Introduction to the Sheridan Research and Extension Center

Brian Mealor[1,2]

Introduction

The mission of the Sheridan Research and Extension Center (ShREC) is to serve Wyoming's applied research, education, and extension needs in horticulture, rangeland restoration, and forage science. We seek to continually improve our performance in all aspects of this mission. Our extension and outreach efforts have significantly increased over the past few years and have included target-specific field days, intensive multi-day workshops, and one-on-one consultations with local producers, land managers, and homeowners. With two field locations (Wyarno, east of Sheridan, and the Adams Ranch, just south of Sheridan College), a research greenhouse, and state-of-the-art laboratory space, we are able to facilitate research ranging from highly technical to very applied. While a lot of research occurs on these sites, ShREC also serves as home base for additional research and educational endeavors around the state and region.

2018-19 Updates

As with much of UW, 2018-19 has been a year of change for ShREC. Our horticulture faculty member and friend, Dr. Sadanand Dhekney, accepted a position with another institution and left our team. On the eve of the 2019 field day, we posted the announcement to begin the search for a new faculty member to fill his vacated position in the E.A. Whitney Endowed Professorship. We hope to have a new colleague in place and engaged prior to next year's field day.

The 2019 field day will give attendees an introduction to the variety of projects under way at the Adams Ranch facility this season: cover crops, weed management, viticulture, small grains, soil fertility, forage agronomy, native plant propagation, community engagement, rangeland restoration, and more. We are thankful to have the opportunity to provide this information to our community!

Acknowledgments

Members of the ShREC team strive to provide a setting where researchers, students, and other partners have access to high-quality research and learning opportunities. Our partnerships with Whitney Benefits, Sheridan College, UW Extension, the ShREC Advisory Board, and others expand our ability to serve the needs of stakeholders in Sheridan County and north-central and northeast Wyoming. We also thank other entities that have provided direct support in multiple forms over the past year: Monsanto Co., Plank Stewardship Initiative, Sheridan County CattleWomen, Alforex™ Seeds, Allied Seed Company, Granite Seed Company, Corteva™ Agriscience, Bayer Crop Science, Plank Stewardship Initiative, Bureau of Land Management, Sheridan County Weed and Pest, USDA-NRCS, and others.

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PARP: I, II, III, IV, VI, VII, VIII, IX, X, XII

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Comparing Establishment Methods Among Difficult to Produce Native Plant Materials

Jaycie Arndt[1,2], Beth Fowers[1], Brian Mealor[1,3]

Introduction

Some native species are highly desirable in reclamation and restoration settings, but seed availability is limited because the species is challenging to effectively establish, grow, harvest, clean, and condition. Additionally, propagation methods may directly impact native plant restoration efforts where original seed sources are limited. We evaluated methods for seed increase of native plants sulfur-flower buckwheat (*Eriogonum umbellatum* Torr.) and desert biscuitroot (*Lomatium foeniculaceum* J.M. Coult. & Rose). Sulfur-flower Buckwheat is a native, low growing, woody mat-forming perennial that is important for quail, sage-grouse, and ungulate forage, and for pollinator habitat. Desert biscuitroot is a broad-leaved, herbaceous perennial of the Apiaceae. It is used for medicinal purposes and is an important forage for sage grouse.

Objectives

The objective of this study was to compare establishment between direct-seeding and transplanting containerized seedlings for seed production fields in northeast Wyoming.

Materials and Methods

Transplanting Method: We placed seeds from each species in a cooler (37.27 degrees Fahrenheit) in January of 2017. As seeds germinated in the cooler, we moved them into cone-tainers in a greenhouse (71-50 degrees Fahrenheit) throughout the spring. In May of 2017, we transplanted forbs at 12 inch spacing into 3 separate blocks of 4 rows in the field. We recorded establishment by counting every live plant in June of 2018 and again in June of 2019. We determined establishment success by comparing the number of forbs transplanted to live plants one and two years post transplanting.
Direct Seeding Method: In October 2017 we drill seeded the forbs into 3 blocks of 4 rows. We seeded sulfur buckwheat at 20 seeds/ft and desert biscuitroot at 30 seeds/ft. We recorded establishment by counting every live plant in June of 2018 and 2019. We determined establishment success by comparing the number of pure seeds per row to the number of live plants present.

