation has potential to enhance the economic and ecological sustainability of farms through the production of biodiesel and bio-based jet fuels throughout the region. Information on fertilizer management in dryland camelina is limited.

Objectives

Our objectives were to evaluate the effects of nitrogen and phosphorus on *C. sativa* yields and oil content.

Materials and Methods

In spring 2011, a 12-treatment nitrogen/phosphorus (N/P) fertilizer trial was initiated on a portion of each block of an ongoing winter wheat-camelina (camelina replacing fallow) rotation on dryland strips at SAREC. This is part of a 2008 Western Sustainable Agriculture Research and Education-funded project comparing a traditional winter wheat-fallow system to a wheat-camelina rotation in field-scale replicated trials. There were four N application rates (0, 20, 40 and 80 lbs N/ac) and three P rates (0, 30, and 60 lbs P/ac). Both N and P were broadcast on May 16, 2011. Phosphorus fertilizer used was



Augustine Obour pours camelina seeds.

Figure 1. Harvesting camelina with a small plot harvester. Jerry Nachtman drives the combine while Augustine Obour collects seed.

monoammonium phosphate (11-52-0 [MAP]). N fertilization was with urea (46-0-0) after adjusting for N amount supplied from MAP application (example 60 lbs/ac MAP supply 13 lbs N/ac). Camelina was harvested August 17 for seed yield using a small plot combine (Fig. 1).

Results and Discussion

Oil content has not been analyzed yet so only seed yield data is presented in this report. Preliminary results in 2011 showed P fertilization had no significant effect on camelina yields. Seed yield was 700 lbs/ac for treatments with no P application. It was 800 lbs/ac for the highest P application rate of 60 lbs/ac when averaged across N rates.

However, N application significantly increased camelina seed yield (Fig. 2). The addition of 20 lbs/ac N increased camelina yields by 10% (712 lbs/ac) compared to plots that received no nitrogen application (650 lbs/ac). Seeds yields were 830 lbs/ac and 900 lbs/ac when N was applied at 40 and 80 lbs/ac, respectively—this represents a yield increase of 28 and 39%, respectively, compared to when no N was applied. It is worth mentioning that the yield differences between treatments that received 40 and 80 lbs/ac N were not statistically different. Preliminary data suggest that N fertilization at 40 lbs/ac will be sufficient for camelina production on drylands in southeastern Wyoming and other central High Plains regions with similar moisture regimes.

Acknowledgments

The Plant Sciences Department provided funding. We thank SAREC farm manager Robert Baumgartner and the farm crew for assistance.

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Key words: biofuels, camelina, fertilization

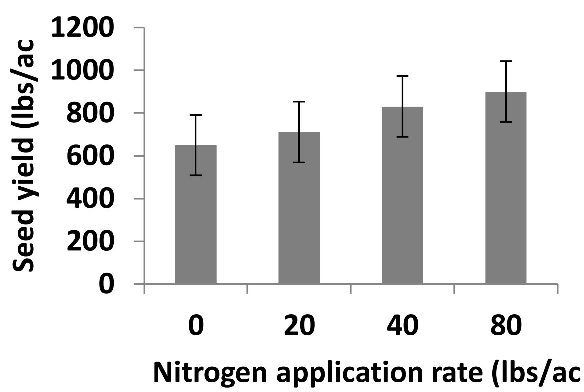

Figure 2. Camelina seed yield response to different N application rates in 2011.

Soil Fertility Challenges in Northern High Plains Organic Farming Operations

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Introduction

Since implementation of the U.S. Department of Agriculture's (USDA) National Organic Program (NOP) in 2002, the number of certified organic farms has continually increased. According to the USDA's Economic Research Service, Wyoming currently ranks second in terms of total organic acreage, yet unique soil fertility challenges exist for those 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 in an effort to enhance available soil P. However, organic farmers are limited with respect to the fertilizers or amendments allowed for use under the NOP. Unfortunately, there is little information available regarding the agronomic effectiveness of some fertilizers or amendments on calcareous soils, especially with respect to P. The USDA Organic Agriculture Research and Extension Initiative (OREI) seeks to address these issues.

Objectives

The goal of this study is to assess the impact of alternative soil amendments on nutrient cycling—particularly phosphorus—in calcareous soils under organic management.

Materials and Methods

Field experiments are conducted on an irrigated 36-acre half-pivot at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. The following alternative soil amendments were applied at manufacturer's recommended rates in 2011: "Biohumus" humic acid @ 2 gal./ac.; "SP-1" compost tea @ 6 gal./ac.; "Steamed bone meal" @ 1,300 lbs./ac.; "Ida-Gro pelletized phosphate" @ 500 lbs./ac. Amendments were applied alone and in combinations in 8-ft. x 20-ft. plots. For comparison, two controls were included: no treatments (2010 and 2011) and raw manure (2011 only).

Results and Discussion

Amendments were applied at manufacturer's recommended rates in 2010 and 2011. Initial results suggest that the alternative amendments do not provide additional P, unlike manure or conventional fertilizer applications (Table 1). The available P in 2011 declined compared to 2010. This may have occurred because the available P was already diminished, and little additional available P was provided via the amendments even though crop demand was high. Crops may be tapping into what P became available via degradation of the organic P pool to supply needed P. These soils are low in organic matter, thus this organic P pool will decline quickly, potentially leaving the crops susceptible to a P deficiency in the long term if P needs are not met.

Table 1. Available soil P after two years of amendment applications.

	Plant Available P (lb/ac)	
Treatment	**June 2010**	**June 2011**
No treatment	39	24
Composted manure	*NA*	54*
Humic acid	43	17
Compost tea	37	16
Bone meal	43	19
Rock phosphate	36	18
Humic acid + Bone meal	43	24
Compost tea + Bone meal	35	20
Humic acid + Rock phosphate	35	28
Compost tea + Rock phosphate	48	23
Conventional fertilizer	77*	80*

**P<0.05 for amendments compared to no treatment within years.*

Acknowledgments

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Key words: organic farming, fertilization, phosphorus

The Sustainable Agriculture Systems Project

J.B. Norton[1], R. Ghimire[1], U. Norton[2], J. Meeks[1], S. Paisley[3]

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Introduction

Production approaches that reduce costs, increase value, and/or improve productivity represent potentially important opportunities for agricultural prosperity in Wyoming, but there is little information about investments, time requirements, or productivity.

Objectives

We established the Sustainable Agriculture Systems Project (SASP) in 2009 to investigate potential for reduced-input and certified organic production in Wyoming crop and livestock operations.

Materials and Methods

SASP began with 24 plots on 36 acres under one-half pivot sprinkler at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC; Fig. 1). In 2011, we added a dryland crop component on SAREC's wheat strips, with replicates at the University of Nebraska research station in Sidney, Nebraska. The plots constitute a research framework for long-term monitoring of agronomic, economic, and ecosystem service parameters on plots managed for conventional, reduced-input, and organic production of both cash crops and beef calves. All the management activities are planned by an advisory group that meets at least twice a year to reflect on progress and challenges and to plan for the coming year.

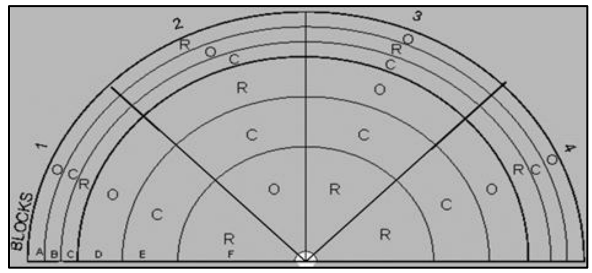

Figure 1. SAREC irrigated plots. A, B, C: 1-acre cash crop plots; D, E, F: 2-acre beef calf plots. O, organic; C, conventional; R, reduced-input.

We aim for SASP to join a network of long-term agricultural research. Long-term research with different agricultural approaches operating side-by-side is valuable for several reasons:
1) understanding agroecological processes and economics during conversion to alternative practices; 2) developing innovations for each approach; 3) tracking sustainability; and 4) providing a rich setting for engaging farmers, ranchers, researchers, educators, and students in discussions of philosophies and sustainability. Projects like the Wisconsin Integrated Cropping Systems Trial Project (http://wicst.wisc.edu), the Sustainable Agriculture Farming Systems

Project (California) (http://safs.ucdavis.edu), and the Center for Environmental Farming Systems (North Carolina) (www.cefs.ncsu.edu) produce practical and basic knowledge for prosperous and sustainable agriculture. Each case shows that the longer the trials are in place, the more valuable they are.

The irrigated cash crop plots consist of four-year rotations under each approach, with beans-corn-sugarbeet-corn for conventional and reduced-input plots and oat/alfalfa-alfalfa-corn-beans for organic plots. Irrigated beef calf plots are operated as yearling operations under each approach, with three years of grass-alfalfa and one year of corn for each. Conventional plots are plowed, disked, harrowed, and fertilized according to soil tests, and cultivated and sprayed for weed control. Reduced-input plots are shallow-tilled with one pass by a Landstar® implement, fertilized according to soil tests, and sprayed for weeds. Organic plots are managed according to U.S. Department of Agriculture (USDA) National Organic Program guidelines, with tillage for weed control and compost for fertility. For the livestock component, 24 weaned calves are selected from the SAREC herd for genetic similarity in the fall, and eight are assigned to each approach. Conventional calves go to the feedlot to be fed a grower-approved ration until sale. Reduced-input and organic calves spend the winter on stubble, moving to grass in May and to the feedlot for three to four months in the fall to be fed rations from the plots.

Results and Discussion

After three years of production on the irrigated plots, we've noted that conversion to reduced tillage caused marked increases in labile organic matter, which improves soil properties and provides a time-release source of nutrients but is rapidly decomposed when tilled. We measured changes in the laboratory, and we can also see results in darker soil colors, better structure, and abundant earthworms. The farm crew at SAREC has been recording all management activities and inputs for compilation of economic parameters that will start this summer. By year's end, we plan to have a comprehensive report of economic and agronomic sustainability after one four-year rotation.

The original four-year irrigated project leveraged additional funding that keeps the project going until 2014. After that, we believe the value of long-term research may be able to justify continued operation of the SASP research framework.

Acknowledgments

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Key words: organic production, reduced tillage

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

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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.” Our laboratory has 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 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, 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.

Objectives

The objectives of the experiment are to evaluate the impacts of maternal protein supplementation during the last trimester on: 1) growth rates and feed efficiency of steer calves from weaning to finish, and 2) 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 has been conducted at the University of Nebraska–Lincoln’s (UNL) Gudmundsen Sandhills Laboratory involving 135 crossbred, mature cows per year. Pregnant, March-calving cows grazed dormant upland range from December 1, 2010, to February 28, 2011, and received the daily equivalent of either 0, 1, or 2 lbs (dry matter) per cow of a protein supplement (used in previous experiments).

Because a substantial amount of cattle in the Great Plains 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 from the Laramie Research and Extension Center (LREC) will be randomly assigned to receive either 0, 1, or 2 lbs of protein supplement at LREC. Supplementation began December 1, 2010, through February 28, 2011. The non-supplemented group will graze winter pasture until either weather or forage quantities dictate that forage be supplemented.

Cows at both UNL and LREC were estrous synchronized and artificially inseminated with semen from one bull at each institution for both years of the experiment. Synchronization and artificial insemination conception rates will be evaluated to allow for determination of any treatment influences on gestation length. Steer calves from UNL were shipped to the feedlot in North Platte where growth performance will be monitored through harvest. Steer calves from LREC were individually fed utilizing GrowSafe technology at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. Measurements 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 were collected on a subset of steers to determine shear force in the meat laboratory at South Dakota State University. Further, an economic analysis of profitability differences among treatments will be conducted.

Results and Discussion

The feeding portion of this study occurred in 2010 and 2011. Steers from this study will be harvested this summer, and results will be disseminated this fall.

Acknowledgments

We recognize the hard work of Travis Smith, LREC Beef Unit manager, and Jim Freeburn and the entire staff at SAREC. This project was funded by the U.S. Department of Agriculture’s Five-State Ruminant Consortium.

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Key words: protein supplementation, carcass characteristics, fetal development

SAREC 2011–2012 Forage-Based Bull Performance and Efficiency Test

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Introduction

As feed and grain prices remain high, one of the most important areas of interest in the beef cattle industry has been measuring and characterizing feed efficiency and residual feed intake (RFI) in both commercial and registered cattle.

Four years ago, the James C. Hageman Sustainable Agriculture Research and Extension Center's (SAREC) GrowSafe testing facility began working with producers to help evaluate registered bulls and heifers for feed efficiency and RFI utilizing a forage-based growing diet. Bulls are received in mid-November, adapted to the forage-based diet and GrowSafe feed bunks for 21 days, and tested for weight gain, feed intake, efficiency, and RFI for 70 days. Tests typically finish in mid-February of each year. Over the last four years, the SAREC testing facility has worked with 13 Angus and Hereford breeders predominantly from Wyoming but also Nebraska, South Dakota, and Kansas. Consignors must provide a minimum of four head, with eight bulls per GrowSafe node during the formal test.

Objectives

Our objectives were to evaluate bulls in a 90-day performance and feed efficiency test utilizing a predominantly forage-based growing diet. Bulls are evaluated for individual growth performance, feed efficiency, and RFI rankings.

Materials and Methods

The forage-based growing diet used during the test consists of whole-shelled corn, ground grass/alfalfa hay, first-cutting grass/alfalfa haylage, and protein pellet. Bulls are fed 2X/day during the testing period. Bulls were weighed at arrival, weighed on two consecutive days at the beginning and end of the 70-day test, and weighed biweekly during the testing period. This past winter, six Wyoming seedstock producers from Goshen, Niobrara, and Laramie counties, along with one producer from western Kansas, consigned 67 bulls to the 2011–12 feed efficiency and RFI test.

Table 1. Feeding summary of bulls on 2011–12 forage-based feed efficiency test.

	Start wt. (lb)	Final wt. (lb)	ADG (lb/d)	Dry matter intake (lb/d)	Dry matter feed efficiency	Residual feed intake (RFI)
Group Avg	781	1051	3.87	21.24	5.60	0.00
Minimum	570	808	2.61	15.77	3.76	-4.17
Maximum	1020	1276	4.86	28.78	10.49	+6.29

Results and Discussion

One of the major components of the forage-based test is to evaluate bulls in a similar environment for feed efficiency (lbs of feed required for one pound of weight gain), and RFI.

RFI is a newer comparison that tries to adjust for each unique test environment by comparing each bull's "efficiency" to the average for the group. A negative RFI (-4.17 in the table) indicates that there was a specific bull that required 4.17 fewer lbs of feed to achieve the average daily gain (ADG) for the pen. A positive RFI indicates a less efficient bull that requires more feed to achieve the same weight gain. An animal with "average" efficiency when compared to the group would have an RFI of 0. RFI appears to be moderately heritable, and consistent selection for negative RFI should lead to improvements in feed efficiency.

The SAREC forage-based performance and efficiency test is open to any producers who would like to evaluate their bulls in a common setting while collecting individual feed efficiency and RFI data

Acknowledgments

This is a cooperative project between the consignors and SAREC. The authors wish to express appreciation to the consignors and our colleagues at SAREC for efforts to make this a successful program.

Contact Information

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Key words: bull test, feed efficiency, forage diet

Best Management Practices Audit and Inventory of Biological Properties at the Rogers Research Site

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Editor's Note

At press time, a large wildfire burning in southeastern Wyoming's Laramie Peak area had burned most of the structures, including two cabins, and the majority of vegetation at the Rogers Research Site (RRS), reports Professor Steve Williams. "Even though the Arapaho Fire—and other wildfires burning in Wyoming and surrounding states—is a tragedy from a human standpoint, it will afford us research, outreach, and instructional opportunities in terms of post-fire vegetation regeneration," Williams says. "Before the Arapaho Fire started, I wrote in this paper about the potential for forest fire research at RRS. That research potential is now here."

Introduction

The RRS is in the Laramie Mountains southeast of Laramie Peak. This parcel is being developed as a forestry-research oriented site and is administratively associated with the James C. Hageman Sustainable Agriculture Research and Extension Center. Bringing the RRS on-line as a viable research station has required a concerted five-year effort to create a site for research and other activities. A committee of potential users has visited the site and made recommendations regarding infrastructure needs of the RRS and research potential.

During the last year, efforts have been initiated to conduct a best management practices (BMPs) forestry audit of the site and an inventory of biological resources. This will provide future users with baseline information on plant and microbial communities that impact wildlife, domestic animals, and water quality.

The RRS is composed of 320 acres of mostly mixed conifer and aspen woodlands and grass and shrub lands. The average elevation is approximately 7,000 feet. There is a small, permanent stream and a small

Figure 1. Pond on the Rogers Research Site (Photo by S. Williams).

water impoundment on the property, both of which support willow and alder stands (Fig.1). Soils are on granite and variable in depth but are mostly shallow and well drained. Approximately 180,000 acres of surrounding lands are on the Douglas Ranger District of the Medicine Bow National Forest. There are also parcels of private land.

The RRS has potential for research, outreach, and teaching unlike other lands currently controlled by the University of Wyoming. Much of the potential of the RRS is in development of UW and U.S. Forest Service (USFS) research. It has potential as a base of operations for expanded work with the USFS as well as for providing a site for more intensive research confined to the RRS property. There is potential for forest fire research including management of fire in forests containing vacation and permanent homes and associated structures. Other areas of possible work are water management and erosion control, grazing management and interactions of domestic livestock with wildlife, timber management including BMPs, and demonstrations of these for timber harvest contractors and private owners of forested land.

Objectives

The objectives of this article are to inform the general public and potential users about the RRS and its potential for research and other uses. We are also reporting the general results of the 2011 BMPs forestry audit and initial efforts toward an inventory of biological resources of the RRS.

Materials and Methods

The BMP forestry audit was conducted through the Wyoming State Forestry Division in conjunction with the U.S. Forest Service, other agencies, and private contractors. This was to determine if appropriate timber harvesting was being done to avoid soil erosion. First steps toward the inventory were conducted by selecting sites across the RRS that would represent various vegetation and soil associations in the area.

Results and Discussion

The results of the BMP audit showed that the small timber harvesting activities on the RRS site were being conducted to minimize erosion and water contamination. Eight sites were selected for initiation of biological inventory. These sites represent the various vegetation and soil associations on the RRS.

Acknowledgments

Funding has been through the Wyoming Agricultural Experiment Station. Forestry audit funds were from UW Extension.

Contact Information

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Key words: forestry, best management practices, biological inventory

2012 Sheridan Research and Extension Center Field Day

V.D. Jeliazkov (Zheljazkov)[1]

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Introduction

The Sheridan Research and Extension Center (ShREC) is seven miles east of Sheridan at an elevation of 3,800 feet. ShREC is in the U.S. Department of Agriculture's (USDA) Plant Hardiness Zone 4 with an average growing season of 120 days and average annual precipitation of 15 inches. The main station at Wyarno includes approximately 250 acres; field crops are dryland while vegetables and fruit trees are under irrigation. ShREC also manages sites at Sheridan College (SC), which are under irrigation. In addition, ShREC is to begin managing the 450-acre Adams Ranch south of SC. The ranch, owned by Whitney Benefits, includes approximately 240 acres of irrigated cropland.

Importance of ShREC

Since the start of ShREC, the aim has been to make research work useful to Wyoming farmers, ranchers, homeowners, and others. In the last 5–6 years, ShREC initiated research projects in horticulture and turf grass. The research in horticultural specialty crops expanded in 2011–2012. The research should benefit agricultural producers, homeowners, golf course greenskeepers, horticulturalists, and others.

ShREC PRECIPITATION 2007–2011 (inches)

Month	2007 Precipitation	2008 Precipitation	2009 Precipitation	2010 Precipitation	2011 Precipitation	75-Year Average Precipitation
January	0.24	0.33	1.01	0.03	0.42	0.54
February	0.28	0.10	0.03	0.15	0.34	0.51
March	1.60	0.53	1.01	0.16	1.09	0.97
April	0.24	0.39	0.73	1.86	1.92	1.90
May	4.00	5.27	0.31	5.12	6.13	2.55
June	2.53	3.12	2.77	2.29	1.57	2.60
July	0.65	1.88	0.89	1.31	1.83	1.22
August	0.59	0.25	1.16	0.79	0.33	0.91
September	0.96	1.80	0.09	0.18	0.29	1.44
October	2.75	1.97	1.06	0.60	3.10	1.21
November	0.14	0.38	0.13	0.31	0.75	0.77
December	0.42	0.70	0.18	0.13	0.31	0.54
Total	**14.40**	**16.72**	**9.37**	**12.93**	**18.08**	**15.16**

Current Research

Evaluation of alfalfa. There is one ongoing trial since 2007 on dryland. Another new trial was initiated in 2012 on both dryland and irrigated sites. The objective is to provide Wyoming growers with information on alfalfa variety performance under dryland and irrigated conditions.

Small grain variety trial. This was initiated in spring 2011 as a research and demonstration project for spring wheat, barley, and oat varieties. However, a hail storm in July 2011 decimated the trial. Another trial was initiated in spring 2012.

Sainfoin variety trial. This was also initiated in spring 2011 as a demonstration project.

Homeowner turf trial. Objectives are to demonstrate the appearance and resilience of different lawn grasses for the Sheridan area. The trial includes 28 varieties of turf grass planted in September 2005.

Lignocellulosic species for biofuel production. This project is funded by the Sun Grant Initiative through USDA. Goals are to develop economically feasible and environmentally sound production systems for emerging (alternative) biofuel crops.

Utilization of coal-bed methane (CBM) discharge water for irrigation of agricultural crops. The goal is to provide information on the use of CBM discharge water for irrigation of horticultural and field crops.

Establishment of mints as specialty crops for Wyoming. The long-term goal is to establish sustainable mint essential oil production in Wyoming. We are testing several species (peppermint, Scotch spearmint, Native spearmint, and Japanese cornmint) for the environmental conditions of Wyoming.