Results and Discussion

Sulfur-flower buckwheat had better establishment with the transplanting methodology (Table 1). Desert biscuitroot had statistically similar establishment between seeding methods (Table 1). However, the visible establishment of desert biscuitroot within the plot shows that direct seeding has higher establishment. The direct seeding method used more seeds per foot, which led to a lower percentage of survivors, but more actual live plants were present as compared to the transplanted forbs. There appears to be a trade-off between time input and seed input with the desert biscuitroot seeding.

Acknowledgments

We thank the ShREC field crews for assistance with planting and maintenance of the forbs and Granite Seed, Inc. for supplying seed for this research.

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Keywords: reclamation, sage-grouse habitat, native plants

PARP: X.3, XII.1

Table 1. Establishment of sulfur-flower buckwheat and desert biscuitroot one and two years after planting with different planting methods (direct seeding or transplant from greenhouse.

	Establishment (%) with 95% Confidence Intervals			
	One Year After Planting (2018)		Two Years After Planting (2019)	
	Direct Seeding	Transplanted	Direct Seeding	Transplanted
Sulfur-flower buckwheat	0.17%	71.7% +/- 21%	0.23% +/- 0.4%	58.3% +/- 31.6%
Desert biscuitroot	10.2% +/- 1.5	18.1% +/- 19.4%	6.5% +/- 0.9%	10.1% +/- 21.2%

*year one of direct seeding of buckwheat has no confidence interval because there was only establishment in one block.

Indaziflam Effects on Seed Production and Viability for Various Rangeland Grasses

Beth Fowers[1], and Brian Mealor[1,2]

Introduction

Annual weeds negatively impact grass seed production by directly competing for resources and by contaminating seed lots. Herbicide options in grasses grown for seed are relatively limited. Further, for an herbicide to be useful it must provide acceptable weed control with little reduction in seed production and viability. Indaziflam controls annual grasses and other weeds, but little is known about how it affects seed production and germinability.

Objectives

Our objectives were to evaluate the effects of the herbicide indaziflam on seed production and germinability across a range of established perennial grasses.

Materials and Methods

Thirteen grass species/varieties were seeded in a randomized complete block design with four replicates in 2013 at the Sheridan Research and Extension Center (ShREC) property east of Sheridan near Wyarno, Wyoming. We applied Esplanade 200 SC® (5 oz/ac) plus Roundup WeatherMax® (12 oz/ac) to one-half of each grass plot on March 27, 2017, leaving the other half as a non-treated control. Cheatgrass (aka downy brome, *Bromus tectorum*) and several of the perennial grasses were actively growing at the time of application.

We harvested, counted and weighed mature inflorescences (seedheads) mid to late July (as species matured) in 2017 and 2018, from three bunchgrasses per grass + herbicide plot or, if the species was rhizomatous, from three 0.25 m^2 (2.7ft^2) frames within each grass plot. We evaluated cumulative germination using 50-seed lots in petri dishes with filter paper in a growth chamber set at 70°F daytime and 50°F nighttime temperatures for one month. We analyzed data as a two-way analysis of variance with plant material and herbicide as the two treatments.

Results and Discussion

Control of annual grasses was still apparent two growing seasons after herbicide application, similar to what was observed in year one. However, the damage observed in the first growing season was largely non-existent by the second year. If a difference between plots occurred, positive increases in production or germinability occurred in herbicide treated areas.

By 2018, the number of the perennial grass inflorescences showed either no difference between the non-treated and herbicide areas, or application resulted in an increase. Species that showed an increase with herbicide included some varieties of wheatgrasses and wildryes (Figure 1). Inflorescence weight mimicked the patterns observed for inflorescence number since weight varied as inflorescence number changed and not because of a difference in the weight of the seed produced.

Total number and weight of inflorescences have a direct relationship to seed production. Because germination was decoupled from overall seed production, we can determine germination regardless of the total amount of seed produced. Germinability of most

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species was not impacted by herbicide two growing seasons after application (Figure 2). Some bluebunch wheatgrass and basin wildrye varieties showed an increase in germination in the herbicide treated areas, (between 10 and 30% increase). 'Pryor' slender wheatgrass, was the only species/variety to show any negative response to herbicide application with a reduction in germination in 2018. However, even with the reduction, it still had 80% germination which was better than some species and could be acceptable in a seed production system.