Oilseed crops as potential biodiesel crops for Wyoming. This field study began in fall 2010 and is evaluating coriander, winter canola, and winter mustard as biodiesel crops.

Optimization of high and low tunnel organic vegetable systems for the Sheridan area. This is a project at the ShREC organic garden.

New projects underway include *Evaluating table and wine grape cultivars for Wyoming.* The goal is to identify promising grapevine cultivars for Wyoming, thus overcoming obstacles to initial vineyard establishment, resulting in increased production and early returns. Specific objectives include screening grapevine cultivars for growth and establishment and studying the influence of soil and climate on yield and quality. A vineyard with 40 grape cultivars will be established at ShREC. Vines will be planted on a high cordon trellis at a spacing of 10 ft x 6 ft. Growth and flowering parameters will be recorded for individual cultivars. Yield and quality aspects will be recorded as vines mature and bear to full potential.

Contact Information

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Developing Weed Management Strategies to Improve Reclamation of Drastically Disturbed Lands

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Introduction

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

Non-native and undesirable weed species are often able to readily invade areas with bare soils. Widespread growth of invasive and noxious weeds was the second most prevalent event of non-compliance on coal-bed methane reclamation sites in the Powder River Basin. Potential benefits of not controlling annual weeds like kochia or Russian thistle (wind protection, encouraging soil microbes) on reclamation sites sometimes drive decisions of reclamation contractors to refrain from controlling them, even though policy encourages management of such weeds. To address this issue, this research seeks to determine the relationship between chemical removal of annual weeds and establishment of desirable seeded species.

Objectives

This research addresses the following:
1) Does removal of competitive annual weeds with herbicides improve or diminish the establishment of desirable plant species? 2) What is a successful approach for using various herbicide treatments in reclamation settings? 3) Which desirable species are able to successfully establish in areas treated with herbicides applied at different timings?

Materials and Methods

Three field trials were established in fall 2011 at the Sheridan Research and Extension Center, the Laramie Research and Extension Center, and Ucross, Wyoming. At each site, 10 different seeding treatments were planted in fall 2011 and spring 2012. Seeding treatments included single-species grass plantings and mixes including forbs and shrubs (Table 1). Six pre-emergent herbicide treatments were applied in fall 2011 at the time of fall seeding, and eight post-emergent treatments were applied in spring 2012.

Weed control, desirable species establishment and growth, and percent vegetative cover will be observed for the following three growing seasons. Actual and estimated cost data will be used to evaluate economic implications of the various approaches to reclamation.

Results and Discussion

This project is just underway, and data collection will begin in summer 2012. Early spring emergence of seeded species has been minimal with lower than normal precipitation.

Acknowledgments

This project was supported by a University of Wyoming School of Energy Resources competitive grant, DuPont®, U.S. Bureau of Land Management, Apache Foundation, and the Department of Plant Sciences. Thanks to R.D. Mealor, H.J. Hergert, S. Burnett, J. Unverzagt, L. Lorent, C. Coburn, and others for field assistance.

Contact Information

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Key words: reclamation, restoration, seeding competition, herbicide

Table 1. Grasses and seeding rates used at all three locations. Forb and shrub species were selected as appropriate for each location and included Wyoming big sagebrush, fourwing saltbush, purple prairie clover, scarlet globemallow, and others.

Species	Variety	lb PLS/ac
western wheatgrass	'Arriba'	12
big bluegrass	'Sherman'	4
basin wildrye	'Trailhead'	12
bluebunch wheatgrass	'Anatone'	14
streambank wheatgrass	'Sodar'	12
alkali sacaton	common	2
crested wheatgrass	'Hycrest'	8
Russian wildrye	'Bozoisky'	12

Variation Among Seed Sources of Plant Species for Reclamation

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Introduction

Reclamation efforts are widespread across Wyoming, and these activities frequently require planting native seed. Available seeds often represent plants with origins outside of Wyoming from locations with significantly different climate and soil characteristics. As a result, commercial seed sources may not be well-suited for reclamation environments and could negatively impact revegetation success.

Many native plant species occur across a large geographical range and span hundreds of miles representing multiple latitudes and both high and low elevations. As a result, different populations of a single species are often adapted to local environments at their site of origin. This is known as "local adaptation." Questions arise as to whether moving seeds from long distances to reclamation sites in Wyoming will impact survival and growth of those plants in new environments.

To address concerns about the significance of site of origin for seeding success, we are establishing two demonstration plots representing multiple accessions (or seeds of a single species with different sites of origin) at the Laramie and Sheridan research and extension centers.

Figure 1. *Leymus cinereus*, basin wildrye, seeds (Photo: K.M. Hufford).

Objectives

The primary goal of this project is to test for differences in establishment, growth, and long-term survival of different seed sources for each of seven plant species native to Wyoming. The plot locations near Laramie and Sheridan represent contrasting temperature and rainfall regimes and significantly different elevations. The plot near Laramie is located at approximately 7,300 feet and receives an average of 11 inches of precipitation, while the field site in Sheridan is at 3,800 feet and receives an average of 15 inches of precipitation. These plots will serve as both research and teaching resources to investigate the consequences of using different seed sources of native plant species for reclamation.

Materials and Methods

Each site will be planted with replicates of an average of three wild-collected seed accessions for plant species that are relevant for reclamation. These species include: basin wildrye, Indian ricegrass, Wyoming big sagebrush, basin big sagebrush, rubber rabbitbrush, Gardner's saltbush, and textile onion. Accessions represent different sites of origin within Wyoming. For example, basin wildrye seeds are derived from sites near Worland, Rawlins, and Rock Springs. In addition, we will plant commercial varieties of each species for comparison. Cultivated varieties, or cultivars, are often derived from sites outside of Wyoming. These plantings will be identified by species and site of origin and monitored for establishment, growth, and survival over a period of three or more years. If possible, multiple accessions of additional species will be added to the study in the future.

Results and Discussion

If different populations of a single plant species are adapted to local environmental conditions (such as minimum annual temperature), moving these seeds to new environments may impact their ability to establish and grow. If locally adapted populations of species targeted for reclamation are common, we may inadvertently affect reclamation success depending on the seeds chosen for planting. These demonstration plots represent one of several ongoing efforts to test the consequences of seed source for revegetation success. If differences are observed in survival and growth among alternative seed sources for each species, these results may contribute to future reclamation planning and provoke discussions of appropriate seed sources for native species reclamation in the state and region. Different populations of each species represent biological resources important for healthy ecosystems and habitat. These demonstration plots will contribute to our understanding of the extent of variation among populations of plant species that might be critical for both economic and environmental concerns in Wyoming.

Acknowledgments

The demonstration plots are supported by the Wyoming Reclamation and Restoration Center, and wild-collected seeds are contributed by the U.S. Bureau of Land Management's Seeds of Success program.

Contact Information

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Key words: adaptation, restoration, seeds

Growing Fruit Trees in the Sheridan Area, Wyoming

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Introduction

Research shows that 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.

Currently, the orchard has 59 fruit trees. Apple trees make up the majority with 37 trees of 18 different varieties (Fig. 1). There are 12 plum trees representing seven varieties, six cherry trees representing five varieties, two crabapple trees, a pear tree (Fig. 2), and one 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 trees perform well in the Sheridan area. A secondary objective was to monitor the trees for pests and disease. Information on which diseases and insects are problematic and how to control them will make the recommendations concerning fruit trees—and specific varieties—more pertinent.

Materials and Methods

All of the trees were planted in early spring. The orchard is irrigated using drip tape throughout the summer. Pruning is performed in early spring each year. 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 most prevalent disease has been fire blight, *Erwinia amylovora*. This caused severe damage to many trees,

Figure 1. Apples with no damage in 2010.

Figure 2. Pears ready for harvest in 2010.

Figure 3. Apples damaged by the 2011 hail storm.

forcing the removal of some limbs and even entire trees. The younger trees seem to represent varieties with some resistance to this disease. Of the apple trees planted in 1987, only one 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 in the spring. Cool, wet springs are especially favorable for the spread of this disease.

The fruit trees that survived may represent potential suitable species and varieties for the Sheridan area. Observations of pests and disease and the collection of yield data will continue in the years to come.

A hail storm in July 2011 destroyed most of the fruits (Figs. 3 and 4). Therefore, there were no marketable fruits for harvest.

This long-term project has demonstrated that fruit trees can be successfully grown in the Sheridan area provided that proper pest and disease control measures are implemented. Our goal is to establish a larger research orchard with more species and varieties. Information gained should help area farmers, ranchers, homeowners, and others decide which fruit trees to plant.

Acknowledgments

The project was funded by the Wyoming Agricultural Experiment Station. We thank the student summer workers at ShREC for assistance.

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Key words: fruit trees, orchard

Figure 4. The hail storm in July 2011 damaged or knocked off almost all of the fruits in the orchard. Therefore, there were no marketable fruits for harvest at the end of the season.

Evaluating Table and Wine Grape Cultivars for Wyoming

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Introduction

Grape production in Wyoming evinces strong interest from producers seeking viable alternatives to traditional crops, and homeowners with backyard plantings. Cold winter temperatures, late spring frosts, and a short growing season limit the cultivation of popular bunch grape cultivars in Wyoming.

With the development of new cold-hardy cultivars, the scope for grapevine production in colder regions of the United States, including Wyoming, is rapidly expanding. The Wyoming grape industry, which started with two growers, has now expanded to approximately 20 producers growing grapes on 25–30 acres with an annual fruit production of 40–45 tons.

Grape production and quality is governed by the complex interaction of cultivar with prevailing soil and climatic conditions. Thus, choice of cultivar(s) is a critical factor for successful vineyard establishment. Favorable weather conditions during the growing season can ensure vigorous, disease-free vine growth and high quality fruit production if suitable cultivars for the state can be identified.

Objectives

The goal of the project is to identify promising grapevine cultivars for Wyoming to assist producers in successful vineyard establishment. This should result in increased production and early returns. Objectives include screening cultivars for growth and establishment and studying the influence of soil and climate on yield and quality.

Materials and Methods

A vineyard with 40 grape cultivars will be established at the Sheridan Research and Extension Center (ShREC) east of Sheridan. Vines will be planted on a high cordon trellis at a spacing of 10 ft x 6 ft. Growth parameters including date of bud burst and flower initiation, number of flowers per vine, and pruning weight will be recorded for individual cultivars. Yield and quality will be recorded as vines mature and bear to full potential.

Results and Discussion

The project addresses immediate critical needs of current and future grape growers and residents interested in home gardening. It comes at a time when the

Wyoming grape industry is seeking to expand and will be a source of reliable information for successful vineyard establishment and production.

Acknowledgments

The College of Agriculture and Natural Resources and the Wyoming Agricultural Experiment Station provided financial assistance. Field support from ShREC farm manager Daniel Smith is acknowledged.

Contact Information

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Key words: viticulture, grapevine production, grapes

Homeowner Turf Trial at Sheridan Research and Extension Center

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Introduction

Various turf grass varieties have different characteristics. Homeowners, commercial growers, and others desire information on which varieties perform best in their area. To respond to growers' interest, a turf grass variety trial was initiated at the Sheridan Research and Extension Center (ShREC) in September 2005. Twenty-eight varieties were planted (Table 1). The trial continues to attract much interest from people in and around the Sheridan area.

Objectives

Our objectives were to demonstrate the appearance and resilience of different lawn grasses in the Sheridan area.

Materials and Methods

Ten- by 40-foot plots were hand-seeded in 2005. The plots have been maintained since then, and they are watered one inch per week during the growing season and mowed at the same height. (See Figs. 1–3)

Results and Discussion

This trial has been of interest to many people as it helps them decide which grass variety to plant. The trials are in representative soil for this area. Each variety in the trial faces the same environmental conditions as a homeowner's lawn would encounter in this area. Everyone is welcome to view the trials and other research at ShREC, east of Sheridan.

Acknowledgments

The project was funded by the Wyoming Agricultural Experiment Station. We appreciate the help of student workers at ShREC over the last seven years.

Contact Information

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Key words: turf grass, variety trial

Table 1. Turf grass varieties in the trial.

"Supreme" buffalograss blend
blue grama
'Nordan' crested wheatgrass
'Rush' pubescent wheatgrass
'Hycrest and CDII' hybrid wheatgrass
'Rosanna' western wheatgrass
"North West Tough Lawn" tall fescue
Ace® tall fescue
The Rebels® sun and shade tall fescue mix
Northern Turf™ Brand grass seed mixture
Ace® shady mix
Scotts® Pure Premium® shady mix
Scotts® Classic® sun and shade
'Penncross' bentgrass
bermudagrass and zoysiagrass blend
perennial rye
Outsidepride.com® perennial rye blend
'Sodar' streambank wheatgrass
orchardgrass
timothy
'Rose' creeping red fescue
'Eureka II' hard fescue
'Sheeps' blue fescue
Sheridan Seed "Native Plus" mix
Pennington® Seed shady mix
'Colonial' bentgrass
'Fultz' alkaligrass
Outsidepride.com® Envirolawn

Figures 1–3. Turf plots at the Sheridan Research and Extension Center.

Optimization of High and Low Tunnel Organic Vegetable Systems

V.D. Jeliazkov (Zheljazkov)[1]

[1]Sheridan Research and Extension Center.

Introduction

In 2011, we initiated preliminary trials on organic vegetable production with cabbage, cauliflower, broccoli, lettuce, and basil. In 2012, the project will build on the experience from 2011, on the project leader's previous experience, and on literature reports. The project will also be used for teaching organic food production through the University of Wyoming Outreach School.

There is significant interest in extended-season production systems. High tunnel vegetable production systems have been a focus of recent research and demonstration projects across the state. There are relatively fewer studies on row covers and low tunnel production systems, especially for organic vegetables and herbs. Low tunnel production systems have been widely used in vegetable 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. 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, and they ultimately improve marketable yields. Low tunnels help protect produce from wind, hail, and other inclement weather, as well as pests. They also improve marketable yields.

Objectives

The purpose of this project is to evaluate extended-season production systems for several specialty crops. The five-year goal of vegetable research at the Sheridan Research and Extension Center (ShREC) is to assist with the establishment of sustainable early- and late-season organic production of vegetables, small fruits, and herbs in Wyoming.

Specific objectives are to: (1) Compare three production systems—high tunnel (HT), low tunnel (LT), and no covers for early spring production of cool-season vegetables and herbs; (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 spring 2011 and again in spring 2012 in the organic garden at the ShREC. Transplants were started from certified organic seed in the Sheridan College greenhouse. After 45 days in the greenhouse, transplants were moved to (1) a high tunnel, (2) a low tunnel, or (3) outside with no cover (Fig. 1). The experiments will continue with late-season production of vegetables, small fruits, and herbs. The extent of the project 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 (compounds found in plants, as antioxidants, considered to be beneficial to human health).

Results and Discussion

In 2011, cabbage, cauliflower, broccoli, lettuce, and basil developed well in the high tunnel and low tunnel (Fig. 1). The vegetables outside (with no cover) were well behind the ones in the tunnels (Fig. 1). In July 2011, a major hail storm destroyed the crops outside and in the low tunnel (at that time it was uncovered). Hence, we collected data only from the high tunnel. The plastic in the high and low tunnel was damaged but not destroyed. This experience helps to demonstrate the advantages of protected horticulture. Trials will continue in 2012.

Acknowledgments

The author thanks Adrienne Tatman, Michelle Box, Berva Brock, and Ekaterina Jeliazkova for helping with greenhouse and field experiments.

Contact Information

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Key words: basil, cabbage, cauliflower, broccoli, lettuce, organic, high tunnel

Figure 1. Basil, cabbage, cauliflower, broccoli, and lettuce in the organic garden at ShREC on June 19, 2011: no cover (left), low tunnel (middle), and high tunnel (right) (Photo Valtcho Jeliazkov).

Japanese Cornmint as a Cash Crop for Wyoming

V.D. Jeliazkov (Zheljazkov)[1]

[1]Sheridan Research and Extension Center.

Introduction

Japanese cornmint (*Mentha canadensis* L.), often reported as *M. arvensis* L., belongs to the genus Mentha (Lamiaceae). Japanese cornmint is considered native to most of Europe and parts of Asia, including Siberia, and North America. There is great diversity among the natural populations and among selected commercial cultivars. For the most part, commercial cultivars are natural hybrids and are propagated only vegetatively. Japanese cornmint is the only commercial source for natural menthol (a cyclic terpene alcohol, with three asymmetric carbon atoms), which is the major constituent of its essential oil.

The crystalline menthol and the de-mentholized oil are utilized as aromatic constituents in the food, pharmaceutical, flavoring, and fragrance industries. The wide utilization of menthol is due to its cooling and tingling sensation, which is caused by the stimulating effect of menthol on cold receptors of biological membranes.

Currently, Japanese cornmint is grown commercially in Japan, China, Vietnam, Brazil, and elsewhere in South America and eastern Europe but not in the United States. The U.S. is a major importer of Japanese cornmint essential oil, menthol, and de-mentholized oil. There have been issues with consistency of supply and the quality of Japanese cornmint products imported to the U.S. Domestic production of Japanese cornmint could address these issues and possibly provide a new cash crop for American growers. There are only two recent reports on Japanese cornmint field trials that we are aware of, and they are from our previous research in Mississippi.

Objectives

Field trials were initiated by the Sheridan Research and Extension Center (ShREC) at Sheridan College in 2011 to determine if Japanese cornmint (1) can be grown in Wyoming and (2) could provide comparative yields of herbage, oil, and satisfactory levels of menthol in the oil. A secondary objective was to determine the best time for harvesting Japanese cornmint under Wyoming conditions.

Materials and Methods

Research plots were established with two cultivars (Arvensis 2 and Arvensis 3) of Japanese cornmint. Plots were irrigated via drip tape, and nitrogen (N) was applied based on peppermint N recommendations for the northwestern U.S. Plots were harvested from mid-September to mid-November when the first snow fell. The essential oil was extracted from fresh samples via steam distillation immediately after harvest. The resulting oils were collected and weighed, and the oil content was calculated as g of oil per 100 g of fresh biomass. The oil samples were subjected to gas chromatography analyses for oil chemical composition.

Results and Discussion

Overall, preliminary results suggest that Japanese cornmint can be grown in some areas of Wyoming and provide comparable fresh herbage and oil yields relative to the yields reported in the literature. The essential oil content was also within the typical range reported from other countries. Menthol concentration in the oil was within the limits of variation for this compound as reported from our field trials in Mississippi. Japanese cornmint was not damaged by late fall mild frosts, but it was damaged by heavier frosts later (see photos below). Japanese cornmint survived the winter and emerged in mid-April. The first year of data suggest that Japanese cornmint could be a viable perennial crop for some areas of Wyoming. The trials will continue in 2012 and beyond.

Acknowledgments

The project was funded by University of Wyoming start-up funds allocated to Valtcho Jeliazkov (Zheljazkov). The author thanks Michelle Box, Berva Brock, Lyn Ciampa, and Ekaterina Jeliazkova for helping with the field trials and extraction of essential oil.

Contact Information

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Key words: cash crop, essential oil, mint

Figure 1. 2011 ShREC field trials of Japanese cornmint at Sheridan College. Left: Japanese cornmint developed very well. Right: frost damage on Japanese cornmint plants (Photo: Valtcho Jeliazkov).

Establishment of Peppermint and Spearmint as Specialty Crops for Wyoming

V.D. Jeliazkov (Zheljazkov) [1]

[1]Sheridan Research and Extension Center.

Introduction

Peppermint and spearmint are some of the most widely grown essential oil crops in the U.S. and throughout the world. Peppermint and spearmint essential oils are used in a number of consumer products including chewing gum, toothpaste, mouthwash, pharmaceuticals, confectionary, and aromatherapy. Both mints have been grown in the U.S. for more than 100 years. Peppermint is mainly grown in the Northwest, while spearmints are cropped in the Midwest. Previous research has demonstrated that for best oil quality and high menthol concentration, peppermint must be grown in more northern latitudes, perhaps north of the 41st parallel (the southernmost border of Wyoming).

Objectives

The goal of these studies is to establish sustainable peppermint and spearmint essential oil production in Wyoming. Specific objectives for the first 2–3 years are:

(1) Evaluate productivity and oil quality of peppermint and spearmint oils produced in Wyoming; and (2) optimize nitrogen (N) fertilization for peppermint and spearmint grown in Wyoming.

Materials and Methods

Field trials were initiated by the Sheridan Research and Extension Center (ShREC) in 2011 at Sheridan College (Fig. 1). The trials were established using planting materials of certified cultivars 'Black Mitcham' of peppermint, and 'Native' and 'Scotch' of spearmint. Four N fertilizer rates were applied based on N fertilizer recommendations for mints in Oregon and Washington. Data to be collected includes: (1) initiation and duration of growth stages —by regular observations during the two cropping seasons; (2) plant height and biomass yields from each plot; (3) essential oil content through steam distillation at the ShREC laboratory; (4) essential oil composition.

Results and Discussion

First-year results are encouraging. Both peppermint and spearmint cultivars grew well and were not infested by fungal diseases or pests, common in the typical peppermint growing regions. This may be due to the relatively dryer climate in Wyoming compared to the more humid climate in Washington and Oregon, where most of the U.S. peppermint is grown.

Peppermint and spearmint were harvested once at flowering stage. The essential oil from representative fresh biomass subsamples was extracted via steam distillation. Yields of fresh biomass and essential oil were comparable to reported yields of peppermint and spearmint elsewhere in the U.S. The essential oil samples are currently being analyzed for oil composition and quality. Both peppermint and spearmints survived the winter and emerged in early April 2012. First-year data suggest that peppermint and spearmint can be grown as specialty crops in the Sheridan area and perhaps other areas of Wyoming and beyond for essential oil production. We expect two cuts in 2012 due to favorable spring weather, which led to early plant development.