Control of annual grasses leads to reduced competition pressure on desirable perennial grasses and is likely why positive impacts were observed in 2018. Negative impacts to the perennial grasses observed in the first growing season after herbicide applications can be attributed to the impacts of glyphosate on established species if application occurs after dormancy has been broken. While data from 2018 allows us to assume most negative impacts in the first year were from glyphosate, it is not possible to separate impacts of either chemical in year one. Subsequent growing season impacts can be attributed to indaziflam impacts since glyphosate does not have a residual time. Data collection from the second growing season has allowed us to begin identifying impacts of indaziflam on seed production and germination of established species and future work will further increase that knowledge as the chemical breaks down.

Acknowledgments
We thank ShREC interns for their help with data collection and Bayer Crop Science for funding support.

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Keywords: indaziflam, perennial grass, seed production

PARP: III:5, 7, 11

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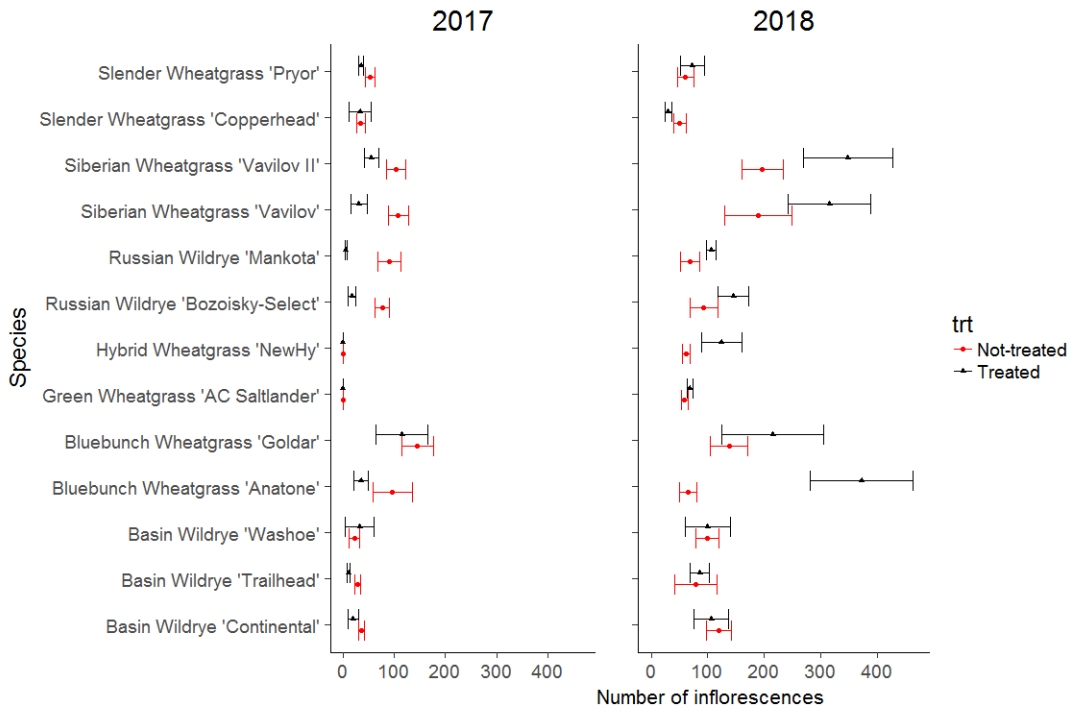

Figure 1. Total number of grass inflorescences across 14 plant materials (species) from 2017 and 2018 by herbicide treatment (mean +/- se). Glyphosate (420 g ai/ha) and indaziflam (73 g ai/ha) were applied March 27, 2017.

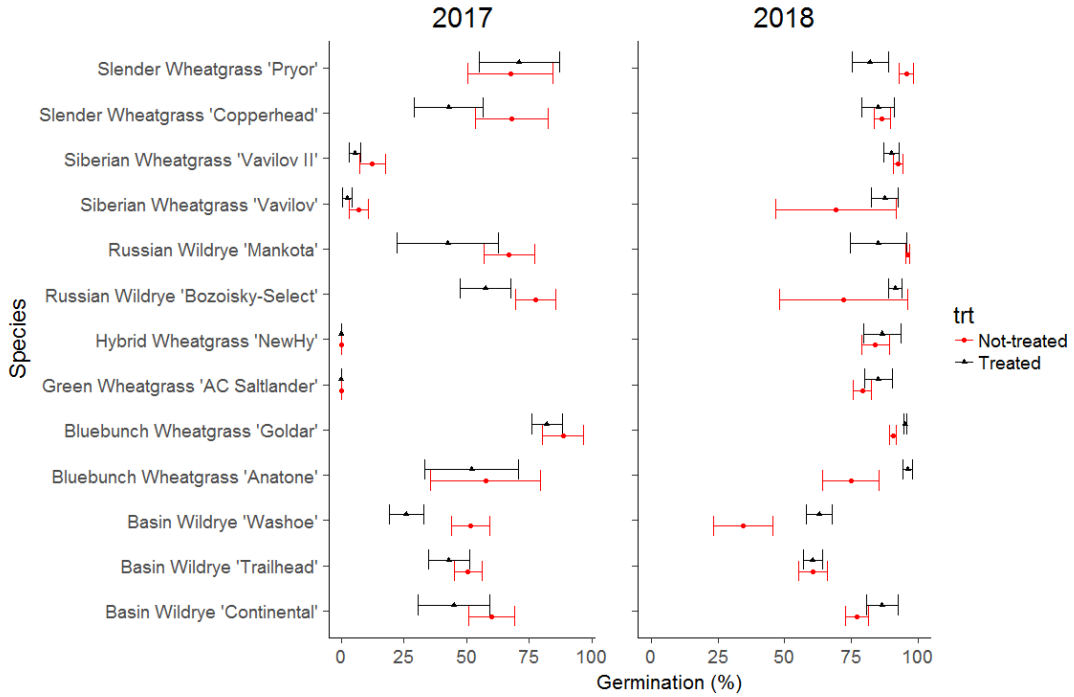

Figure 2. Cumulative seed germination (4 replicates, 50 seeds per rep) across 14 plant materials (species) from 2017 and 2018 by herbicide treatment (mean +/- se). Glyphosate (420 g ai/ha) and indaziflam (73 g ai/ha) were applied March 27, 2017.

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Effects of Ventenata Removal on Rangelands of Northeast Wyoming

Marshall Hart[1, 2] & Brian Mealor[1, 2]

Introduction

Invasive annual grasses have invaded vast areas in the western United States and are a major concern for conservation efforts. In Wyoming and the Great Plains, there are two newly documented species: ventenata (*Ventenata dubia* (Leers) Coss.) and medusahead (*Taeniatherum caput-medusae* (L.) Nevski). These species reduce forage availability and biodiversity, may increase erosion, and accelerate fire cycles in the intermountain west (Hilken and Miller 1980; Washington State Noxious Weed Control Board 2016), but little is known about their biology and ecology in the northern mixedgrass prairie of the Great Plains.

Objectives

Currently, there are landscape scale control efforts by the Northeast Wyoming Invasive Grasses Working Group (NEWIGWG) to contain, control, and eradicate these species from northeast Wyoming. To inform these control efforts, we asked several questions centered around the effects of ventenata removal after herbicide application: How effective were herbicide treatments? Did perennial grasses recover as a result of control? What is the forage quality of invasive grasses compared to perennial grasses? And what is the community level response to ventenata removal?

Materials and Methods

To answer these questions, we sampled sites treated by NEWIGWG paired with adjacent non-treated sites. Treated sites were sprayed aerially with 123 g·ha-1 each of imazapic plus aminopyralid (47 L·ha-1 total solution) in fall of 2016 or 2017 in Sheridan County, WY. We placed three 15.24 m (50 ft) transects, each with three 0.25 m^2 sub-plots, within each block. Along each transect, we conducted a line-point intercept at 0.31 m (1 ft) intervals. In each sub-plot, we collected and sorted all above-ground biomass into the following functional groups: annual grass, annual forbs, perennial grass, and perennial forbs. Each of these groups was dried and weighed before being sent to a lab and analyzed for crude protein and total digestible nutrients (TDN). Data were then pooled at the plot level and analyzed with paired t-tests.

Results and Discussion

Herbicide treatment successfully reduced annual grass biomass ($p=0.002$; **Fig. 1**) and reduced ventenata cover ($p=0.001$; **Table 1**). However, there was not an associated increase in perennial or total grass biomass (**Fig. 1)**, which may be due to high variability in responses of perennial grasses. There was also no change in species richness to ventenata removal. The short time since ventenata removal may also explain the lack of response in the plant community and biomass of perennial grasses. There may not have been enough time following removal to allow perennial species to fully recover. However, cover of the most dominant perennial species, western wheatgrass (*Pascopyrum smithii* (Rydb.) Á. Löve) increased ($p=0.04$; **Table 1**), showing that there was some improvement. Unfortunately, ventenata was observed reestablishing in older treatments (those that had been treated two year prior). This means that full recovery of species richness and perennial forage should not be expected at these sites.