Acknowledgments

This project was supported by University of Wyoming start-up funds awarded to Valtcho Jeliazkov (Zheljazkov). We thank Ekaterina Jeliazkova, Lyn Ciampa, and Dan Smith for help with field trials and essential oil extractions.

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Key words: peppermint, spearmint, essential oil

Figure 1. 2011 ShREC spearmint field trial near Sheridan College's Watt Regional Agriculture Center.

Research Aims to Unlock Chemicals in Junipers to Help Produce Anti-Cancer Drugs

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Introduction

Juniper species are found across the globe. Some of the species hybridize under natural conditions in the north-central United States, creating numerous chemotypes (trees with different chemistry).

The leaves (needles) of some junipers contain two important natural products: podophyllotoxin and essential oil. Podophyllotoxin is utilized as a precursor to the semi-synthetic anti-cancer drugs etoposide and teniposide (Fig. 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 psoriasis and malaria and as a treatment for rheumatoid arthritis.

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

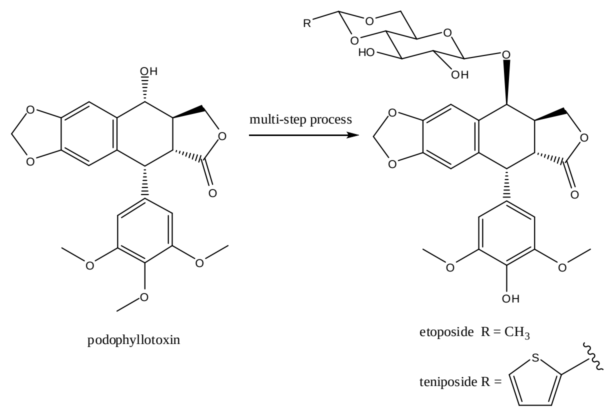

Figure 1. Schematic representation of the commercial process converting podophyllotoxin into either etoposide or teniposide.

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. Specific objectives of this study are to: (1) sample junipers in the Bighorn Mountains and identify trees with the highest podophyllotoxin concentration; and (2) establish a nursery of juniper trees with high podophyllotoxin concentration at the Sheridan Research and Extension Center (ShREC) to be used as genetic material for further cultivar development.

Materials and Methods

In 2011, we conducted a preliminary study to evaluate variation in podophyllotoxin concentrations in juniper species found in the Bighorn Mountains. These included bioprospecting—searching for potentially beneficial natural products—of three Juniperus species: *Juniperus communis* L. (common juniper), *J. horizontalis* Moench. (creeping juniper), and *J. scopulorum* Sarg. (Rocky Mountain juniper).

Sampling was conducted across the Bighorn Mountains at various altitudes. Small representative samples from each tree sampled were submitted for identification and for extraction and quantification of podophyllotoxin. Currently, the samples are being analyzed for concentrations of podophyllotoxin.

It is our goal to create a geographic information systems map with these resources and make it available to state agencies in Wyoming, the National Park Service, and others. The trees showing the highest concentrations of podophyllotoxin will be sampled again, propagated through rooting of cuttings, and established as a breeding nursery at ShREC. The nursery will then be used for cultivar development. Currently, we know of no juniper cultivar developed for production of natural products (although there are a number of cultivars from several juniper species for ornamental purposes).

Acknowledgments

The project is funded by University of Wyoming start-up funds awarded to Valtcho Jeliazkov (Zheljazkov). A project proposal was submitted for funding to the Wyoming Department of Agriculture's Specialty Crop Block Grant Program. We thank Lyn Ciampa for his help with juniper sampling.

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Key words: juniper, podophyllotoxin, Bighorn Mountains

Figure 2. Rocky mountain junipers in the Bighorn Mountains, Wyoming (Photo: Valtcho Jeliazkov).

Evaluation of Alfalfa and Sainfoin Varieties in Sheridan Under Dryland and Irrigated Environments

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Introduction

Alfalfa is a major forage crop in Wyoming, and farmers and ranchers are interested in variety demonstration trials. To respond to the interest of area ranchers and farmers, a variety trial was established by the Sheridan Research and Extension Center (ShREC) in the spring of 2012.

Objectives

Our objective is to provide Wyoming agricultural producers with information on the performance of alfalfa varieties grown under dryland and irrigated conditions.

Materials and Methods

Trials were seeded on June 4, 2012, at two locations: Sheridan College (irrigated) and ShREC east of Sheridan (dryland). A third location will be established soon on a grower's field and will be irrigated with discharge water from coal-bed methane wells. In these trials, 17 alfalfa varieties are used. In addition, we included three sainfoin varieties (Table 1.) A randomized block design is used at the three trial locations, all in four replicates. Each variety will be assessed for establishment rate, seed heading data, yield, and forage quality.

Table 1. List of Varieties

1	Shaw
2	Ranger
3	Multileaf 9111
4	Magnum VI
5	Magnum VI wet
6	Maxi Graze GT
7	340 Brand
8	Ladak 65
9	Ladak creeper
10	Somerset
11	1080 Topcut
12	1080 Highcountry
13	55Q27
14	54V09
15	Bullseye
16	Tug of war
17	Falcata type
18	Delaney Sainfoin
19	Shoshone Sainfoin
20	ESKI Sainfoin

Our goal is to run the trial for 5–7 years to obtain representative data. Each variety was planted with a 6-row plot drill, 12 lbs/ac in 5- x 20-foot plots. Harvest will be performed by hand or using a forage harvester. Fresh and dry yields will be recorded. Representative tissue samples from each plot will be analyzed for forage quality.

Results and Discussion

Trials are being established, and we will release results to the public when the study is complete.

Acknowledgments

The project is funded by University of Wyoming start-up funds allocated to Valtcho Jeliazkov (Zheljazkov) and by the Wyoming Agricultural Experiment Station.

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Key words: forage, alfalfa, sainfoin, irrigated, dryland

Development of a Production System for Emerging Feedstock with Double Utilization

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Introduction

This is a project funded by the Sun Grant Initiative, and in 2012 it will be in its second year. 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 could also be used for production of high-value chemicals (essential oils), which would make them attractive to growers. After the extraction of the essential oil, the remaining biomass would be used as feedstock for ethanol production.

Our preliminary studies demonstrated that some high-value crops would be suitable alternatives to commonly used lignocellulosic species, such as switchgrass, wheat, or 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. The project is testing a number of high-value crops, and economic analysis will identify which are the best crops for the North Central region, including Wyoming, 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 (essential oil), 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 biomass. The revenue from these alternative crops is expected to be higher than from switchgrass, wheat, or reed canarygrass.

Goals and Objectives

The goal of this project is to develop economically feasible and environmentally sound production systems for emerging (alternative) essential oil/biofuel crops for the North Central region.

To accomplish this, our research and education grant will be used to:

1) Determine crop biomass yields, plant chemical (essential oil) content and composition, and soil nutrient and water dynamics in response to: (a) crop species, (b) nitrogen, and (c) site or irrigation.

2) Estimate 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 near Sheridan College were initiated by the Sheridan Research and Extension Center in 2011 (Fig. 1). The project has been expanded this year. In addition, a graduate student will be assigned to work on this project.

The following responses will be measured: (1) fresh and dry matter yields of the alternative crops as well as the 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 in laboratory experiments; (4) biomass quality.

Results

As indicated above, the project was initiated in 2011 but will be expanded in 2012. The crops were harvested in 2011 at maturity. The statistical analyses of biomass yields are yet to be completed. Hence, no data reporting is possible at this stage. Representative subsamples were generated to be analyzed for ethanol production. In addition, samples from the essential oil crops were subjected to oil extraction using steam distillation. The oil samples are being processed for chemical composition and quality. Soil samples are also awaiting analyses for concentration of available nutrients.

Acknowledgments

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Key words: essential oil, biofuel, feedstock, emerging crop, natural product

Figure 1. One of the essential oil/biofuel project sites was established in 2011 at a site near Sheridan College. In 2012, the project will be expanded.

Winter Oilseed Crops as Potential Biodiesel Crops for Wyoming

V.D. Jeliazkov (Zheljazkov)[1]

[1]Sheridan Research and Extension Center.

Introduction

There has been increased interest in developing biodiesel production in Wyoming. Individual growers and co-op members have established small production facilities for biodiesel production, using various feedstocks. With recent increases in diesel prices, small-scale local production of biodiesel becomes a feasible alternative.

Biodiesel is one of the renewable fuels; currently, it is produced mainly from canola, sunflower, and other oilseed crops. For use in vehicles that burn diesel, biodiesel is typically blended with fossil diesel fuel (2–30%), but it may also be used in pure form (100% 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, and hence help reduce global warming; 3) can reduce particulate and other harmful emissions for human health; 4) is not toxic and 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 cold starting; 7) crops that are used for production may be grown on marginal lands that may not be 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, we know of no comprehensive or side-by-side comparison of oilseeds in the region. Also, while 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 potential biodiesel crops for Wyoming, namely winter canola, winter Indian mustard, and coriander.

Materials and Methods

Winter canola, winter mustard, and coriander were seeded in October 2010 at the Sheridan Research and Extension Center (ShREC). Nitrogen fertilizer was applied at four different rates to each crop. The trial was re-established in fall 2011. However, canola and mustard did not emerge and had to be reseeded in spring 2012.

Results and Discussion

Due to late planting in fall 2010, the three crops emerged in spring 2011. Mustard emergence was rather sporadic, canola was somewhat better, while most coriander emergence was very good.

Canola and mustard flowered in early June, whereas coriander flowered several weeks later (Fig. 1). A hail storm in July 2011 decimated all plants.

The experiment was replanted in fall 2011. As indicated, canola and mustard did not emerge, which triggered a replanting in spring 2012. Currently, all crops are developing very well.

Crops will be harvested when they reach maturity, plants will be threshed, and seed samples will be analyzed for oil content and fatty acid composition. Results will be posted on the Wyoming Agricultural Experiment Station website and possibly published in a refereed journal.

It is hoped that this preliminary study will provide information to farmers and ranchers in the region who are interested in oilseeds for biodiesel production.

We hope to expand this study with on-farm research and demonstration trials.

Figure 1. Coriander, canola, and mustard trials at ShREC in June 2011 (Photo: Valtcho Jeliazkov).

Acknowledgments

The project was funded by University of Wyoming start-up funds allocated to Valtcho Jeliazkov (Zheljazkov). The author thanks Byron Nelson and Adrienne Tatman for setting up field experiments in 2010 and Dan Smith and Rochelle Koltiska for replanting canola and mustard in 2012.

Contact Information

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Key words: biodiesel, feedstocks, oilseeds

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

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

Introduction

Wyoming is a large producer of coal-bed methane (CBM), a naturally occurring methane trapped in coal seams by water. To facilitate extraction of CBM, water in the coal seams has to be pumped out. This water is designated as coal-bed methane water (CBMW). CBMW quality may vary significantly at different CBM production sites. In general, CBMW is characterized with high pH, high salts and sodium (Na) concentrations, and high sodium adsorption ratio (SAR). Such saline water can affect normal plant growth but also may have significant negative impacts on soil chemical and biological properties.

In Wyoming, CBM production has led to a large amount of CBMW that may be stored in containment ponds, released into rivers and streams, or used for irrigation. Many ranchers and farmers have used CBMW for irrigation of forages, mainly alfalfa or grass/alfalfa forage. However, the long-term effects of irrigation with CBMW on crops and soils are not fully understood.

There are no known published studies on the use of CBMW with low dissolved solids to be used for irrigation of horticultural crops. Native soils differ significantly from growth media used in greenhouse production, which are mostly based on peat and perlite.

The Sheridan Research and Extension Center (ShREC) is in an area with intensive CBM production and subsequent CBMW availability. There are a number of CBM wells near ShREC property. Local ranchers, companies that manage CBMW in the Sheridan area and beyond, as well as the general public would like to see more research on the use of CBMW. There is a need to develop alternative methods of CBMW utilization to reduce environmental pollution and recycle water.

Objectives

The goal of this ongoing research is to generate information for the development of feasible technologies for the use of CBMW in agriculture, with the following specific objectives:

(1) Evaluate CBMW suitability for irrigation of horticultural crops grown under greenhouse conditions,

(2) Evaluate CBMW for irrigation of forages and other field crops.

Materials and Methods

The project is expected to develop into a major program at ShREC. The first step is the assessment of CBMW for irrigation of various crops under controlled environmental conditions. The second step will be the assessment of the most suitable agricultural crops (such as forages, small grains, and vegetables) capable of growing under CBMW irrigation.

Several container studies have been conducted in 2012. These include experiments with Swiss chard, basil, peppers, cabbage, Japanese cornmint, lemongrass, and palmarosa. Tissue samples are being analyzed for accumulation of Na (to test the salinity tolerance) and other tissue compounds that reflect crop quality. The growth medium and soil samples are being analyzed for pH, SAR, and concentration of various nutrients and for soil/growth medium biological properties.

Acknowledgments

The project was funded by University of Wyoming start-up funds allocated to Valtcho Jeliazkov (Zheljazkov). The authors thank Adrienne Tatman, Berva Brock, and Lyn Ciampa for helping with greenhouse experiments and BeneTerra® in Sheridan for providing CBMW.

Contact Information

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Key words: coal-bed methane water, irrigation, horticultural crops

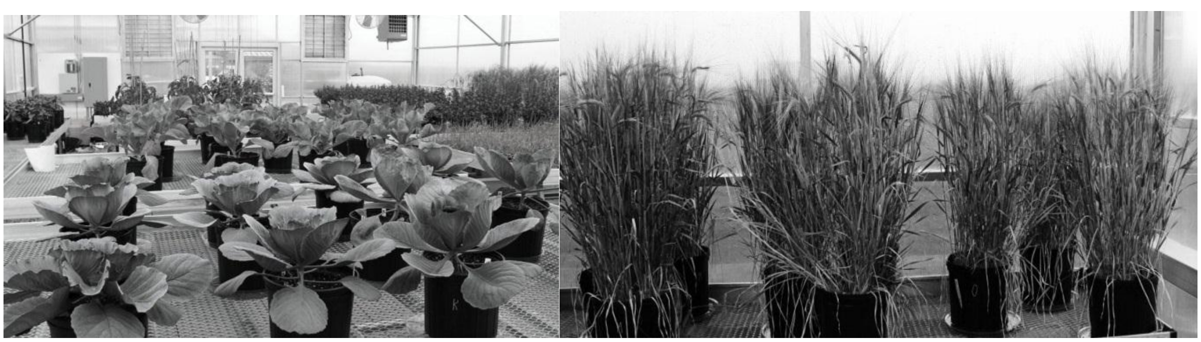

Figure 1. Greenhouse experiments on the utilization of CBMW for irrigation of various horticultural and agronomic crops (Photo: Valtcho Jeliazkov).

Effects of Coal-Bed Methane Discharge Water on Peppermint

V.D. Jeliazkov (Zheljazkov)[1], C.L. Cantrell[2], T. Astatkie[3], E. Jeliazkova[1]

[1]Sheridan Research and Extension Center; [2]U.S. Department of Agriculture–Agricultural Research Service's Natural Products Utilization Research Unit, University, Mississippi; [3]Nova Scotia Agricultural College, Truro, Nova Scotia, Canada.

Introduction

Wyoming is one of the largest energy-producing states in the country and a large producer of coal-bed methane (CBM). To release methane out of coal seams, ground water must be pumped to the surface. The water may then be reinjected into an aquifer or, as is most commonly done, dealt with on the surface. Wyoming is an arid state with relatively inadequate fresh water supplies for irrigation. Hence, some agricultural producers use CBM discharge water for irrigation of various crops, mainly forages. CBM discharge water has various qualities at different locations. Typical issues are high salt content and high sodium adsorption ratio (SAR). There is limited information on the effect of CBM discharge water on various crops, and no known information on how CBM water affects the synthesis and accumulation of plant secondary metabolites, such as essential oils. A controlled-environment container experiment was conducted by the Sheridan Research and Extension Center (ShREC) to address this knowledge gap (Fig. 1).

Objectives

The objectives of this study were to evaluate the effect of CBM discharge water on peppermint productivity, essential oil content, and composition grown in commercially available growth medium.

Materials and Methods

This experiment was conducted in 2011 at ShREC. The effect of CBM water on plant height, fresh herbage yield, oil content, oil yield, oil constituents, and nutrients in the growth medium was measured at the end of the experiment.

All plants were harvested at the same time—flowering. Fresh herbage samples were extracted immediately for essential oil. The oil content was calculated as g of oil per 100 g of fresh peppermint herbage. The extracted oil samples were analyzed for chemical constituents on gas chromatograph.

Results and Discussion

CBM discharge water treatments affected plant height, fresh herbage yields, and oil yields. Growth medium characteristics also changed as a result of CBM water treatments. Overall, the oil quality was within the acceptable range for peppermint and comparable to literature reports. This preliminary study demonstrated that CBM discharge water could be utilized for irrigation of peppermint, a high-value crop produced in the Northwest. However, it is suggested that irrigation with CBM water should be supplemented with other higher quality water for best peppermint yields and quality.

Acknowledgments

The project was funded by the Department of Plant Sciences.

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

Figure 1. Peppermint being irrigated with coal-bed methane discharge water in 2011 (Photo: Valtcho Jeliazkov).

Effect of Distillation Time on Essential Oil Content, Composition, and Bioactivity of Dried Oregano

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Introduction

Oregano (*Origanum vulgare* L.) is an aromatic plant that has been used as a medicinal since ancient times (Fig. 1). Oregano aroma is due to its essential oil, a natural product with wide applications in the food, cosmetics, and other industries. The wide use of oregano essential oil is due not only to its pleasant aroma but also to its proven antimicrobial and antioxidant activities.

Usually, oregano essential oil is extracted using steam distillation. The hypothesis of this study was that the length of the distillation time would affect oregano essential oil composition and antioxidant activity.

Figure 1. Oregano plant (Photo: Valtcho Jeliazkov).

Objectives

The objectives were to evaluate the effect of distillation times (1.25, 2.5, 5, 10, 20, 40, 80, 160, 240, and 360 min) on oregano essential oil yield, composition, and oil antioxidant activity.

Materials and Methods

The experiment was conducted at the Sheridan Research and Extension Center in 2011. In this experiment, we used bulk certified dried leaves of *Origanum vulgare* L. Each sample consisted of 250 g of dried oregano leaves; all distillation times were performed in three replicates. The distillations were conducted using two-liter steam distillation units. The essential oil was analyzed on a gas chromatograph. The antioxidant activity of oregano essential oil was tested using the oxygen radical absorbance capacity oil (ORACoil) method.

Results and Discussion

Statistical analyses were performed to evaluate the effect of distillation time on essential oil content, and the concentration and yield of the following oil constituents: *alpha*-Thujene, *alpha*-Pinene, camphene, l-octen-3-ol, myrcene, *alpha*-Terpinene, para-Cymene, *beta*-Phyllanderene/Limonene, *gamma*-Terpinene, cis-Sabinene hydrate, terpinolene, trans-Sabinene hydrate, borneol, 4-terpineol, carvacrol, *beta*-Caryophylenne, *beta*-Bisabolene, and para-Cymene.

Our results demonstrated that of the distillation times tested, maximum essential oil yields from dried oregano leaves were achieved at 240 minutes. Distillation time altered essential oil composition but not the oil antioxidant activity.

Generally, the concentration of the main oil constituent, carvacrol, rose when the length of the distillation time was increased to 240 minutes. A reverse trend was observed for most of the other oil constituents. Results demonstrated that distillation time must be taken into consideration when comparing reports on oregano essential oil content or composition. A report on our research was published in the June 2012 issue of *HortScience* (go to http://hortsci.ashspublications.org).

Acknowledgments

This project was supported by University of Wyoming start-up funds awarded to Valtcho Jeliazkov (Zheljazkov). We thank Adrienne Tatman for help with extractions.

Contact Information

For additional information, contact Valtcho Jeliazkov (Zheljazkov) at shrec@uwyo.edu or 307-737-2415.

Key words: oregano, *Origanum vulgare* L., essential oil, steam distillation, antioxidant capacity

Extraction Time Affects Essential Oil Yield and Composition of Ponderosa Pine but Does Not Change Oil Antioxidant Activity

V.D. Jeliazkov (Zheljazkov) [1], *T. Astatkie*[2], *V. Schlegel*[3]

[1]Sheridan Research and Extension Center; [2]Nova Scotia Agricultural College, Truro, Nova Scotia Canada; [3]University of Nebraska–Lincoln, Food Science and Technology Department, Lincoln, Nebraska.

Introduction

Ponderosa pine (*Pinus ponderosa* Dougl. ex Laws), also known as western yellow pine, is an important and widely distributed species in Wyoming and other parts of the western United States. The tree provides important shelter and food for a number of wildlife species, while the wood and leaves are sources for various products such as timber and essential oil. The essential oil is used as an aromatic agent in a number of consumer products.

Ponderosa pine oil has shown antimicrobial and antifungal properties; this has contributed to a wide international market for ponderosa pine essential oil. The essential oil is traditionally extracted using steam distillation. Researchers have reported various durations of the distillation time for essential oil extraction from ponderosa pine. It is not known if the length of the distillation time would affect ponderosa pine essential oil yield, composition, or bioactivity. Therefore, a distillation time trial was designed and conducted at the Sheridan Research and Extension Center (ShREC).

Objectives

The objective was to evaluate the effect of distillation times (5, 10, 20, 40, 80, 160, 240, and 360 min) on pine essential oil yield, composition, and bioactivity.

Materials and Methods

To avoid variations in oil content and chemistry due to genetic or other differences, essential oil was extracted from fresh pine needles and small branches of a single tree (approximately 60–70 years old). Each sample included 500 g fresh needles; all treatments were in three replicates. The resulting essential oils were measured and analyzed using a gas chromatograph. In addition, selected oils were analyzed for antioxidative capacity using the oxygen radical absorbance capacity method.

Results and Discussion

Statistical analyses (a one-way analysis of variance) were performed to reveal the effect of distillation time on essential oil yield and the concentration and yield of the following oil chemical constituents: *alpha*-Pinene, *beta*-Pinene, *beta*-Myrcene, *delta*-3-Carene, *d*-Limonene, cis-Ocimene, linalyl anthranilate, *alpha*-Terpinyl acetate, germacrene-D, *alpha*-Muurolene, *gamma*-

Cadinene, *delta*-Cadinene, and germacrene-D-4-ol. The ponderosa pine's main constituents were *alpha*-Pinene and *beta*-Pinene, which generally constituted more than 20 percent of the oil. Generally, the longer distillation time resulted in increased oil yields; the maximum yield was reached at 160 min. Distillation time had significant effect on the concentration of most oil constituents (oil chemical composition), but it did not change the oil antioxidant capacity. In general, the concentration of the major oil constituents (*alpha*-Pinene and *beta*-Pinene) was greater at shorter distillation times and decreased with longer distillation times. The concentrations of most other constituents, however, followed the opposite trend. It is suggested that distillation time can be used to obtain ponderosa pine essential oil with differential chemical compositions, possibly to meet specific market requirements. Results from this study can be used to compare literature reports on ponderosa pine essential oil composition in which different distillation times were used. This report also demonstrated that distillation time must be reported when extracting essential oil from ponderosa pine. A report on our research was published in the June 2012 issue of *HortScience* (go to http://hortsci.ashspublications.org/).

Acknowledgments

This project was supported by University of Wyoming start-up funds. We thank Adrienne Tatman for help with extractions.

Contact Information

For additional information, contact Valtcho Jeliazkov (Zheljazkov) at shrec@uwyo.edu or 307-737-2415.

Key words: ponderosa pine, *Pinus ponderosa*, essential oil, steam distillation, antioxidant capacity

Figure 1. Ponderosa pine tree, and a close-up of pine needles, at ShREC (Photo Valtcho Jeliazkov).

Study on Essential Oil Content, Composition, and Bioactivity of Sagebrush Species in the Bighorn Mountains, Wyoming

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Introduction

Sagebrush includes several species, which are some of the most widely distributed species in Wyoming and other states. For example, according to the U.S. Department of Agriculture distribution map, one of the sagebrush species, big sagebrush (*Artemisia tridentata*), is found in 15 states (Arizona, California, Colorado, Idaho, Massachusetts, Montana, North Dakota, Nebraska, New Mexico, Nevada, Oregon, South Dakota, Utah, Washington, and Wyoming) and two Canadian provinces (Alberta and British Columbia). There is evidence that pronghorn antelope evolved with sagebrush and now browse it extensively. Other large animals, including mule deer and elk, browse sagebrush, which is also consumed by domestic species including sheep. Sagebrush provides cover for many wildlife species. In addition, sagebrush species are used extensively in reclamation of disturbed lands.

Sagebrush species contain significant amounts of aromatic essential oil, which is generally considered toxic. However, the essential oil composition of various sagebrush species and subspecies has not been well characterized.

Objectives

The objective of this study is to evaluate the variation in sagebrush species found in north-central Wyoming's Bighorn Mountains area, and their essential oil content, composition, and bioactivity.

Materials and Methods

In 2011, we conducted a preliminary study in the Bighorn Mountains area to identify the sagebrush species and characterize the essential oils. Samples were collected at elevations ranging from 3,800 to 9,800 feet. Both herbage and soil samples were taken from each collection site. GPS coordinates were recorded, and a picture of each collection site was taken for storage in a digital library. The herbage samples were extracted via steam distillation, and the essential oil content was calculated. Representative samples from the extracted essential oils were submitted for chemical composition by gas chromatography. In addition, samples from each collection site were botanically identified.

Results and Discussion

The samples we collected were identified, and most of them were found to belong to big sagebrush subspecies: *A. tridentata* var. *vaseyana* (mountain big sagebrush), *A. tridentata* var. *wyomingensis* (Wyoming big sagebrush), and *A. tridentata* var. *tridentata* (basin big sagebrush). Of these, the most widespread species was *A. tridentata* var. *vaseyana*.

The extraction of essential oil found that essential oil content within a species and subspecies varied widely. Generally, the essential oil content of sagebrush species and subspecies varied significantly. As expected, the chemical profile of the essential oil also varied within a subspecies. These findings demonstrate the presence of chemotypes (individual plants or populations with differential chemical composition of the essential oil) within sagebrush species.

The antioxidant activity of the essential oils from the species and subspecies also varied significantly. This preliminary study identified for the first time the variability of sagebrush species, their essential oil content, and their composition in the Bighorn Mountains. The research will continue in other parts of Wyoming.

Figure 1. Sampling sagebrush species in summer of 2011 in the Bighorn Mountains (Photo: Valtcho Jeliazkov).

Acknowledgments

The project was funded by University of Wyoming start-up funds and funds from the Department of Plant Sciences awarded to Valtcho Jeliazkov (Zheljazkov).

Contact Information

For additional information, contact Valtcho Jeliazkov (Zheljazkov) at shrec@uwyo.edu or 307-737-2415.

Key words: sagebrush, Artemisia, essential oil, antioxidant capacity

2012 Powell Research and Extension Center Field Day

A. Mesbah[1]

[1]Director, Powell Research and Extension Center.

Introduction

The Powell Research and Extension Center (PREC) is one mile north of Powell on Highway 25 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 one inch of average precipitation.

Employees at PREC include two faculty researchers, a research associate II, a farm manager, two assistant farm managers, and an office associate. PREC personnel conduct research and provide services to benefit the northwestern Wyoming counties of Fremont, Hot Springs, Washakie, Big Horn, and Park—and beyond.

Two hundred of the 220 acres at the PREC are irrigated cropland. Research focuses include agronomic weed control, irrigation, cropping systems, high tunnel production, variety performance testing, transgenic variety response to herbicide treatments, and alternative crops. The center participates in numerous regional research and education projects.

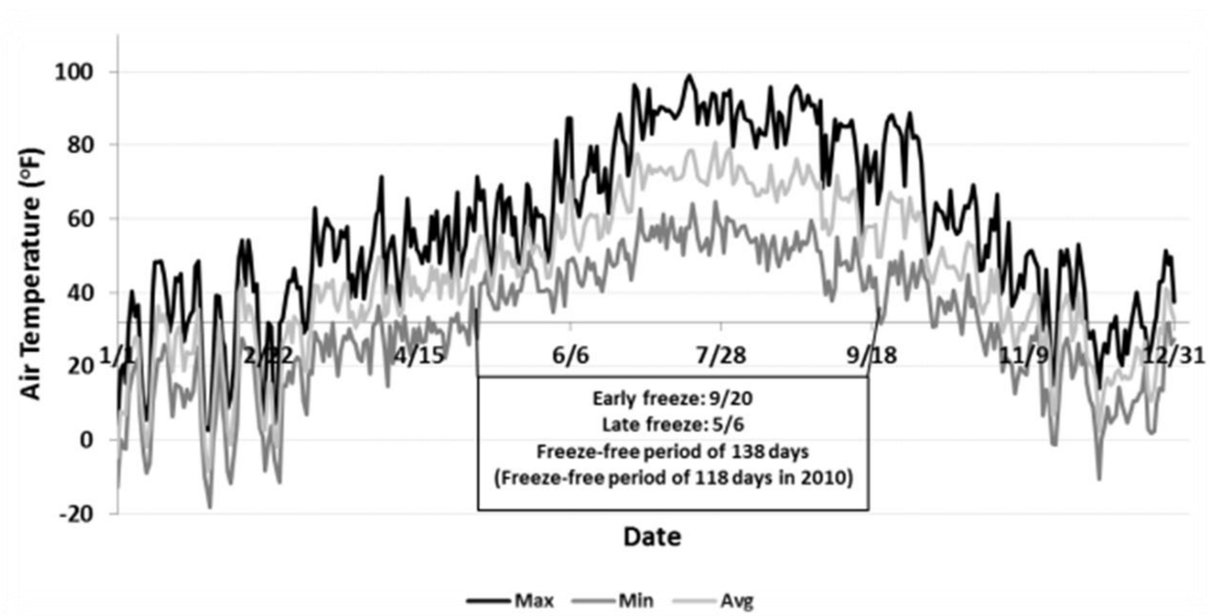

Figure 1. Weather conditions at PREC during the 2011 growing season.

Background Information

The 2011 growing season was characterized as dry, with a total rainfall of 7.4 inches, and with a freeze-free period of 138 days (from May 6 to September 20) (Fig. 1). The wettest months were May (3.07 in), April (1.03 in), and October (1.4 in). June and July, with only 0.24 and 0.05 inches of rainfall, respectively, were dry (Fig. 2).

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

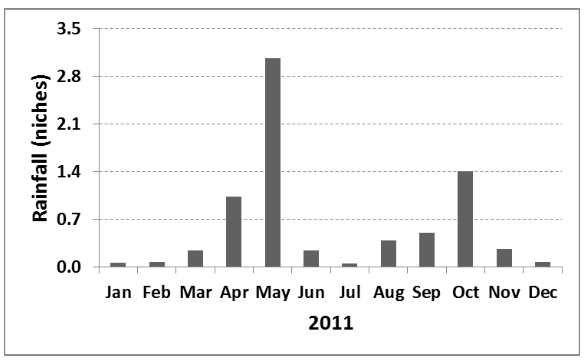

Figure 2. Monthly precipitation recorded at PREC (Wyoming Agricultural Weather Network at www.WAWN.net) during 2011.

Facility Improvements and Acquisitions

Improvements at PREC during 2011 included surface drip irrigation (Fig. 3), constructed with monies from Abdel Mesbah and Axel Garcia y Garcia projects.

Acknowledgments

The dedication and effort of the PREC team is recognized.

Contact Information

For additional information, contact Abdel Mesbah at sabah@uwyo.edu or 307-754-2223.

Figure 3. Installation of surface drip irrigation at PREC.

Subsurface- and Sprinkler-Irrigated Corn

M. Abritta[1], A. Garcia y Garcia[2]

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Introduction

The most important irrigation method in Wyoming is surface, which accounts for approximately 75 percent of the irrigated land in the state. Although its efficiency is generally low, the method is well established; however, more efficient methods, such as sprinklers and drip, are growing in importance in the region. For instance, center pivot and lateral move systems are gradually becoming preferred options among producers in the region. To a lesser extent, drip irrigation methods are also being used for both agricultural and horticultural crops. Among others, some of the advantages of sprinkler and drip irrigation systems are that farmers are in control of their irrigation scheduling, the efficiency of such systems is higher than flooded, and the water-use efficiency is generally higher.

Objectives

The goal of this study was to determine yield differences of corn grown in fields irrigated with subsurface and sprinkler methods.

Materials and Methods

The experiments were conducted at the Powell Research and Extension Center

Figure 1. Corn grown under a lateral move irrigation system at PREC.

(PREC). Corn was planted under lateral move sprinkler irrigation and under subsurface drip irrigation. The Food and Agriculture Organization of the United Nations' FAO-56 crop evapotranspiration (ET) approach (ET-weather based + specific crop coefficient) was used to calculate the amount of water to be applied at each irrigation event. Additionally, results from commercial corn with similar management were used for comparison.

Weather conditions were monitored using a dedicated automated weather station deployed in the field. Soil moisture was monitored using a neutron probe. Yield and sampling for growth analysis were conducted.

Results and Discussion

Our study showed similar yield results when irrigating corn with either subsurface drip or lateral move sprinkler systems. Also, full-irrigated corn was comparatively similar to corn yield from flood-irrigated fields (Tables 1 and 2).

When limiting irrigation, the variation on yield among replications was higher under the subsurface drip-irrigated field than under the lateral move sprinkler field. Under extreme limitation of water (50% of full irrigation), better yield was obtained in the subsurface drip-irrigated field. This may be because water was delivered at 12 inches depth, minimizing losses due to evaporation.

Yield of corn planted under subsurface drip and lateral move sprinkler irrigation systems are as high (or higher) than yield of corn from flood irrigation fields.

Acknowledgments

The project was funded by AgroFresh Inc./ Dow Chemical Co. Thanks to Mike Killen and his crew as well as Randall Violett, Joan Tromble, and our summer helpers for their support.

Contact Information

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Key words: corn, irrigation, water efficiency

Table 1. Average yield of corn grown in a subsurface drip-irrigated field.

Treatment	Average Yield (lb/acre) ‡	STDEV[a]	CV(%)[b]
Full	9305 a	702	8
70% Full	7045 b	537	8
50% Full	5126 c	1175	23
Flooded	9888		

‡Within column, means followed by the same letter are not significantly different at $\alpha = 0.05$.
[a]Standard deviation
[b]Coefficient of variation

Table 2. Average yield of corn grown in a lateral move-irrigated field.

Treatment	Average Yield (lb/acre) ‡	STDEV [a]	CV(%) [b]
Full	9940 a	484	5
70% Full	7231 b	491	7
50% Full	3563 c	479	13
Flooded	9888		

‡Within column, means followed by the same letter are not significantly different at $\alpha = 0.05$.
[a]Standard deviation
[b]Coefficient of variation

Effect of Limited Irrigation on Yield of Sunflower Grown in the Bighorn Basin of Wyoming

M. Abritta[1], A. Garcia y Garcia[2], A. Mesbah[2], M. Killen[2]

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

Introduction

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

Sunflowers are considered moderately tolerant to drought and heat and are well adapted to conditions in several areas in Wyoming. Due to its growing importance in the region, the Powell Research and Extension Center (PREC) started a research program on sunflower in the Bighorn Basin region. We present here some of our results from the 2010 and 2011 growing seasons.

Objectives

The main goal was to determine sunflower's response to limited irrigation.

Materials and Methods

A sunflower variety was planted in a clay loam soil at PREC during the 2010 and 2011 growing seasons using a randomized complete block design with four replicates. The plants were surface irrigated. Irrigation strategies consisted of 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 was applied as usually scheduled by area farmers.

Soil moisture was monitored at different depths on a weekly basis using a neutron probe. Growth analysis and yield and seed size were obtained.

Results and Discussion

Our results showed that little to no irrigation reduces yield of sunflower by as much as 60 percent. During two years of study, we also found that one irrigation for establishment and then starting irrigation at R4 (when the flowers start to open) provided yields slightly below the yield we could obtain from a full-irrigated field. Starting irrigation at R1 (when a miniature floral head is visible) provided inconsistent results (Fig. 1).

While soil moisture in the full-irrigated treatment was as high as 28 percent and as low as 19 percent, soil moisture in the rainfed treatment dramatically changed from around 26 percent at the beginning of the growing season to as low as 10–13 percent at the end of the growing season in the whole soil profile. For both R1 and R4 treatments, soil moisture was reduced to around 15 percent, but then, when irrigation started, the soil profile was replenished, allowing the plant to recover from stress (Fig. 2).

Our results showed that irrigation is necessary to grow a successful sunflower crop in the Bighorn Basin. Irrigation may not be strictly necessary during the vegetative stages of the crop. As a result, producers may be able to save one to two irrigation applications with a direct benefit on their income.

Acknowledgments

The project was funded by the Department of Plant Sciences. Thanks to Joan Tromble, Brad May, and Keith Schaefer for field support.

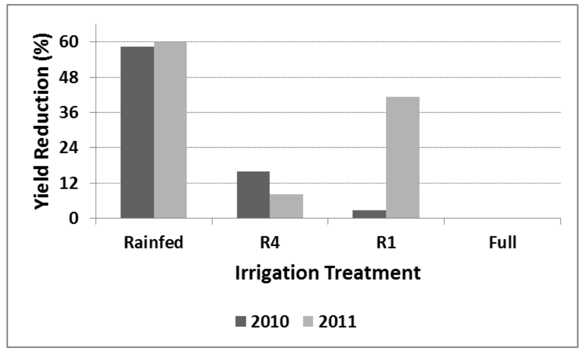

Figure 1. Effect of limited irrigation on yield of sunflower at PREC.

Contact Information

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Key words: sunflower, irrigation, water stress

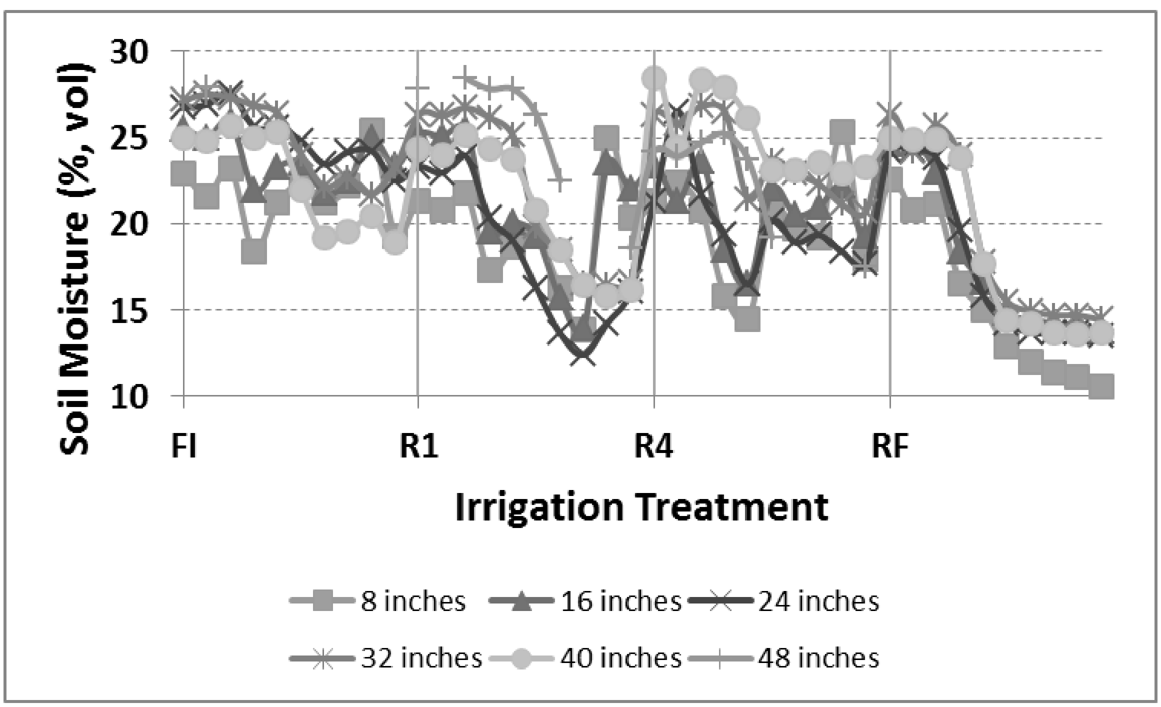

Figure 2. Variation of soil moisture throughout the 2011 growing season at PREC.

Phosphorus Fertility in Sugarbeets

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[1]Powell Research and Extension Center; [2]U.S. Department of Agriculture–Agricultural Research Service, Sidney, Montana.

Introduction

It has often been reported that banding phosphorus fertilizer results in more efficient uptake of this essential nutrient. As a result, it is sometimes recommended that phosphorus application rate be decreased by 30 to 50 percent compared to broadcast rates when fertilizer is banded. There has also been interest in seed-placed 10-34-0 fertilizer applied at between 3 to 5 gal/acre since research from the Red River Valley in the central United States showed that this practice produced yields similar to a conventional broadcast application at much higher rates. There are also additives available, which, when added to phosphorus fertilizers as advertised, reportedly increase phosphorus-use efficiency by inhibiting soil reactions that tie up phosphorus.

With the rising cost of fertilizer, sugarbeet growers are interested in these and other practices that help reduce input costs. However, little field research data are available under modern production practices with current sugarbeet varieties that show whether these practices provide enough of an increase in phosphorus-use efficiency to allow growers to reduce application rates.

Objectives

Objectives are to 1) evaluate the effect of phosphorus fertilizer placement, formulation, and application rate on sugarbeet yield and sugar content, and 2) determine optimum phosphorus rate for banded and broadcast applications.

Materials and Methods

The study was established this year under furrow irrigation at the Powell Research and Extension Center (PREC) to evaluate the effect of liquid and dry phosphorus fertilizer formulations with and without a phosphorus-availability enhancer (Avail) on early-season growth and harvest yield components of sugarbeet. A furrow-irrigated field with medium to low soil-test phosphorus was prepared for planting with conventional tillage practices. Dry monoammonium phosphate (MAP) fertilizer (analysis: 11-52-0) was broadcast in the spring on tilled plots at 0, 30, 60, 120, 180, 240, and 300 lb (P_2O_5)/acre. Broadcast fertilizer was applied to individual plots and incorporated by tillage prior to bedding. Liquid ammonium polyphosphate fertilizer (analysis: 10-34-0; density: 11.65 lb/gal) was banded in the spring at a depth of 3 inches directly below the seed row at the same rates as with MAP. Band application was accomplished using a bedder to which fertilizer injection knives have been added. A low-salt liquid pop-up (analysis: 8-24-0) was applied at 15 lb P_2O_5/acre in the seed row at planting to one complete set of banded phosphorus treatments. This was achieved by using a sugarbeet planter equipped with tubes to distribute the liquid fertilizer to each seed row just ahead of the seed-furrow closer wheels. Seed of a glyphosate-tolerant sugarbeet variety was planted 0.75- to 1.0-inch deep in 22-inch rows. Plots are being irrigated using conventional furrow-irrigation practices, and pests are being controlled using recommended practices.

Plots of 11 by 50 feet are in a split-plot arrangement of a randomized complete block design. Phosphorus formulation is the main plot and phosphorus rate the split plot. Observations concerning differences in growth are being recorded. Plant population is being determined four to five times beginning when the seedlings first emerged and repeated at two- to three-day intervals for 10 days then repeated once more 10 days later. Whole-plant samples were collected in June, two months after planting, by randomly removing six whole plants from each plot. Tops and roots were separated, dried at 60° C, and weighed. Yield (fresh root weight) and quality (root sucrose content and impurities) will be determined from samples harvested in late September or early October.