Nutrition analysis of samples showed that perennial grasses have higher crude protein and TDN than annual grasses ($p<0.05$;

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Table 2). However, this higher nutritional content was not reflected in the amount of crude protein and TDN per acre (**Table 1)**. This may be due to high variability in biomass of perennial grasses. Although there was not a significant difference in the amount of these nutrients between treated and non-treated sites, these nutrients are not necessarily available to cattle or wildlife since ventenata is highly unpalatable.

Acknowledgments

We thank the members of NEWIGWG and the Sheridan Research and Extension Center for helping with planning and gathering data.

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Keywords: ventenata, forage production, conservation, weed management

PARP: III.7,11; VI.3

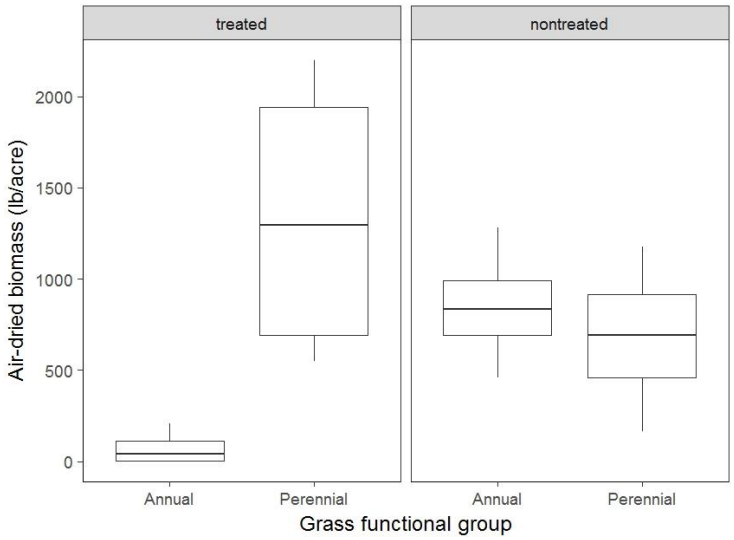

Figure 1. Mean grass biomass by herbicide treatment in a ventenata-invaded rangeland in northeast Wyoming. Annual grass biomass decreased (p=0.002) while perennial and total grass biomass did not change.

Table 1. Mean biomass, crude protein, total digestible nutrients (TDN), and cover of ventenata, western wheatgrass, and bare ground by herbicide treatment in northeast Wyoming. Standard error is in parenthesis. Significant findings are bolded (p<0.05). *Animal unit month per acre (AUM·ac^{-1}) based on 50% use assuming equal use of annual and perennial grasses.

Treatment (n)	Biomass (lb·ac^{-1})	Available AUM·ac^{-1}*	Crude Protein (lb·ac^{-1})	TDN (lb·ac^{-1})	Ventenata Cover (%)	Western Wheatgrass Cover (%)	Bare Ground (%)
Non-treated (5)	1566.3 (274)	0.98 (0.17)	92.4 (17.0)	852.2 (150.9)	**33.8 (5.0)**	**30.8 (2.1)**	**9.0 (2.8)**
Treated (4)	2017.0 (696)	1.26 (0.44)	158.5 (44.5)	1374.5 (443.2)	**8.6 (2.2)**	**42.7 (4.9)**	**23.5 (4.0)**

Table 2. Crude protein and total digestible nutrients (TDN) of non-treated samples of perennial and annual grasses collected July 2018 in Sheridan County, WY. Standard error is in parenthesis. Means between annual and perennial grasses differed for both crude protein and TDN (p<0.001).