Results and Discussion

This research was initiated earlier this year, and data collection is underway. Full results will be available by the end of the 2012 growing season.

Acknowledgments

The project is funded by the Western Sugar Cooperative Grower Joint Research Committee. Appreciation is extended to PREC station crew, technical personnel, and others who play an integral role in our research activities.

Contact Information

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Key words: sugarbeet, fertility, phosphorus

Evaluation of Mechanical Incorporation Equipment for Dry Bean Herbicides

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

Introduction

Dry Bean producers in Wyoming often struggle to control common weeds, such as nightshade species, found in dry edible bean fields. Nightshade causes severe harvesting issues and can threaten bean seed certification due to strict Wyoming Seed Certification Service standards. Many herbicides used for control of nightshade species in the dry bean crop are applied before planting and require mechanical incorporation to be effective. Some growers experience adequate control while others struggle and are required to hire labor to remove nightshade prior to harvest. One possible explanation for poor control is inadequate incorporation of the herbicide into soil.

Objectives

The objective of the study is to compare nightshade control from Eptam® plus Sonalan® when incorporated with five different field implements.

Materials and Methods

A field study was established at the Powell Research and Extension Center in 2011 and is underway again in 2012. Eptam plus Sonalan was applied in mid-May and immediately incorporated with one of five different implements, with one or two passes. The trial was then bedded, pre-irrigated, and planted to dry beans.

Results and Discussion

In general, weed control was the worst when a roller harrow was used to incorporate the herbicide (Table 1). Two passes of the incorporation implement only increased weed control significantly more than one pass when the roller harrow was used. However, there was a slight trend for better redroot pigweed control with two passes compared to one pass of several implements. Additional data will be collected in 2012 to determine whether this trend is actually due to the incorporation or variability in the data. The Vibra Shank with points also tended to provide greater redroot pigweed control compared with the Vibra Shank with sweeps. This effect is probably not due to the points vs. sweeps but rather the difference in soil mixing caused by depth or action of the implement. Video of each implement as it is running through the field can be viewed online at:

Vibra Shank with sweeps: http://youtu.be/lnjVweAIgd4

Vibra Shank with points: http://youtu.be/eCHf43NqrSw

S-tine: http://youtu.be/uyOV20M_MWw

Disk: http://youtu.be/bxBBl5BmE-E

Roller harrow: http://youtu.be/UFTYpBLT_Yc

Acknowledgments

This research is funded by the Wyoming Crop Improvement Association and Wyoming Seed Certification Service.

Contact Information

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Key words: dry beans, weed control, nightshade, incorporation

Table 1. Weed control with Eptam plus Sonalan as influenced by mechanical incorporation implement and number of incorporation passes.

	Weed control (%)							
	Redroot pigweed		Green foxtail		Wild buckwheat		Hairy nightshade	
Implement	1-pass	2-pass	1-pass	2-pass	1-pass	2-pass	1-pass	2-pass
Vibra Shank with points	96	99	100	100	93	91	94	92
Vibra Shank with sweeps	93	93	100	100	91	90	90	93
Roller harrow	80	90	96	99	65	78	99	98
S-tine with points	97	98	100	100	96	95	98	98
Disk	95	99	100	100	94	98	93	99
LSD (0.05)	---- 6 ----		---- 3 ----		---- 11 ----		---- 8 ----	

2011 Foundation Seed

M. Moore[1], M. Killen[2], B. May[2], K. Schaefer[2]

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

Introduction

The Wyoming Seed Certification Service (WSCS), aside from being charged with providing seed certification services for the state, also produces and sells foundation-class certified seed of a limited number of crops and varieties. The crops and varieties that are produced are dictated by the benefits to, and needs of, Wyoming seed producers, but seed producers in the region also benefit. Various methods and locations are utilized to produce, condition, and distribute foundation seed offered for sale by this program, including production on University of Wyoming research and extension centers and under contract with Wyoming producers and seed conditioners. Income from seed sales funds this effort, and income is also provided to production cooperators. Seed source location of varieties and crops not offered by the WSCS is also provided upon request. In the case of foundation-class seed from other states, orders are placed on behalf of Wyoming seed producers, with billing and shipping services provided.

Foundation seed is, as the name implies, the foundation for future generations of seed, culminating in seed used for commercial crop production. Wyoming's seed industry cannot function without quality seed stock, which is first and foremost defined as seed that is true to variety. It must also meet or exceed foundation-class seed standards for other crop seed, weed seed, and inert matter contamination. While there are often tolerances for those contaminants, seed stock with no weed seed or other crop seed is the goal. Two examples of varieties that are important to the state but unavailable from other sources or exceedingly expensive due to shipping costs include 'Buckskin' winter wheat and 'Shoshone' sainfoin. 'Buckskin' is an older variety, but it is still planted on more acres in Wyoming than any other winter wheat variety. 'Shoshone' is a University of Wyoming release, and thus we are charged with maintaining seed stock for the life of the variety.

Foundation seed currently offered for sale by this program includes 'Maverick' pinto bean, 'Shoshone' sainfoin, 'Lander' alfalfa seed, 'Buckskin' winter wheat, 'Oahe' intermediate wheatgrass, 'Monida' oats, and 'Powell' oats.

Objectives

The objectives are to produce and sell foundation-class certified seed of crops and varieties that benefit, and answer the needs of, Wyoming seed producers.

Materials and Methods

During the 2011 growing season, foundation seed of two varieties of oats was produced at the Powell Research and Extension Center (PREC) by PREC staff. Stock seed of 'Monida' and 'Powell' oats was purchased from the Idaho Foundation Seed Program, and five acres of each variety were planted. Off-type oat plants as well as other crop and weed contaminants were removed by hand during the growing season by PREC and WSCS staff. Twenty thousand pounds of 'Monida' and 17,000 pounds of 'Powell' were harvested and conditioned. They were notably the first crops to be conditioned and bagged in the recently completed foundation seed building at PREC. Seed conditioning and bagging were done by Brad May and Keith Schaefer under the supervision of Mike Moore and Mike Killen. Limited amounts of both varieties were bagged and palletized to meet grower needs this spring, and the remainder of the seed was stored in metal tote boxes, which protect from rodent damage.

In addition to the oat production, a field of foundation-class 'Delaney' sainfoin was established in 2011 west of Powell by Corey Forman, who is under contract with the WSCS to produce foundation seed. Seed stock was provided by the Montana Foundation Seed Program and the Bridger Plant Materials Center. Foundation seed should be harvested in 2012 and available for sale in 2013.

Results and Discussion

Seed tests on both seed lots by the Wyoming Seed Analysis Laboratory indicated zero weed or other crop seed content, with purities above 99.92 percent and germination of 98 percent. Both seed lots exceed Wyoming standards for foundation seed and meet the goal of this program to provide quality seed stock to Wyoming seed producers. Sufficient seed of both varieties was produced to meet predictable needs for the next three to four years.

Acknowledgments

The authors gratefully acknowledge the foundation seed growers and the Wyoming Agricultural Experiment Station for contributions and continued support.

Contact Information

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

Key words: foundation seed, seed cleaning, certified seed

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

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

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 many 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 plant that does not cause toxicity problems to animals), drought tolerant, and winter hardy tall fescue system in these pastures may have potential to increase productivity, quality, sustainability, and profitability. Tall fescue is one of the most productive cool-season grasses 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 objectives of this project are to identify novel tall fescue cultivars/lines that will be suitable for growing in the western mountain regions, specifically the Bighorn Basin, and generate information on growth, forage yield, and seed yield that will benefit local growers as well as growers throughout Wyoming and perhaps beyond.

Materials and Methods

The study 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 the primary treatment in 22-inch rows with four replications. There were also two additional treatments consisting of three nitrogen (N) levels (0, 100, and 150 pounds N/acre) and three clipping times (none, early, and late). 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 and 2011, N was applied in two splits: one in the early growth stage and the second in late growth after the first cut for both studies. For forage yield, plots were mechanically harvested twice in both 2010 and 2011. Plots for seed production in both locations were also harvested in 2010 and 2011.

Results and Discussion

For all cultivars/lines, the lowest forage dry matter (DM) yield was associated with the control treatment (no N), while a significant DM yield increase (2–3 fold) was obtained from the 50- and 100-pound N/acre treatment (Table 1). A similar trend was observed for the seed production study in both locations; however, clipping time had significant effects on seed yield for all cultivars/lines. Late clipping consistently produced the lowest seed yield compared to no or early clipping, while early clipping produced the greatest seed yield. The highest seed 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 (data not presented). Data collected in 2011 showed a similar trend (data not shown), and reporting of expected outcomes will be ongoing.

Acknowledgments

The study is funded by the Wyoming Crop Improvement Association. We acknowledge Associate Professor Malay Saha with The Samuel Roberts Noble Foundation and plant geneticist Blair Waldron and agronomist Rob Smith with the U.S. Department of Agriculture's Agricultural Research Service in Utah for providing seeds of tall fescue cultivars/lines.

Contact Information

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Key words: novel tall fescue, forage yield, seed yield

Table 1. Effect of N on forage DM yield [pound (lb)/acre] of tall fescue cultivar/line under irrigation at PREC and 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

Effect of Water Stress on Alfalfa Establishment

C. Carter[1], A. Garcia y Garcia[2], A. Islam[1]

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

Introduction

Alfalfa, the most valuable crop in Wyoming, is produced under both irrigated and rainfed conditions with higher yield in irrigated lands compared to dryland. Understanding alfalfa plant response to water shortage is essential to establish proper on-farm water management strategies. Research has shown that alfalfa yield is greatly affected by limited water, especially if experienced during the establishment year.

Objectives

The main goals of this study are to determine the impact of limiting irrigation water on alfalfa growth and yield during establishment.

Materials and Methods

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

Variables measured include water use, soil moisture, and yield. Soil moisture is continuously monitored using a Watermark system, which transmits data to a data logger via radio communication devices (Fig. 1). Environmental conditions are monitored using an automated station as part of the Wyoming Agricultural Weather Network (www.WAWN.net) located near the experimental area.

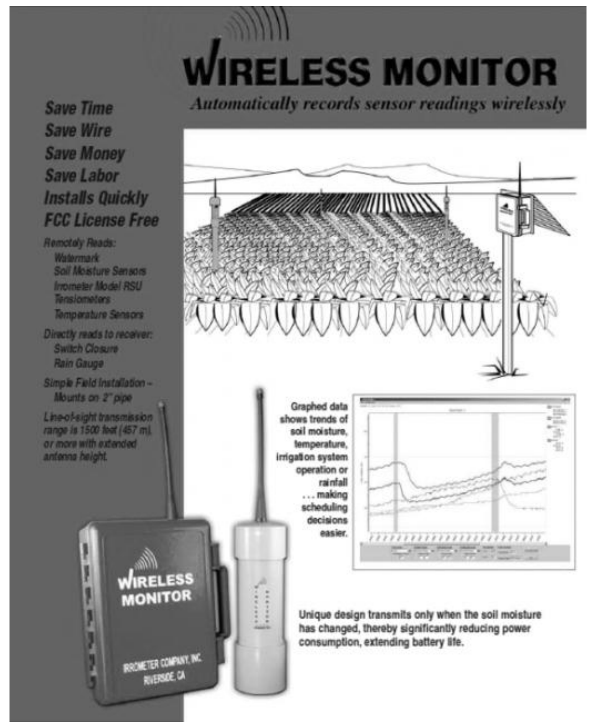

Figure 1. Watermark system used to monitor soil moisture at the experimental field at PREC.

Results and Discussion

Weather conditions during the 2011 growing season were dry and cooler than normal. Alfalfa was clipped once, on August 30, 2011. Our results from the only clip conducted showed that limiting irrigation drastically affected alfalfa yield (Fig. 2)

During establishment (first year), the variety 'Shaw' performed better under limited water than the other varieties. Yield gap due to lack of water was as high as 600 lb/acre for variety 'Mountaineer' and as low as 300 lb/acre for 'Shaw' (Fig. 3).

Our results showed that during establishment, limiting water to alfalfa could result in yield decrease. In areas where water is limiting, one should choose drought-tolerant varieties to reduce the negative effect of limiting water on yield.

Acknowledgments

The project was funded by the Wyoming Agricultural Experiment Station Competitive Grants Program (WYO-462-11). Thanks to Mike Killen and his crew as well as Randy Violett and Joan Tromble for their support with this study.

Contact Information

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

Key words: irrigation, water shortage, alfalfa

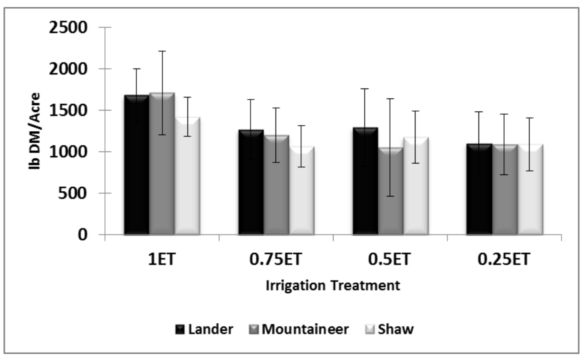

Figure 2. Effect of limiting irrigation on yield of alfalfa (first clip) at PREC.

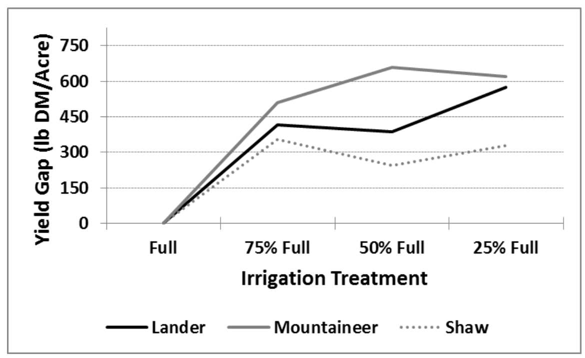

Figure 3. Yield gap of alfalfa due to limiting water at PREC.

Tomato Production Inside and Outside High Tunnel

A. Mesbah[1], A. Garcia y Garcia[2], S. Frost[3]

[1]Powell Research and Extension Center; [2]University of Wyoming Extension.

Introduction

High tunnel operations have been viewed by many as a means to diversify and improve farm income. Growers are trying to take advantage of vegetable crop production, which, in general, has higher return per unit area than agronomic crops. In Wyoming, warm-season crops, such as tomatoes, usually don't mature until late August or early September and have a very short "harvest window" before frost. However, research shows that tomatoes can mature as much as four weeks earlier in high tunnels, and the yield and quality are often far superior. In addition, high tunnels can greatly aid in the control of diseases and in reducing common vegetable pest problems.

Objectives

The objectives are to evaluate new releases of short-growing season tomato cultivars and compare organic to inorganic production inside and outside high tunnels.

Materials and Methods

Several trials were conducted inside and outside high tunnels at the Powell Research and Extension Center (PREC) to evaluate the performance of four varieties of tomato grown under two fertility regimes (organic and inorganic). Planted were three determinate varieties (‘Sunbrite’, ‘Legend’, and ‘Bush Goliath’ hybrid) and one indeterminate variety (‘Peron Sprayless’). Indeterminate (vining) varieties bear fruit over the course of a season, while determinate (bush) varieties bear their crop all at once. The experimental area was divided into two halves—one half was fertilized with manure and the other half with conventional nitrogen (urea) and incorporated into the soil with a hand-pushed rototiller.

Figure 1. Irrigation scheduling using tensiometers.

Tomato cultivars were first planted in the greenhouse April 28 and then transplanted into the high tunnels May 20 and outside the high tunnels May 27. All cultivars were arranged in a randomized complete block design. A drip irrigation system with spaghetti tubing was used to irrigate the plants. Tensiometers were installed at 6- and 12-inch depths to monitor soil moisture and manage irrigation (Fig. 1). Plots were kept weed free by hand weeding.

Results and Discussion

There was significant difference between varieties, inside/outside, as well as inorganic/organic (Table 1). With all four varieties, production inside the high tunnel was far higher than outside. Similarly, inorganic production was higher than organic except for 'Bush Goliath' hybrid grown inside the high tunnel, which was equal. Of the four varieties researched, three ('Sunbrite', 'Peron Sprayless', and 'Legend') ripened earlier in the high tunnel (last week of July) as compared to the outside (mid-August). Bush Goliath hybrid was a late-producing variety (mid-August) under high tunnel. Legend produced more fruits per plant but a smaller fruit size compared to the others. The best tasting and most aesthetically pleasing fruit came from Sunbrite and Peron Sprayless grown inorganically under the high tunnel. The last harvest of tomatoes in the field was September 20. Tomatoes in the high tunnel survived until October 18. The high tunnel extended the late season by at least four weeks.

Table 1. Performance of four tomato cultivars.

Variety	Fertility	Inside Yield	Outside Yield
	(regime)	(lb/plant)	
Sunbrite	Inorganic	25	6
	Organic	10	5
Peron Sprayless	Inorganic	22	3
	Organic	14	2
Legend	Inorganic	23	3
	Organic	15	2
Bush Goliath Hy	Inorganic	17	2
	Organic	17	1
LSD (0.05)	--	4.3	1.7

Acknowledgments

The project was funded by the Wyoming Department of Agriculture. Appreciation is extended to Bob Prchal for assistance.

Contact Information

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Key words: tomato, high tunnel

Fertilizing Flood-Irrigated Spring Wheat for High Protein

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Introduction

Producing wheat with protein levels above the 14-percent cutoff for price premiums requires balance among yield-determining moisture and nutrients. Wheat utilizes nitrogen (N) to produce biomass and grain to the point where yield is constricted by moisture or other nutrients. It then uses additional N to create protein. Optimizing yield and protein content under irrigation requires precise amounts of water to constrain yield so that excess N is diverted to protein. Irrigating for maximum yield makes achieving 14-percent protein difficult. With unlimited water, wheat requires a huge amount of N to reach its yield potential. None is left over for protein development. The higher the yield, the more N is required to change protein content. But controlling irrigation timing and application rates can be difficult for furrow-irrigated crop production.

Objectives

Our objective was to evaluate options for growing high-protein wheat with current irrigation practices.

Materials and Methods

We conducted the study on furrow-irrigated, deep clay loam soils at the Powell Research and Extension Center during summer 2011 on 'Alzada' durum planted at 125 lbs/acre and 'Volt' hard red spring (HRS) wheat planted at 100 lbs/acre. Both were planted 1.5 inches deep at a row spacing of seven inches. We supplemented residual soil N based on an early spring soil test to achieve 1.5, 2.3, and 3.2 lbs N/bushel of our 120-bushel/acre yield goal, which amounts to 100, 200, and 300 lbs of N/acre, respectively, on 9- x 20-foot plots replicated four times (128 total plots). Nitrogen was applied as follows:

1. Urea (46% N; 78¢/lb N) all preplant-incorporated (PPI);
2. ESN all PPI (44% N polymer-coated, enhanced-efficiency urea, Agrium Inc.; 88¢/lb N);
3. ½ ESN +(½ from urea + residual) all PPI;
4. Split urea PPI + liquid urea-ammonium-nitrate (UAN; 32% N; 87.5¢/lb N);
5. Late-season urea broadcast at tillering.

Prices are from the Big Horn Co-Op Marketing Association in Powell on May 30, 2012. We also evaluated plots with no added N. We irrigated HRS six times and durum five times. Phosphorus was applied at 25 lbs/acre as MAP.

Results and Discussion

Grain from five of the 128 plots attained 14 percent protein, three of which occurred in

ESN PPI applied to HRS wheat at 300 lbs per acre, which resulted in the only treatment with average protein content over 14 percent. ESN showed promise for durum wheat as well, resulting in significantly higher protein than other treatments, but only at the highest N rates (Fig. 1). Grain protein content responded to N rate across most of the treatments, while grain yield leveled off at 100 lbs added N/acre (1.5 lbs N/bushel yield goal) in most treatments (Fig. 1). Our results indicate that growers who furrow irrigate six times per year stand the best chance of producing wheat with protein levels greater than 14 percent by planting HRS wheat and incorporating N fertilizer prior to planting to provide about 416 lbs N per acre (fertilizer + residual), with ESN providing at least 70 percent of the available N. This amounts to 3.4 lbs N/ bushel. These values are based on total N available (residual soil N plus fertilizer N). Reducing irrigation may be more cost effective. This way yield N requirements would be met sooner, leaving more N for protein. Nonetheless, the enhanced-efficiency fertilizer ESN shows promise for wheat with protein levels in excess of 14 percent.

Acknowledgments

Funded by the Wyoming Agricultural Experiment Station.

Contact Information

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Key words: wheat, fertilization, protein

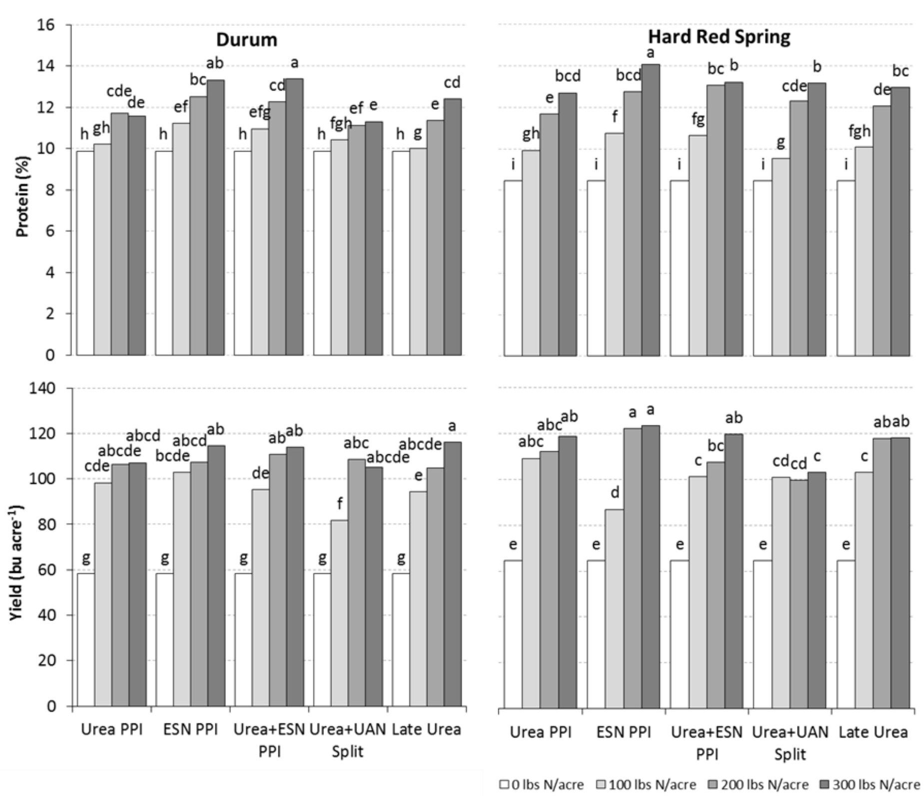

Figure 1. Average protein content and yield for each treatment (four plots per treatment). Bars without the same letter above them represent significantly different values at 95 percent confidence. PPI = preplant-incorporated.

Reducing Hearing Loss in Ranchers and Farmers

R.R. Weigel[1,2]

[1]Wyoming AgrAbility; [2]Family and Consumer Sciences Department.

Introduction

Nearly 75 percent of all ranchers and farmers suffer from some hearing loss, compared with one in 10 of the general public that develop hearing loss, according to the New York Center for Agricultural Medicine and Health. Hearing loss is prevalent among adults and is the third most common physical condition.

Hearing loss can happen gradually, in fact so gradually that it may not be noticeable to the person who is losing his or her hearing. It can also be caused by both loudness and the length of time a person is exposed to loud noises.

Exposure to noise above 85 decibels (dB) can cause hearing loss and ringing in the ear (tinnitus) (Fig. 1). A dB is the unit used to measure the loudness of sound. For example, a chain saw has a sound intensity of about 109 dB. Without proper hearing protection, running a chain saw for only two minutes can cause hearing damage.

Hearing loss in adults can be inherited from parents, or it can be acquired from illness, ototoxic (ear damaging) chemicals or medications, exposure to loud noise, tumors, head injury, or the aging process. The bad news about hearing loss is that it is permanent. Once it is lost, it can't be recovered. But there is good news: it is easy to protect against.

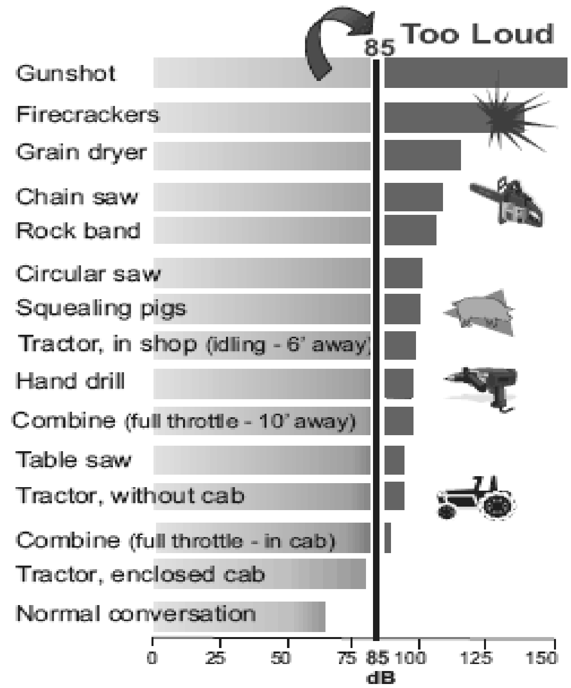

Figure 1. Decibel level of common sounds.

Objectives

Participants at the Wyoming Agricultural Experiment Station's field days will:

- understand the causes of hearing loss in agriculture and adult life,
- learn ways to reduce the potential for developing hearing loss,
- view personal protective equipment that helps minimize the development of hearing loss,

- receive resource materials that help agriculturists protect their hearing.

Materials and Methods

A brief presentation will be given on reducing hearing loss in ranchers and farmers, including ranch and farm youths. A display on hearing protection will be included. In addition, written information from the National Institute for Occupational Safety and Health (NIOSH) and the National Agriculture Safety Database (NASD), along with complimentary ear plugs from Wyoming AgrAbility, will be available for participants.

Results and Discussion

The first step is to recognize that many sounds on the ranch or farm can be damaging. If any noise is so loud that people must shout to be heard, or if the noise hurts your ears, makes your ears ring, or leaves you slightly deaf for several hours after exposure, it is too loud, and steps should be taken to protect yourself. Eliminating the noise is the perfect solution, but since that is not always possible, hearing protection devices (HPD) such as ear plugs and/or ear muffs should be worn.

Other steps to minimize the impact of noise can include:

- reduce equipment noise by replacing worn, loose, or unbalanced machine parts;
- rearrange workshop layout to dissipate noise;
- limit time exposed to noise in any one day—rotate tasks;
- make hearing protection convenient—keep ear plugs or muffs close by;
- keep young people away from noisy areas and equipment as they are more vulnerable due to still developing auditory systems.

Because ranchers and farmers are continually exposed to loud noises, they should have their hearing tested regularly. An audiogram will reveal signs of hearing loss so steps can be taken to reduce exposure and stop further hearing damage.

Acknowledgments

Wyoming AgrAbility: Cultivating Accessible Agriculture is funded by the U.S. Department of Agriculture National Institute of Food and Agriculture under agreement 2010-41590-20741. Information in this article comes from NIOSH, NASD, Kansas State University, and Wyoming AgrAbility: Cultivating Accessible Agriculture.

Contact Information

For additional information, contact Randy Weigel at weig@uwyo.edu, 307-766-4186, or toll-free 866-395-3985.

Key words: hearing loss, hearing protection devices, noise levels

2011 Dry Bean Performance Evaluation

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

Introduction

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

Objectives

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

Materials and Methods

The experiment was conducted at PREC. Weed control consisted of a preplant-incorporated treatment of 2 pints Sonalan® and 14 ounces 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 June 3, 2011. 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 followed by an exceptional fall allowed all of the entries to reach maturity. A hail event at harvest negatively affected some of the later-maturing lines. Yields across entries averaged 2,725 pounds per acre. Use caution in assessing this data, as it is only from one growing season.

Contact Information

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Key words: dry beans, variety trial

Table 1. 2011 Dry Bean Performance Evaluation

Name	Market class	Yield lbs./A	Seeds per pound	50% Bloom days after planting	Pod Maturity days after planting
Zorro	black	3078	2094	58	95
Eclipse	black	2589	2329	57	96
T-39	black	2266	2432	57	96
UCD 0801	cranberry	2417	877	55	98
Bellagio	cranberry	2229	875	54	94
Majesty	drk. red kidney	2753	700	55	93
Coyne	great northern	2947	1190	54	83
OAC Inferno	lt. red kidney	2709	788	55	98
CELRK	lt. red kidney	2465	799	53	86
Avalanche	navy	2961	2294	57	94
Rexeter	navy	2679	2425	57	99
Indie	navy	2405	2472	58	91
T-9903	navy	2036	2090	55	93
ND307	pinto	3506	1138	56	96
Lariat	pinto	3484	1118	59	96
ND020351-R	pinto	3286	1244	56	92
Max	pinto	3223	1060	54	79
PT9-6	pinto	3193	1305	55	95
PT8-6	pinto	3167	1092	54	90
Lucas	pinto	3148	1153	55	86
Maverick	pinto	2962	1226	56	93
Stampede	pinto	2922	1165	58	96
Quincy	pinto	2777	1086	54	83
CO55646	pinto	2625	1143	56	86
Odyssey	pinto	2563	1145	53	85
IP08-2	pinto	2493	1383	56	91
Croisant	pinto	2472	1336	55	90
IP09-3	pinto	2447	1065	56	94
Sequoia	pinto	2398	1306	54	89
Othello	pinto	2388	1168	53	78
PT8-15	pinto	2182	996	54	83
Apache	pinto	2127	1210	54	83
Mean		2725	1366	55	91
CV		19.25	5.09	2.71	2.99
LSD		737	98	2	4

2011 Sunflower Variety Strip Test

M. Killen[1], B. May[1], K. Schaefer[1]

[1]Powell Research and Extension Center.

Introduction

Variety performance evaluations conducted by the Wyoming Agricultural Experiment Station (WAES) are a continuous and ongoing program.

Objectives

Testing of Dahlgren & Company, Inc., sunflower varieties was conducted to help growers select varieties adapted to the region.

Materials and Methods

The experiment was at the Powell Research and Extension Center (PREC) during 2011. The soil was a Garland clay loam (fine, mixed, mesic; Typic Haplargid) and had a cropping history of: 2010–corn, 2009–barley, and 2008–beans. The soil was fertilized for a yield goal of 3,000 lbs/acre. Fertilizer was applied May 3 at the rate of 140 lb/acre N and 50 lb/acre P_2O_5 in the form of urea (46-0-0) and diammonium phosphate (11-52-0).

Four sunflower varieties were planted in 1.35-acre strips June 4. The seeding depth was 2 inches. Weeds were controlled by a pre-plant incorporated application of ethalfluralin (2 pt Sonalan®). Furrow irrigations were May 5, July 7, July 18, July 29, August 11, August 22, and August 31.

Measurements included plant population, flowering date, test weight, percent moisture, seed size, and yield. Plots were harvested November 11 using a Case IH 1440 combine.

Results and Discussion

Rain in May delayed planting until June 4. Some white mold (stalk and head rot) was observed. Results are presented in Table 1. The highest yielding entry was 9569 at 3,207 lbs/acre, while the lowest was 9512 at 2,215 lbs/acre after dockage. 9512 had higher foreign matter dockage and moisture shrink than other entries. Also, 9512 had a lower plant population. Results are posted annually online at: www.uwyo.edu/plantsciences/uwplant/trials.html

Acknowledgments

Appreciation is extended to PREC staff for assistance during 2011. Dahlgren's cooperation is appreciated.

Contact Information

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

Key words: sunflower, variety trial

Table 1. PREC 2011 sunflower variety strip test.

	Dahlgren Variety			
	9569	***9599***	***9512***	***9579***
Plants/acre	15,744	15,744	13,070	16,338
Flowering Date	6-Aug	7-Aug	3-Aug	5-Aug
Moisture %				
10/10/2011*	30.0	38.0	26.0	33.0
*oven method				
10/10/2011	34.3	38.5	27.0	47.2
10/27/2011	13.2	17.8	14.4	12.5
11/11/2011**	13.6	13.8	15.2	13.7
**harvest date				
Test weight lb/bu				
by UW	20.6	18.2	19.7	18.3
Dahlgren	21.4	19.1	20.9	19.8
Yield				
Dirt lbs/acre	3649	3442	2918	3324
FM%	5.3	4.6	13.3	6.9
Moisture Shrink	6.8	7.4	10.8	6.8
Total Dock	12.1	12.0	24.1	13.7
Total lbs/acre	3207	3029	2215	2869
Seed Size				
over 23/64	36	60	82	96
over 22/64	48	66	84	94
over 20/64	64	73	83	92
over 14/64	67	80	90	95

Confection Sunflower Variety Trial at PREC

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

[1]Powell Research and Extension Center.

Introduction

Researchers at the Powell Research and Extension Center (PREC) have been conducting trials on confection sunflower as an alternative crop for Wyoming's Bighorn and Wind River basins since 2007. Since then, many growers have become interested in growing sunflower in northwest Wyoming. Therefore, more research is needed concerning cultural practices such as variety selection, planting dates, and irrigation.

Objectives

Our objectives were to evaluate several confection (non-oil) sunflower varieties for adaptability and yield response.

Materials and Methods

This study was conducted at PREC. The experimental site was fertilized with 120 lbs/A nitrogen and 50 lbs/A phosphorus. A pre-planting herbicide approach was taken using 2 pts/A of ethalfluralin, which was tank-mixed with 1 pt/A of pendimethalin. This was incorporated into soil with the fertilizer using a Brillion roller harrow. Planting was accomplished using a John Deere Maximerge 7200 planter equipped with corn plates in 22-inch rows. The resulting stand had an average spacing of 15 inches between plants within the row for a population of 19,000 plants per acre. Irrigation was accomplished using gravity flow gated pipe on 22-inch furrows. Varieties were arranged in a randomized complete block design with four replications. Ten feet of the center row of each plot was hand-harvested, dried, and thrashed using an ALMACO thrashing machine. Seeds were cleaned and weighed. A sample of clean seed was tested using a DICKEY-john Corporation GAC® 2100b analyzer at the Wyoming Seed Analysis Laboratory near Powell to get a test weight and average moisture content.

Results and Discussion

All of the varieties flowered within two days of each other. There was no insect or disease damage observed throughout the growing season. The average yield ranged from 2,329 to 3,269 lbs/A depending on the variety (Table 1). These yields make confection sunflower production an economically viable crop for the Bighorn and Wind River basins.

Table 1. Sunflower variety performance

Variety	Yield lbs/A	Test wt*
Dahlgren 9569	2750	21
Dahlgren 9579	3269	22
SS38A	2863	24
2215	2475	22
2216	2329	22
2217	2521	22
LSD (5%)	205	NS

* The test weight was calculated at an average moisture of 7.6 percent.

Acknowledgments

Partial financial support was provided by the National Sunflower Association. Appreciation is extended to PREC station crew, technical personnel, and others who play an integral role in our research activities.

Contact Information

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Key words: confection sunflower, variety testing

2011 Spring Barley Variety Performance Evaluation

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

[1]Powell Research and Extension Center.

Introduction

Variety performance evaluations conducted by the Wyoming Agricultural Experiment Station (WAES) are a continuous and ongoing program. In cooperation with the Western Regional Spring Barley Nursery and private seed companies, the WAES evaluates a wide range of germplasm.

Objectives

Testing of spring barley varieties was conducted to help growers select varieties adapted to the region.

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.

The experiment was at the Powell Research and Extension Center (PREC). The soil was a Garland clay loam and had a cropping history of: 2010–beans, 2009–barley, and 2008–beets. Fertilizer was applied March 28 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). On April 5, 42 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 per acre. Weeds were controlled by post application of a tank mixture of bromoxynil, 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, respectively, on June 4. Furrow irrigations were April 25, June 9, June 25, July 7, and July 20. Subplots, 5.3 by 8 feet, were harvested August 10 using a plot combine.

Results and Discussion

Results from 2011 are presented in Table 1. The highest yielding malting barley entry was 'Merit' at 151.8 bu/acre, while the highest yielding feed/food entry was 2004NZ151 at 169.6 bu/acre.

Acknowledgments

Appreciation is extended to PREC staff for their assistance. Riverland Ag Corporation, WestBred, and Canterra Seeds provided entries for testing.

Contact Information

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Key words: barley, variety trial

Table 1. Agronomic performance of spring barley genotypes grown at PREC during 2011.

Variety	Row Type	Grade	Grain Yield (bu/acre)	Test Weight (lb/bu)	Plump 6/64 (% above screen)	Plump 5.5/64 (% above screen)	Plant Height (inches)	Heading Date	Lodging (1-9)
				Malting					
Merit	2	malting	151.8	47.5	86.1	94.9	38.1	3-Jul	2.3
2B04-0175	2	malting	149.9	50.5	95.0	98.2	41.1	30-Jun	1.3
ND22421	6	malting	149.9	49.2	97.1	99.1	38.2	26-Jun	1.3
2B06-0929	2	malting	149.1	49.1	95.5	98.3	37.6	29-Jun	1.3
2ND26333	2	malting	145.5	50.4	97.9	99.1	36.8	27-Jun	1.0
Merit 57	2	malting	143.7	46.7	84.6	95.3	38.6	1-Jul	1.7
Conrad	2	malting	139.5	51.7	94.4	96.3	39.5	1-Jul	1.0
Moravian 69	2	malting	138.0	48.7	92.1	97.6	28.6	3-Jul	1.0
2B07-1590	2	malting	135.4	49.0	96.6	99.1	39.5	28-Jun	2.3
2B07-1516	2	malting	135.3	47.6	91.2	96.8	41.1	2-Jul	2.3
2ND25272	2	malting	133.8	50.9	98.9	99.7	37.1	27-Jun	1.0
01Ab9663	6	malting	129.8	51.1	97.5	99.3	42.2	29-Jun	1.0
02Ab17271	2	malting	129.7	48.3	89.1	95.9	41.5	2-Jul	1.3
AC Metcalfe	2	malting	129.3	49.7	96.0	98.6	39.4	28-Jun	1.7
2B05-0811	2	malting	128.6	48.7	92.7	97.8	41.4	1-Jul	3.0
Harrington	2	malting	127.1	48.4	95.1	98.3	39.9	30-Jun	2.3
Hocket	2	malting	124.6	52.8	96.2	98.0	38.9	27-Jun	2.3
CDC Kindersley	2	malting	123.4	50.5	93.5	97.8	40.6	30-Jun	2.3
2B06-0933	2	malting	122.9	45.4	92.3	98.0	35.9	30-Jun	1.3
Mayfair	6	malting	118.3	47.1	96.2	98.4	43.3	28-Jun	1.0
2ND24388	2	malting	117.3	50.6	98.2	98.9	38.7	27-Jun	2.0
Bentley	2	malting	104.5	45.6	91.3	97.7	40.5	30-Jun	1.3
2ND25276	2	malting	104.2	48.4	97.3	99.1	39.3	30-Jun	1.7
ND23898	6	malting	98.5	49.4	90.9	97.5	46.8	27-Jun	1.0
				Feed/Food					
2004NZ151	2	feed	169.6	51.3	93.0	98.0	32.8	1-Jul	1.7
06WA-412.4	2	feed	163.4	53.3	97.0	99.1	37.2	30-Jun	1.0
2004NZ163	2	feed	157.8	53.7	95.6	98.8	30.6	1-Jul	1.0
MT061169	2	feed	150.5	51.3	94.1	96.6	38.5	28-Jun	2.0
UT6R2120-14	6	feed	149.9	50.3	92.5	97.4	41.2	25-Jun	1.7
05WA-316.K	2	feed	148.9	49.4	94.4	98.4	39.1	28-Jun	1.0
Steptoe	6	feed	147.6	47.9	96.5	98.8	42.6	26-Jun	2.3
Baronesse	2	feed	146.8	50.6	94.5	98.7	39.3	30-Jun	1.0
UT04B2041-42	6	feed	141.0	50.6	94.2	98.0	43.5	27-Jun	1.0
MT020162	2	feed	138.9	52.7	95.8	98.7	40.7	29-Jun	1.3
05WA-316.99	2	feed	132.6	48.9	97.0	98.9	40.8	28-Jun	1.0
Champion	2	feed	131.2	51.8	96.3	98.9	38.1	27-Jun	1.3
Gallatin	2	feed	131.0	51.3	94.5	97.7	42.0	27-Jun	2.7
MT070111	2	feed	129.3	50.5	95.5	98.7	38.6	1-Jul	1.0
Haxby	2	feed	128.4	53.4	96.2	98.9	37.7	30-Jun	1.0
WAS 2	2	f/waxy	136.6	51.8	98.4	99.3	34.5	27-Jun	1.0
CDC Rattan	2	F,W,H*	107.3	43.1	53.1	90.4	39.5	2-Jul	2.0
CDC Fiber	2	F,W,H*	81.1	35.3	85.8	97.7	42.3	3-Jul	3.3
Mean			133.9	49.4	93.3	97.9	39.1	29-Jun	1.6
$LSD_{(.05)}$			24.1	2.8	4.5	2.4	4.5		1.0
CV%			11.1	3.5	2.9	1.5	7.1		41.0

*F=food, W=waxy, H=hulless

2011 Spring Wheat Variety Performance Evaluation

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

[1]Powell Research and Extension Center.

Introduction

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, WAES evaluates a wide range of spring wheat germplasm each year.

Objectives

Testing of spring wheat varieties was conducted to help growers select varieties adapted to the region.

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, test weight, and protein. The experiment was at the Powell Research and Extension Center (PREC). The soil was a Garland clay loam (fine, mixed, mesic; Typic Haplargid) and had a cropping history of: 2010–dry beans, 2009–small grains, and 2008–dry beans. Fertilizer was applied April 1 at the rate of 230 lb/acre N and 50 lb/acre of P_2O_5 in the form of urea (46-0-0) and diammonium phosphate (11-52-0). On April 5, 30 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 150 pounds 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 and 0.50 pounds active ingredient per acre on June 4. Furrow irrigations were April 27, June 9, June 23, July 8, July 20, and August 4. Subplots, 5.3 by 8 feet, were harvested August 24 using a plot combine.

Results and Discussion

Results are presented in Table 1. The highest yielding entry was ‘Prestea’ hard white wheat at 130.9 bu/acre.

Acknowledgments

Appreciation is extended to PREC staff for assistance. Also, WestBred provided several entries for testing.

Contact Information

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Key words: spring wheat, variety trial

Table 1. Agronomic performance of spring wheat genotypes grown at PREC during 2011.