Functional Group (n)	Crude Protein (%)	TDN (%)
Perennial (5)	**6.84 (0.20)**	**59.32 (0.57)**
Annual (5)	**5.16 (0.32)**	**50.68 (1.01)**

Perennial Cool-Season Grasses under Irrigation for Hay Production and Fall Grazing

Blaine Horn[1], Anowar Islam[2], Dan Smith[3], Valtcho Jeliazkov[4], and Axel Garcia y Garcia[5]

Introduction

Perennial cool-season grasses comprise nearly 25% of hay field acreage in northeast Wyoming. The most popular grasses used for hay production under irrigation in this region has been smooth or meadow brome. Although these two grasses are productive with good stand persistence, they generally reach anthesis, optimum stage for hay harvest, by mid-June most years in northern Wyoming. For operations with significant acreage this could result in some of the hay being lower in quality than what a lactating beef cow or sheep ewe requires due to the maturity of the grasses at harvest. Likewise small hay operations dependent upon custom harvesters can have their fields harvested when these grasses are at a later maturity than desired. The opportunity to select perennial cool-season grasses with varying maturity dates could benefit hay producers in being able to furnish good quality hay for their own livestock as well as to their clients.

Objectives

Objectives of this study were to assess (1) late spring/early summer hay yields of perennial cool-season grasses; (2) regrowth yields of these grasses for fall grazing; and (3) forage quality of the hay and regrowth.

Materials and Methods

Perennial cool-season introduced grasses seeded in September 2014 underwent harvests over a three year period to assess their hay yields and regrowth forage yields. Hay harvests occurred on 16, 15, and 20 June in 2016, 2017, and 2018, respectively for ‘Manchar’ and ‘Carlton’ smooth brome, ‘Paddock’ and ‘MacBeth’ meadow brome, ‘Latar’ and ‘Profile’ orchard, and ‘Fawn’ and ‘Texoma MaxQ II’ tall fescue; and on 30 June in 2016 and 2017, and on 5 July in 2018 for, ’Luna’ and ‘Manska’ pubescent wheatgrass, ‘Oahe’ and ‘Rush’ intermediate wheatgrass, and ‘Climax’ and ‘Tuukka’ timothy. Desired stage of maturity for harvest was post-flowering to visible seed development. Regrowth of the grasses underwent a harvest on 10 October 2016, 28 September 2017, and 2 October 2018. The plot area received 150 pounds per acre of nitrogen in November 2015, and in April 2017 and 2018. In addition, 30 and 50 pounds of phosphate was applied in November 2015 and April 2017, respectively.

Results and Discussion

The intermediate and pubescent wheatgrasses produced the most hay (4.4 T/ac), followed by the bromes, ‘Latar’ orchardgrass, ‘Texoma MaxQ II’ tall fescue, and ‘Tuukka’ timothy (3.4 T/ac) (see Table). The two-week harvest delay may have been a contributing factor for why the wheatgrasses produced an extra T/ac of hay each year but they were at the same phenological growth stage as the other grasses when harvested. ‘Latar’ orchardgrass produced the most regrowth forage among the grasses followed by ‘Texoma MaxQ II’ tall fescue and then ‘Profile’ orchardgrass (see Table). Regrowth of the grasses averaged 41% of their hay yields in 2016 but fell to 9.5% and 5.6% in 2017 and 2018, respectively. Furthermore, 2017 and 2018 regrowth yields were 25% and 13% of those in 2016, respectively. A plausible reason for the dramatically lower regrowth yields in 2017 and 2018 compared to 2016 was the amount of moisture (precipitation + irrigation) the plots received

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in August to the day before harvest. The amounts were 14.0, 7.6, and 7.0 inches in 2016, 2017, and 2018, respectively. We should have applied an additional 7.0 inches of water in 2017 and 2018. This would have especially been true for 2018 as mean daily temperatures averaged 7.6 degrees warmer compared to in 2016 and 2017 which were similar. (See 2017 and 2018 Field Days Bulletins for quality components).

Acknowledgments
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Keywords: Cool season grasses, hay production, regrowth yields

PARP: I:2

Table Sh1. Hay yields (12% moisture) for the early summer harvests, and regrowth dry matter yields (12% moisture) for the early autumn harvest of the cool-season perennial grasses.