Variety HR unless indicated	Grain Yield bu/acre	Protein %	Test Weight lb/bu	Plant height inches	Heading Date	Lodging 1-9
WB Prestea HW	130.9	11.8	62.9	33.7	4-Jul	1.0
Solano	130.5	11.9	60.8	29.5	5-Jul	1.0
Volt	129.3	11.9	62.7	31.9	8-Jul	1.0
Choteau	126.7	12.2	59.3	35.7	8-Jul	1.0
Breaker	124.4	12.8	60.2	35.7	8-Jul	1.0
WB Rockland	123.7	12.6	62.7	27.4	4-Jul	1.0
WB Gunnison	123.0	12.6	59.7	34.8	8-Jul	1.0
Alturas SW	122.8	10.3	58.9	35.7	8-Jul	1.0
2375	122.7	12.5	59.5	36.7	8-Jul	1.0
WB-Mayville	121.1	12.8	59.3	33.5	8-Jul	1.0
Hank	119.5	12.8	58.3	33.9	8-Jul	1.0
Kuntz	117.7	12.4	60.0	33.1	8-Jul	1.3
WB Fuzion	117.5	12.5	58.8	36.5	4-Jul	1.0
Samson	117.2	12.3	58.8	34.8	8-Jul	1.0
Brennan	116.6	12.9	62.8	34.0	4-Jul	1.0
Verde	116.4	11.5	61.3	37.5	9-Jul	1.0
Reeder	115.0	12.8	59.3	37.8	8-Jul	1.0
Jedd	112.6	12.0	57.0	29.4	4-Jul	1.0
Alzada Durum	112.6	10.2	59.9	29.9	4-Jul	2.0
Outlook	110.6	12.5	57.6	38.7	8-Jul	1.0
O Neal	110.1	12.4	59.4	35.8	8-Jul	1.0
Vida	109.8	13.1	59.0	38.6	8-Jul	1.7
Alzada Durum 150*	107.7	11.0	60.2	29.9	4-Jul	2.0
Belfield Durum	99.9	11.4	59.2	29.1	4-Jul	1.3
McNeal	99.2	12.0	59.2	36.5	20-Jul	1.0
Vantage	94.5	14.2	63.7	34.5	12-Jul	1.0
Keene	84.5	13.8	62.6	44.5	8-Jul	3.7
X-2210 Triticale	76.6		46.0	49.5	14-Jul	1.7
Chris	66.2	14.7	59.0	44.4	8-Jul	6.7
Marquis	63.9	14.2	59.2	46.1	8-Jul	5.0
Mean	110.8	12.4	59.6	35.6	7-Jul	1.5
LSD	11	0.9	2.5	3		0.7
CV%	6.1	4.6	2.6	5.1		28.9

*seeded 150 lbs/acre

Roundup Ready® Corn Control in Roundup Ready® Sugarbeet

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

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Introduction

Volunteer Roundup Ready® corn is becoming a troublesome weed in Roundup Ready® sugarbeet. Preliminary competition studies by Department of Plant Sciences Assistant Professor Andrew Kniss at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle reveal that volunteer corn densities of one plant per 50, 20, and 10 ft^2 reduced sugarbeet root yield by 2.5, 9, and 23 percent, respectively.

Objectives

The objectives of this study were to (1) evaluate the effectiveness and application timing of several grass herbicides in controlling volunteer Roundup Ready (RR) corn; and (2) evaluate Roundup Ready sugarbeet tolerance to these grass herbicides.

Materials and Methods

Field studies were conducted at the Powell Research and Extension Center (PREC). RR sugarbeet was planted in a field infested with RR corn. Herbicide treatments consisted of glyphosate (22 oz/A) mixed with clethodim (6 oz/A), sethoxydim (9 oz/A), or quizalofop (4oz/A) and applied at 4-inch (early application) and/or 8-inch (late application) tall corn. All treatments were compared to glyphosate applied alone. Treatments were arranged in a randomized complete block design with four replications. RR corn infestation was heavy (15 to 20 plants/10 ft. of row) and uniform throughout the experimental site. RR corn control, sugarbeet injury, and yield data were subjected to analysis of variance, and means were compared using least significant difference (LSD) at 5 percent.

Results and Discussion

All treatments containing grass herbicides plus crop oil concentrate caused 5-percent sugarbeet injury with early application. No injury was recorded with the split application treatments. RR corn control with early application using quizalofop or clethodim was similar to that with the second application—93 and 98 percent, respectively. Excellent volunteer corn control without causing any sugarbeet injury was achieved with split application of clethodim or quizalofop—97 and 100 percent, respectively. Volunteer corn control with the sethoxydim applied early, late, or as a split application was poor (40–50%). Sugarbeet yield was 7.5 to 16.9 tons/A higher in plots treated with grass herbicides as compared to plots treated with Roundup® alone (13.4 tons/A).

In general, sugarbeet root yield was closely related to volunteer corn control. No significant effect was recorded with any of the treatments concerning sucrose content.

Acknowledgments

Appreciation is extended to the PREC station crew, technical personnel, and others who play an integral role in our research activities.

Contact Information

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Key words: weed management, Roundup Ready corn, Roundup Ready sugarbeet, grass herbicides

Table 1. RR corn control and RR sugarbeet response to several grass herbicides.

Treatment	Time	RR corn	Sugarbeet	
		Control	Injury	Yield
	(Inch)	(%)	(%)	(T/A)
sethoxydim	4	45	5	19.9
sethoxydim	8	40	5	22.4
sethoxydim	4/8	45	0	20.9
quizalofop	4	93	5	28.4
quizalofop	8	93	3	28.4
quizalofop	4/8	97	0	30.4
clethodim	4	98	5	29.6
clethodim	8	98	3	29.5
clethodim	4/8	100	0	30.3
glyphosate	4/8	0	0	13.4
LSD (5%)	--	5.3	2.4	4.4

Effect of Weed Removal Timing on Weed Control and Sugarbeet Yield

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

Introduction

The effectiveness of Roundup Ready® technology in sugarbeet is making growers wait longer to apply the first Roundup® treatment. This late application might control weeds, but early weed competition might reduce sugarbeet yield. Information on sugarbeet yield loss from early weed competition is needed.

Objectives

The objectives of this study were to
(1) evaluate weed control with glyphosate applied at different weed stages;
(2) evaluate the impact of glyphosate rate and timing of initial weed control on sugarbeet yield and sucrose.

Materials and Methods

Field experiments were conducted at the Powell Research and Extension Center to evaluate the benefit of early removal of weeds in the glyphosate-tolerant sugarbeet system as well as sugarbeet response to early applications (cotyledon stage) using higher glyphosate rates. Herbicide treatments consisted of two applications of Roundup PowerMAX® starting with 32 oz/A then 22 oz/A at four weed heights (<1”, 1–2”, 2–3”, and 3–4”). All treatments were compared to weedy check. Weed infestations at the experimental site were moderate: 10 to 15 plants/10 feet of row.

Results and Discussion

No injury was recorded with any treatment. Early applications (cotyledon stage) of Roundup did not have any effect on the sugarbeet population (data not shown). In general, weed control was excellent (95 to 100%) with all treatments except for wild buckwheat (Table 1). Excellent wild buckwheat control (98–100%) was achieved when weeds were up to 2” tall at time of application. However, when glyphosate was applied to 3- or 4-inch tall wild buckwheat, the control was reduced to 82–94 percent. Sugarbeet root yields when the weeds were removed early at 0–1” or 1–2” tall were similar and averaged more than 29 tons/A. However, sugarbeet root yield was reduced by at least 1.5 and 2.8 tons/A when weeds were removed at 2–3” or 3–4” tall, respectively. Since weed control in general was excellent, this yield reduction could be caused mostly by early weed competition. No apparent effect was recorded with any of the treatments concerning sucrose content.

Table 1. Weed control at different weed sizes

Treatment	Time (inch)	Weed Control: Pig weed (%)	Buck wheat (%)	Grasses (%)
Roundup	1	100	100	98
Roundup	2	100	98	95
Roundup	3	100	92	100
Roundup	4	100	82	100
LSD (5%)	--	NS	7	NS

Table 2. Sugarbeet response to weed removal at different weed sizes.

Treatment	Time (inch)	Sugarbeet Response: Injury (%)	Yield (T/A)	Sucrose (%)
Roundup	1	0	29.2	18.5
Roundup	2	0	29.6	18.3
Roundup	3	0	27.5	18.1
Roundup	4	0	26.3	18.4
LSD (5%)	--	NS	2.3	NS

Acknowledgments

Partial financial support for this project was provided by the Western Sugar Cooperative Grower Joint Research Committee. Appreciation is extended to station crew, technical personnel, and others who play an integral role in our research activities.

Contact Information

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Key words: weed management, weed removal timing, sugarbeets, Roundup

Yield of Sugarbeet Grown with Different Cropping Systems and Irrigation Regimes

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[1]Powell Research and Extension Center.

Introduction

Cropping systems such as no-till and strip-till, among others, are considered sustainable practices that have been adopted worldwide. Water conservation due to an improved water-holding capacity of the soils and, consequently, a more efficient use of water and an improved carbon storage capacity of the soil are among the benefits of those systems.

Semiarid environments, such as in the Bighorn Basin, may benefit from alternative cropping systems. However, crop type, management practices such as irrigation, and the unique environment of the region may be a challenge to adopting such cropping systems.

Objectives

The main objectives of this study were to determine the effect of different cropping systems and irrigation regimes on yield of sugarbeet.

Materials and Methods

The experiment was conducted at the Powell Research and Extension Center (PREC) during the 2011 growing season. Sugarbeet was planted under four cropping systems: conventional till (CT), no-till (NT), strip-till (ST), and disk ripper (DR) in a 13-acre portion of a 54-acre lateral move sprinkler-irrigated field. Irrigation treatments of full irrigated, 70 percent of full irrigated, and 50 percent of full irrigated were superimposed on each cropping system. The irrigation amounts were calculated using a procedure to determine water balance.

Soil moisture was monitored at different depths on a weekly basis using a Watermark (www.irrometer.com) system attached to Spectrum Technologies' WatchDog® weather loggers (www.specmeters.com).

Results and Discussion

Results showed that the establishment of the crop was more homogeneous in all but the NT treatment (Fig. 1).

Significant differences ($P<0.05$) on yield were observed between irrigation treatments (Fig.2). Also, significant differences ($P<0.05$) on plant population between cropping systems were observed. However, no yield difference was observed between cropping systems.

Results from one year of study showed that NT and ST systems may have the potential

Figure 1. Sugarbeet grown under conventional and no-till cropping systems at PREC.

Figure 2. Water stress on sugarbeet grown under conventional till. Irrigation water received was 50 percent of the full irrigated treatment.

for a more efficient use of water though there were no significant differences (Fig. 3).

Acknowledgments

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Contact Information

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Key words: sugarbeet, tillage systems, irrigation

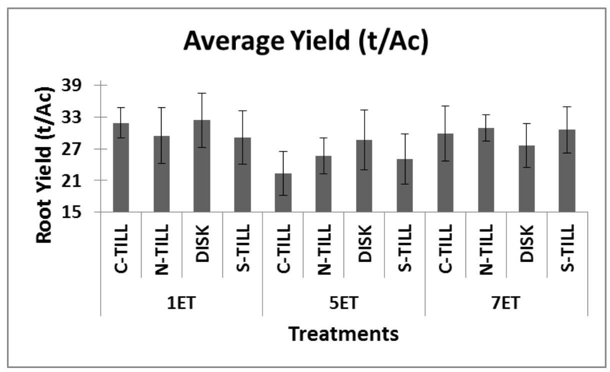

Figure 3. Root yield of sugarbeet grown under different cropping systems and irrigation regimes

Soybean Variety Trial at Powell R&E Center

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[1]Powell Research and Extension Center.

Introduction

Soybean (*Glycine max* L.) is a legume-type species with a variety of maturity groups based on day length, and accordingly influenced by latitude. As a legume, soybean fixes atmospheric nitrogen (N) so little to no N fertilizer is needed.

Soybean grows in many different regions under many soil types and would easily fit into northwestern Wyoming crop rotations. Soybean also provides a pause in biological cycles of various diseases common to local irrigated crops; therefore, it could help improve other crop yields and bring N back into the soil.

Objectives

The main objective of this study was to assess the yield performance of eight soybean varieties grown in northwestern Wyoming.

Materials and Methods

The study was conducted during the 2011 growing season at the Powell Research and Extension Center (PREC). A conventional till system was used to plant eight soybean varieties on June 7, 2011, in a randomized complete block design with four replications. Seeds were planted with a grain drill in 6-inch spacing to a desired population of 150,000 plants per acre in a clay loam soil. Fertilization occurred June 6, 2011, at 50, 50, and 30 lb/acre of N, phosphorus, and potassium, respectively. The crop was furrow irrigated June 10, July 12, July 27, August 9, August 23, and September 8.

Results and Discussion

Plants were harvested October 31, 2011, with a Wintersteiger plot combine. Yields as high as 2,171 lb/acre from Rea Hybrids variety 63G31 and as low as 1,340 lb/acre from Legend Seeds variety 0028RR were obtained (Table 1).

Consistently, Legend Seeds' varieties showed low yields; the variety 0028RR showed significantly lower yield as compared to the other varieties.

Soybean yield varied as a function of the maturity group. For conditions in the Bighorn Basin, soybean maturity groups 0.20–0.40 seem to perform better than other maturity groups.

Table 1. 2011 soybean variety trial at PREC.

Brand	Variety	Maturity	Average Yield (lb/A)[1]
Rea Hybrids	63G31	0.30	2171
Pioneer Hi-Bred	90M02	0.00	2122
Pioneer Hi-Bred	90Y20	0.20	2096
Pioneer Hi-Bred	90Y42	0.40	1969
Legend Seeds	0065RR	0.60	1860
Pride Seeds/Legend	004R21	0.40	1832
Legend Seeds	003R21	0.30	1789
Legend Seeds	0028RR	0.20	1340
AVERAGE			1897
LSD[2]			504

[1] Differences between varieties are significant ($P < 0.05$) only if they are equal to or greater than the least significant difference (LSD) value.
[2] Average lb/bushel = 60.

Acknowledgments

Thanks to Joan Tromble for her support with this study.

Contact Information

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Key words: soybean varieties, yield performance

Effect of QuickRoots™ on Yield of Soybean Grown in the Bighorn Basin of Wyoming

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Introduction

Soybean (*Glycine max* L.) is a legume-type species with a variety of maturity groups based on day length and, accordingly, influenced by latitude. As a legume, soybean fixes atmospheric nitrogen (N) so little to no N fertilizer is needed. Alternative technologies, such as QuickRoots™ (www.tjquickroots.com), are supposed to enhance the capabilities of plants to uptake nutrients. The QuickRoots™ system contains live microorganisms designed to inhabit and grow with roots as they develop. The system is supposed to increase specific soil plant nutrient availability and to release plant-available phosphorous (P) from within soil to increase root mass. This could allow the roots to explore a greater volume of soil. An increase in nutrient availability leads to increased plant health and vigor, which translates into higher yield.

Objectives

The main objective of this study was to determine whether QuickRoots™ increases yield of soybeans grown in northwestern Wyoming's Bighorn Basin.

Materials and Methods

The study was conducted during the 2011 growing season at the Powell Research and Extension Center. Eight soybean varieties with four replications were planted with and without QuickRoots™ on June 7, 2011. Seeds were planted with a grain drill in 6-inch spacing to a desired population of 150,000 plants per acre in a clay loam soil. Fertilization occurred June 6, 2011, at 50, 50, and 30 lb/acre of N, P, and potassium, respectively. The crop was furrow irrigated June 10, July 12, July 27, August 9, August 23, and September 8.

Results and Discussion

Soybeans were harvested October 31, 2011, with a Wintersteiger plot combine. No significant differences were observed when comparing QuickRoots™-treated soybean versus non-treated soybean. Because there were no observable differences, both treated and non-treated fields were analyzed as a single experiment. The highest yield was obtained from Rea Hybrids variety 63G31 under both QuickRoots™ treatment and non-treated soybeans (Table 1). However, no significant differences were found between Rea Hybrids 63G31 and the Pioneer varieties.

Table 1. Yield of eight soybean varieties grown in the Bighorn Basin.

Brand	Variety	Maturity	Yield (lb/A)[1]
Rea Hybrids	63G31	0.30	2321
Pioneer	90Y20	0.20	2084
Pioneer	90Y42	0.40	2049
Pioneer	90M02	0.00	1973
PS-Legend	004R21	00.4	1828
Legend	003R21	00.3	1795
Legend	0065RR	00.6	1655
Legend	0028RR	00.2	1447
Average			1894
LSD[2]			382

[1]Harvest date: October 31, 2011; Average lb/bushel: 60.

[2]Differences between varieties are significant ($P < 0.05$) only if they are equal to or greater than the LSD value.

Consistently, Legend Seeds' varieties were lower yielding, with 0028RR showing significantly lower yield compared to the other varieties.

Our results from one year showed that QuickRoots™ did not increase soybean yield grown under conditions of the Bighorn Basin.

Soybean maturity groups 0.20–0.40 seem to perform better than other maturity groups in the region.

Acknowledgments

Thanks to Joan Tromble for her support with this study.

Contact Information

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Key words*:* soybean varieties, soil fertility, nitrogen fixation

Cucumber Production Inside and Outside High Tunnel

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Introduction

Vegetable crop production in high tunnels is growing rapidly in Wyoming and other states, with new growers and new crops finding their comfort zone under those plastic roofs and walls. The movement to high tunnels started with people wanting a cheaper kind of greenhouse to produce high quality crops 3–4 weeks earlier in the spring and extend the growing season in the fall by 3–4 weeks. Many warm-season vegetable crops can bring a higher price early in the growing season before large supplies are available. To encourage early vegetable production and capture the profitable early market, growers can use plastic tunnels. Several researchers have shown that warm-season vegetable crops such as cucumber do very well (yield and quality) when grown in high tunnels.

Objectives

The objectives of the study were to evaluate new releases of short-growing season cucumber cultivars and compare production inside to outside high tunnels.

Materials and Methods

Several trials were conducted at the Powell Research and Extension Center to evaluate the performance of four varieties of cucumber grown under two fertility regimes (organic and inorganic) both inside and outside high tunnels. Cucumber cultivars were ‘Diva’ hybrid, ‘Sweeter Yet’ hybrid, ‘Sweet Slice’ hybrid, and ‘Pearl’ hybrid.

The experimental area was divided into two halves—one half was fertilized with manure and the other half with conventional nitrogen (urea) and incorporated into the soil with a hand-driven rototiller. Cucumber cultivars were first planted in the greenhouse April 28 and then transplanted into the high tunnels May 20 and outside the high tunnels May 27. All cultivars were arranged in a randomized complete block design. A drip irrigation system with spaghetti tubing was used to irrigate the plants. Tensiometers were installed at 6- and 12-in depths to monitor soil moisture and manage irrigation (Fig. 1). Plots were kept weed free by hand weeding.

Figure 1. Irrigation scheduling using tensiometers.

Results and Discussion

There was significant difference between varieties, inside/outside, as well as inorganic/organic. With all four varieties, production inside the high tunnel was by far higher than outside. Of the four varieties studied, two ('Sweeter Yet' hybrid and 'Pearl' hybrid) yielded higher and produced more fruit/plant under high tunnel as compared to other varieties. 'Sweeter Yet' ripened earlier in the high tunnel (second week of July) as compared to the other varieties. Lowest yield and number of fruit/plant came from Sweet Slice. The last harvest of cucumber in the field was September 20. Cucumber in the high tunnel survived until October 18. The high tunnel extended the late season by approximately four weeks.

Table 1. Cucumber production.

Variety	Fertility (regime)	Inside Yield (lb/plant)	Outside Yield
Sweeter Yet hybrid	Inorganic	40	7
	Organic	39	11
Sweet Slice hybrid	Inorganic	8	3
	Organic	9	3
Diva hybrid	Inorganic	27	7
	Organic	24	5
Pearl hybrid	Inorganic	34	7
	Organic	41	10
LSD (0.05)	--	5	2.4

Acknowledgments

The project was funded by the Wyoming Department of Agriculture. Appreciation is extended to Bob Prchal for assistance.

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Key words: cucumber, high tunnel

Effect of Phosphorus on Established and Newly Established Sainfoin

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Introduction

Sainfoin (*Onobrychis viciifolia* Scop.), an introduced perennial forage legume, can be used 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 of sainfoin are that it does not cause "bloat" in cattle and has no or few 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 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 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 were incorporated into the established plots. Data will be collected following the same protocols in 2012. It is expected that the study will provide responses of phosphorus applications in this year's data set.

Acknowledgments

We thank PREC field crews for their assistance in plot establishment and harvesting. The study is supported by various sponsored programs.

Contact Information

Key words: sainfoin, phosphorus, fertilization

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

	DM Yield (tons/acre): sainfoin planted in 2007*						**DM Yield (tons/acre): sainfoin planted in 2009#**		
Treatment (pounds/acre)	2009 1st cut	2009 2nd cut	2009 Total	2010 1st cut	2010 2nd cut	2010 Total	2010 1st cut	2010 2nd cut	2010 Total
0 P_20_5	3.3	2.5	5.8	1.3	1.4	2.7	2.3	2.4	4.7
20 P_20_5	3.6	2.7	6.3	1.6	1.6	3.2	2.0	2.3	4.3
40 P_20_5	3.3	2.3	5.5	1.3	1.2	2.5	2.1	2.3	4.4
60 P_20_5	3.5	2.5	6.0	1.4	1.6	3.0	2.4	2.6	5.0
80 P_20_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

Foxtail Barley Management in Irrigated Pastures

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Introduction

Foxtail barley is a native short-lived perennial bunchgrass that spreads by seed and grows in dense bunches with shallow fibrous roots. In pastures, foxtail barley rapidly forms monoculture stands that displace favorable vegetation. Foxtail barley poses a serious threat to livestock and wildlife because of its barbed awns that may cause serious eye and/or mouth injury. Also, it should be noted that hay contaminated with foxtail barley has little to no value. Therefore, an integrated management program to control foxtail barley is needed.

Objectives

The objectives of this study were to evaluate the effectiveness of imazapic herbicide in controlling foxtail barley as well as determine the rate and application timing.

Materials and Methods

Field experiments were conducted on two separate sites in Park County. The sites were selected based on the degree of foxtail barley infestation as well as the similarities of soil characteristics. Imazapic was applied at several rates either as an early application (two-leaf stage or mid-May), late application (five-leaf stage or mid-June), or as a split application (early and late). All treatments were replicated four times and arranged in a randomized complete block design.

Results and Discussion

Early application of imazapic was the most effective with control ranging from 56–73 percent (Table 1). A 12-percent increase in control can be achieved by splitting a 12-oz rate into two 6-oz applications. Early application also dramatically affected seed head production with 95–98 percent seed head suppression. Again, splitting a 12-oz rate into two 6-oz applications gave the best seed head suppression. However, splitting an 8-oz rate into two 4-oz applications has proven to be the most economical solution to control this perennial grass weed. Seed head suppression is a valuable reaction to this herbicide from the standpoint of allowing land managers the ability to graze pastures while taking advantage of a relatively high feed value of this grass when it does not have an unpalatable awn.

Further research is needed to determine the length of time the seed head will be suppressed and how grazing affects the activity of the herbicide. The work done in this study with split applications poses the questions: how early in the growing season should one spray, or could a fall and spring split application be more effective? There is need for more research using this compound to control foxtail barley, but currently it is recommended to use the 8-oz rate split into two 4-oz applications early in the growing season.

Acknowledgments

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Contact Information

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Key words: foxtail barley, imazapic, split application

Table 1. Foxtail barley control with early (E) and/or late (L) applications of imazapic.

Treatment	Rate	Time	Seed Suppress	F. barley control
	(oz/A)	--	(%)	(%)
imazapic	4	E/L	98	59
imazapic	6	E/L	98	73
imazapic	8	E	94	59
imazapic	10	E	92	63
imazapic	12	E	95	61
imazapic	8	L	42	25
imazapic	10	L	44	16
imazapic	12	L	45	25
check	0	--	00	00
LSD (5%)	--	--	10.2	7.1

Enhancing Water-Holding Capacity of Soils with Organic and No-till Production Practices

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Introduction

Uncertainty of rainfall threatens the economic viability of agriculture in the semiarid northern High Plains of Wyoming. The conventional dryland winter wheat–fallow system, commonly used in the semiarid High Plains, was originally adopted to stabilize winter wheat production in the region. Soil moisture storage for the next crop, among other benefits, was one of the reasons. Cropping systems that increase yields while conserving water, improving soil quality, and raising the carbon sequestration capacity of soils are attractive to producers (and others) in the region. Organic production practices are alternatives to energy-intensive production inputs such as synthetic fertilizers.

Soils of organic systems may be better suited to store water for use by crops. As a result, organic farmers have the potential to make more money with less land by more efficient use of water than conventional farmers under the same situation. Transition of conventional to organic and no-till systems may allow for a more sustainable system.

Objectives

The objectives of our study were to determine and compare soil water content and storage in different cropping systems, including conventional, no-till, and organic under both irrigated and dryland conditions.

Materials and Methods

This study is being conducted at the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle. Soil moisture was determined gravimetrically (measured by weight). Soil samples were taken at different depths from 8 inches to 55 inches from both irrigated and dryland fields.

Results and Discussion

Preliminary results showed that under dryland conditions, the organic and no-till systems tend to hold more moisture in the soil profile.

On the surface, soil moisture content is less due to evaporation losses. Soil moisture then increased with depth up to 16 inches. The changes in moisture content at different depths in the conventional system are unexpected and may be due to texture differences in the soil. After the 16-inch

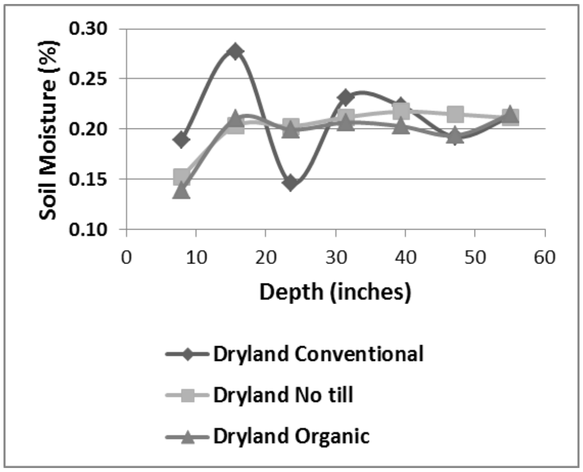

Figure 1. Soil moisture change in the soil profile in a dryland field.

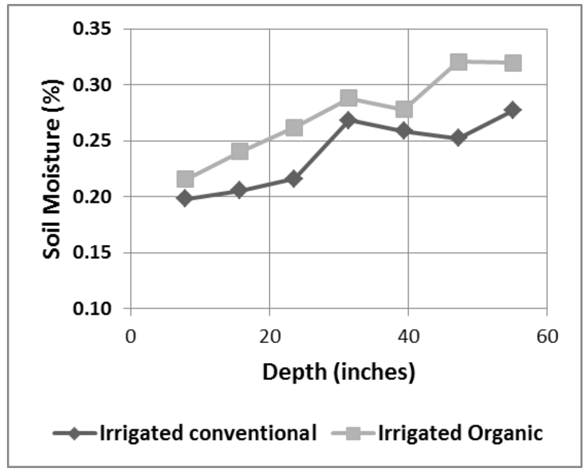

Figure 2. Soil moisture change in the soil profile in an irrigated field.

depth, organic and no-till crops have similar moisture storage throughout the entire profile. Overall, the moisture content of the soil in all three systems appears to be the same at deep depths (Fig. 1).

Under irrigated conditions, the organic production system planted with alfalfa and fertilized with manure showed comparatively higher moisture storage than the conventional production system planted with row crops and treated with conventional fertilizers. Since alfalfa is a high water-use crop, these results may evidence the viability of organic production systems as an option to enhance water-holding capacity of dryland agriculture (Fig. 2), although it is important to realize that using different crops under the systems may also influence results.

Acknowledgments

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Key words: soil water content, cropping systems, tillage practices

Selenium Supplementation Protects in a Mouse Model of Huntington's Disease

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Introduction

Selenium is an essential nutrient that has critical roles in normal body functions. Its effects are mediated by 25 selenium-containing proteins. Selenium deficiency or excess can cause disease in humans and livestock. Furthermore, disruption of normal selenium metabolism may also occur in diseases that have not previously been linked with selenium's action.

Selenium is also critical for brain function as disruptions of selenium homeostasis are sufficient to cause neurodegeneration. Many selenoproteins have roles in maintaining oxidative homeostasis; therefore, defects of selenium metabolism could lead to cell dysfunction and thereby promote disease progression.

Huntington's disease (HD) is a chronic progressive human degenerative condition caused by an autosomal dominant mutation within the gene called huntingtin. Disease signs include involuntary movements and cognitive disturbances. There are no neuroprotective treatments. While there are currently intensive efforts to develop new therapies for HD, the role of dietary manipulation as a means of providing protection has received little attention.

Objectives

Determine if nutritionally relevant elevation of dietary selenium intake has protective effects in a genetically accurate mouse model of Huntington's disease.

Materials and Methods

We studied selenium supplementation in a mouse model of HD. These mice have a transgene (TG) that encodes part of the human mutant huntingtin gene. They develop disease signs that resemble those of human HD including weight loss and problems of motor control. Further, they develop shrinkage of similar brain areas. Selenium was delivered to HD mice from 6 to 12 weeks of age in drinking water at 0.25 and 1.00 parts per million (ppm), in the form of sodium selenite. Outcomes studied included motor performance as measured by a motor endurance test and the amount of misfolded mutant huntingtin protein accumulating in brain.

Results and Discussion

HD mice undergo declines in motor performance. We tested the effect of selenium supplementation on motor endurance as determined using the Rota-rod test. As shown in Fig. 1, selenium-

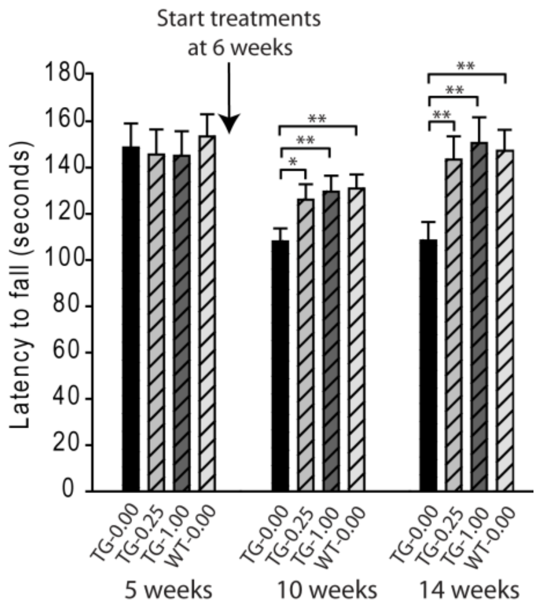

Figure 1. Increased motor endurance in selenium supplemented HD (=TG) mice.

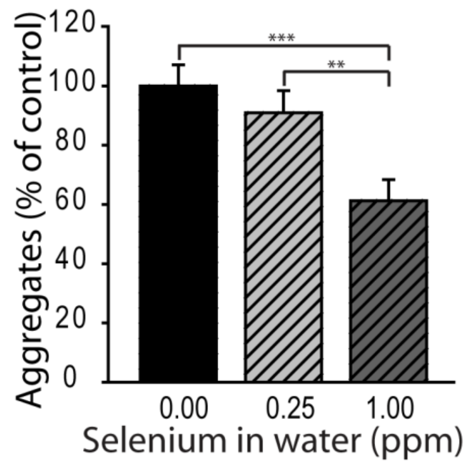

Figure 2. Decreased misfolded huntingtin in 1.00 ppm selenium supplemented HD mice. Mutant huntingtin levels were measured by confocal microscopy. Graph shows quantification of mhtt in motor cortex at 14 weeks of age (n= 10 mice/group).

supplemented HD mice had significantly improved motor endurance.

HD is primarily a brain disease. To determine if protective motor effects are due to effects in brain, we studied brain biochemical outcomes. Mutant huntingtin protein (mhtt) misfolds and accumulates in brain. Further, mhtt is a marker protein for the presence of HD. We therefore quantified mhtt in the brains of our treated and control HD mice.

As shown in Fig. 2, we found that selenium supplementation decreased the amount of misfolded mutant huntingtin protein in the brains of HD mice.

While selenium deficiency and toxicity are well characterized, here we demonstrate that selenium manipulation within a nutritionally acceptable range can favorably modulate phenotype in an animal model of a human disease. This finding could eventually lead to human HD testing. Also, selenium intake within an acceptable range may modulate other diseases including natural diseases of livestock.

Acknowledgments

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Key words: selenium, nutrition, neurodegeneration

Immediate Impacts of Bark Beetle-Induced Forest Mortality on Soil Water and Greenhouse Gas Emissions

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Introduction

Unprecedented outbreaks of mountain pine beetle (*Dendroctonus ponderosae)* (MPB) and associated blue stain fungi, as of 2009, decimated at least 46,332 square miles of coniferous forests in western North America (Fig. 1). Recent predictions suggest that warming is likely to increase the extent and severity of future insect outbreaks, yet the effects of the change in ecosystem structure on ecosystem functions are not well understood

It is known that the beetle disturbance induces a major disequilibrium in water, carbon (C), and nitrogen (N) cycling that contrasts other more-studied disturbances such as fire and logging. A critical unknown is how spatial and temporal variability in the response of soil hydrological and biogeochemical processes will constrain the magnitude of N and C losses to greenhouse gas (GHG) emissions following the MPB outbreak. The two GHG species of interest, methane (CH_4) and nitrous oxide (N_2O), are of particular importance. Moreover, understanding of the patterns of GHG emissions as a function of time since disturbance, stand management, and the degree of MPB infestations is lacking.

Figure 1: Current extent of MPB-induced forest mortality and a blue stain fungi-infected tree.

Objectives

The objective is to assess the magnitude of changes in N_2O and CH_4 on multiple sites following recent MPB infestations.

Materials and Methods

Six lodgepole pine (*Pinus contorta*) forest stands near Chimney Park in southeastern Wyoming's Medicine Bow National Forest have been monitored for three years starting in 2009: three stands were infested with MPB, and three remained uninfested. Infested stands had the presence of bark beetle anywhere between one and four years. Uninfested stands were old and thinned, old and not thinned, or 20 to 25 years old and regenerating after a clearcut. Each of six stands had five randomly selected 15- by 15-m plots with permanent installations for GHG measurements and soil sampling. Methane and N_2O fluxes, soil and litter water, and mineral N content were measured biweekly from snow-free soil surface starting in June for three years. Soil and air temperatures were also measured.

Results and Discussion

An overall increase in N_2O production and decline in CH_4 assimilation occur mostly in June and July and are associated with an increase in soil water content (Table 1). Changes in C, N, and water cycling following MPB infestation are likely to transform terrestrial ecosystems from effective sinks to weak sinks and, later on, sources of atmospheric C and N greenhouse gas (Fig. 2), which, on a scale of massive regional beetle outbreak, can substantially impact modulating atmospheric composition.

Table 1: Soil water content, CH_4, and N_2O fluxes. Monthly values represent differences between averages from infested/uninfested stands.

Month	Soil Water Content ($g\ g^{-1}$)	CH_4 ($ug\ C\ m^{-1}\ hr^{-1}$)	N_2O ($ug\ N\ m^{-2}\ hr^{-1}$)
JUNE	0.03	-0.88	0.90
JULY	0.12	-1.93	0.70
AUG	0.09	-1.86	0.53
SEPT	0.11	-2.12	0.54
OCT	0.11	-2.21	0.14

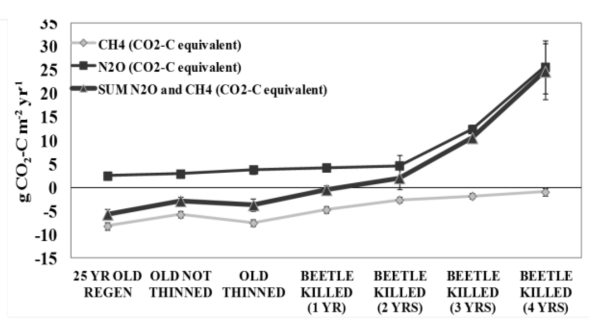

Figure 2: CH_4 and N_2O emissions (expressed as CO_2 equivalents) along "MPB infestation chronosequence."

Acknowledgments

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Key words: bark beetle, lodgepole pine forest, greenhouse gases

Soil Quality under Wheat-Fallow, Minimum-Till, and No-Till Cropping Systems

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Introduction

Most dryland winter wheat in the High Plains is produced with reduced or no-tillage methods that maintain soil cover for improved erosion control, soil moisture content, and nutrient supply. The approaches rebuild soil organic matter content lost during decades of heavy tillage and usually enable a variety of crops to be grown every year without fallow. But crop-fallow dominates in Wyoming dryland agriculture. Wheat is the only crop in this system and is alternated with fallow to keep weeds under control and conserve moisture. Many farmers combine tillage and herbicides to keep fallow strips weed free (conventional). Others use moldboard plows in a system used since the early 1900s (historic). Many dryland farmers in Nebraska and Colorado, and a few in Wyoming, have converted to no-till, where herbicides replace tillage, or to minimum till, where tools like sweeps, noble blades, or rod weeders are combined with herbicides to control weeds and conserve stubble on the surface. The lack of disturbance, along with stubble cover, conserves enough moisture to grow winter wheat, corn, beans, sunflowers, millet, oats, and other crops in continuous rotations.

Objectives

To better understand possible advantages and disadvantages of reduced and no-till for Wyoming farmers, we analyzed soil quality and economics of southeastern Wyoming fields under historic, conventional, minimum till, and no-till.

Materials and Methods

We sampled two fields that had been under each system for at least 10 years, one in a drier, lower-yielding area and one in a higher-yielding area. The historic and conventional fields had been managed under winter wheat-fallow rotations for decades. The no-till and minimum-till fields in the drier area each had a wheat-oat-fallow rotation with fallow being accomplished with shallow weeding implements and herbicides for the minimum till and herbicides alone for the no-till. Minimum- and no-till fields in the higher-yielding area had four-year rotations of wheat, corn, sunflower, and millet, sometimes varying with other crops, but without fallow.

We used a soil probe to sample soils to four feet. We analyzed for total organic carbon and nitrogen, which indicate the organic matter content and overall soil quality and productivity. We also quantified forms of organic matter that respond more rapidly to changing management to detect trends resulting from reduced tillage. Before we collected soil samples, we interviewed farmers about costs and yields associated with each tillage/cropping system combination over a six-year period.

Results and Discussion

Taken together, the soil and economic data indicate that conservation tillage pays in terms of improved soil quality, higher yields, and increased profits. Production costs for no-till and minimum-till systems were higher because of more off-farm inputs of fertilizer and herbicide and other costs associated with growing a wider variety of crops. But reported wheat yields were higher from reduced-tillage systems, and farmers harvested and sold a wider variety of crops with fewer no-income fallow years on their fields. Fig. 1 shows how absence of tillage under no-till leads to accumulation of soil carbon and also to increased stratification, with a much larger difference between the 0- to 12- and the 12- to 24-inch depths than under the tilled systems. It also indicates that relatively low yields from the no-input historic system return the least organic material to the soil, while the combination of less intense tillage and fertilizers under conventional farming may support increased residues returned to the soil, leading to more organic matter.

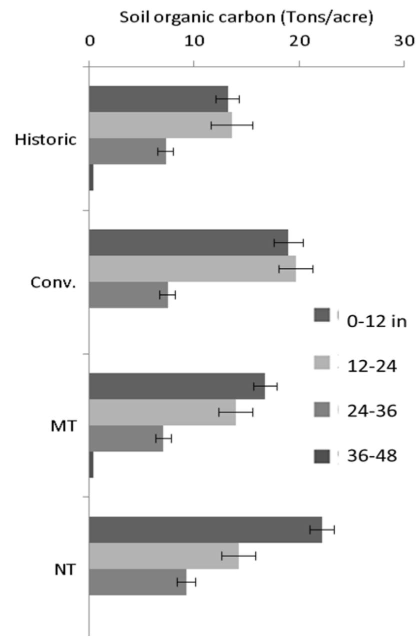

Figure 1. Vertical distribution of soil organic carbon under historic, conventional, minimum till (MT), and no-till (NT).

The management-responsive forms of carbon and nitrogen show a similar trend but more strongly indicate recovery of organic matter under minimum and no-till compared to other farming systems. Our results indicate that conversion to conservation tillage systems is an excellent alternative to crop–fallow rotations for southeastern Wyoming farmers in terms of profits and environmental quality associated with healthier soils.

Contact Information

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Key words:
wheat, tillage practices, soil organic matter

Conservation Agriculture for Sustainable Intensification in Kenya and Uganda

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Introduction

Food insecurity is not abstract for farmers in Kenya and Uganda. Most people depend directly on agriculture, and more than 35 percent of children under age 5 suffer from stunting caused by hunger in early childhood (www.feedthefuture.gov). Climate change is acute, and drought is devastating. Population drives conversion to continuous cropping that depletes soils.

Our team joined the Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANREM-CRSP) in 2010 by winning a competitive five-year grant to develop conservation agriculture production systems (CAPS) for eastern Africa. This places us in a global group of scientists working on sustainable intensification in the world's most food-insecure countries.

Kenyan and Ugandan smallholder farmers growing corn and dry beans face some of the same challenges as farmers of the Great Plains: decades of heavy tillage depleted topsoil, water-holding capacity, and nutrient-supplying potential. But smallholders that use draft animals lack modern implements, herbicides, and other tools. CAPS includes three components for sustainable intensification: 1) minimizing soil disturbance, 2) maintaining permanent soil cover, 3) rotating crops.

The University of Wyoming–East Africa team includes partnerships with Moi University, Kenya; Makerere University, Uganda; SACRED Training Institute, Manor House Agricultural Centre, Kenya; and Appropriate Technology Uganda, Ltd.

Objectives

Our objectives are to develop, evaluate, and implement CAPS for smallholder farms in eastern Uganda and western Kenya.

Materials and Methods

Our approach engages local people in developing CAPS, including constant reflection and redesign to ensure practical and adoptable outcomes.

Our four study areas surround an ancient volcano, Mount Elgon, just north of Lake Victoria. Kapchorwa, Uganda, and Trans-Nzoia, Kenya, are highland sites having rich soils with high potential but drastic erosion. Tororo, Uganda, and Bungoma, Kenya, are densely populated lowland sites having poor soils and very small fields with two growing seasons per year.

We began with a household survey to identify constraints to CAPS adoption. Then stakeholder groups met to define typical systems for corn and dry beans and to design adoptable CAPS. In 2011, we established one on-station and four on-farm field trials at each of the four study areas (20 sites in all). Each trial consists of three cropping system treatments (typical corn-bean intercrop, corn-bean intercrop with a cover crop planted at bean harvest, and corn-bean cover crop rotation in four-row strips), with three tillage treatments (moldboard plow, minimum till, and no-till) for nine treatments in all. We're collecting data on soils, crops, economics, and market implications. We're working with an engineer to develop an animal-drawn, minimum-till implement.

Results and Discussion

Our survey revealed that wealth, mechanized tillage methods, corn yield, and fertilizers and herbicides lag in Tororo. Trans-Nzoia households rank highest in wealth, area of land cultivated, and use of practices like fertilizer and herbicide. Tororo and Bungoma report lower corn yields than Kapchorwa and Trans-Nzoia. Bungoma and Trans-Nzoia households have greater access to tractors and more education than Tororo and Kapchorwa.

First-year results of field trials indicate that alternative rotations and tillage did not substantially reduce yields compared to typical methods used by farmers. This is good news because there is typically a lag as changes in tillage and cropping systems alter soil processes, and farmers learn to use new tools like herbicides. Farmers noted good corn yields following the nitrogen-fixing cover crop and were surprised that heavy tillage may not be necessary. Field tests of our minimum-tillage farm implement in March 2012 went well (Fig. 1) with many farmers claiming it could replace the moldboard plow.

Figure 1. The multi-function implement with a sub-soiler attachment.

Our partners are enthusiastic for the second year. Many cooperators are planning to apply treatments to larger fields.

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