Grass	Variety	Hay yields (T/ac)				Regrowth yields (T/ac)			
		2016	2017	2018	Avg.	2016	2017	2018	Avg.
Smooth brome	Carlton	4.4 b	3.3 e	3.0 e	3.5 b	0.82 f	0.08 e	0.05 e	0.32 g
	Manchar	3.5 c	3.6 cd	2.8 e	3.7 b	1.48 cd	0.21 cde	0.12 de	0.60 de
Meadow brome	MacBeth	3.4 c	3.5 de	2.8 e	3.2 b	1.45 cde	0.43 b	0.16 cde	0.68 cd
	Paddock	4.4 b	3.5 de	2.5 f	3.5 b	1.18 def	0.33 bcd	0.20 cd	0.57 de
Orchard	Latar	2.4 d	3.8 bc	3.5 cd	3.2 b	1.78 abc	0.91 a	0.45 a	1.05 a
	Profile	1.6 e	3.3 e	2.5 f	2.4 c	1.59 bcd	0.49 b	0.37 ab	0.82 bc
Tall fescue	Fawn	1.4 e	3.5 de	3.0 e	1.9 d	1.58 bcd	0.34 bcd	0.27 bc	0.57 def
	Texoma MaxQII™	2.8 cd	3.8 bc	2.9 e	3.2 b	2.13 a	0.47 b	0.28 bc	0.96 ab
Intermediate wheatgrass	Oahe	4.9 a	4.4 a	3.8 bc	4.3 a	1.48 cd	0.19 de	0.09 de	0.59 de
	Rush	4.8 a	4.4 a	4.0 ab	4.4 a	1.01 ef	0.23 cde	0.17 cde	0.47 efg
Pubescent wheatgrass	Luna	5.1 a	4.5 a	4.2 a	4.6 a	0.91 f	0.11 e	0.07 e	0.36 g
	Manska	4.8 a	4.6 a	3.7 c	4.4 a	1.23 def	0.16 de	0.08 de	0.49 efg
Timothy	Tuukka	2.2 d	4.0 b	3.7 c	3.2 b	1.98 ab	0.39 bc	0.12 de	0.38 fg
	Climax		3.0 f	3.6 cd	3.3 b		0.31 bcd	0.13 cde	0.22 h

Note: Column means followed by same letters do not differ at $p<0.05$

Multi-year Cheatgrass Control a Single Herbicide Application

Brian Mealor[1,2], Beth Fowers[1]

Introduction

Although current chemical methods for controlling downy brome (aka cheatgrass/*Bromus tectorum*) are fairly effective, they require relatively frequent re-treatment to maintain cheatgrass suppression on infested sites. Some herbicides not previously used in rangeland settings may provide longer-term control with a single application. Additional tools for suppressing or controlling cheatgrass may improve the ability of ranchers, farmers, land managers, reclamation personnel, and others to restore cheatgrass-impacted rangelands while diminishing potential for developing herbicide-resistant cheatgrass populations by repeated applications of herbicides with the same mechanism of action.

Objectives

Our objectives are to evaluate seven herbicide mixtures at two different timings for their effectiveness in reducing cheatgrass and their impacts on associated vegetation.

Materials and Methods

We applied seven herbicide mixtures at two different timings (March and April) in 2016 with a total volume of 20 gallons per acre with a CO_2-pressurized sprayer and a 10-foot boom with six 8002 nozzles. Treatments were implemented in 10- by 30-foot plots set in a randomized complete block design with three replicates and a replicated, non-treated check. Treatments included Lambient™ (1.2 oz/ac) and Plateau® (7 oz/ac) alone and combined; Esplanade 200 SC® (5 and 7 oz/ac) combined with Roundup WeatherMAX® (16 oz/ac) or combined with Olympus™ (1.2 oz/ac).

Applications on March 3 occurred with a 54°F air temperature, 38% relative humidity, 41°F soil temperature at 2 inches deep, and 5–8 mph wind. Cheatgrass on-site varied from the 1–3 leaf growth stage, and roughly half the plants were purple due to semi-dormancy from cold weather. Applications on April 21 occurred with a 60°F air temperature, 54% relative humidity, 48°F soil temperature at 2 inches deep, and 3 mph wind. Cheatgrass was 2–3 inches tall and actively growing. We visually evaluated cheatgrass control annually 2016-2019 by comparing to nontreated plots.

Results and Discussion

In the season of herbicide application (2016), all Roundup-containing treatments provided very good cheatgrass control (Fig. 1). Second and third year control was very good for all treatments containing Esplanade. In 2019, the fourth growing season after herbicide application, Esplanade at 7 oz/acre plus either Roundup or Olympus applied in April maintained near complete cheatgrass control. This longevity of control from a single treatment is outstanding.

Acknowledgments

Many thanks to ShREC team and summer interns over the past four years for contributing to data collection and to Bayer, US for supporting this research.

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Keywords: cheatgrass, weed management, invasive species

PARP: III:3,5,7, VI:3, XII:1

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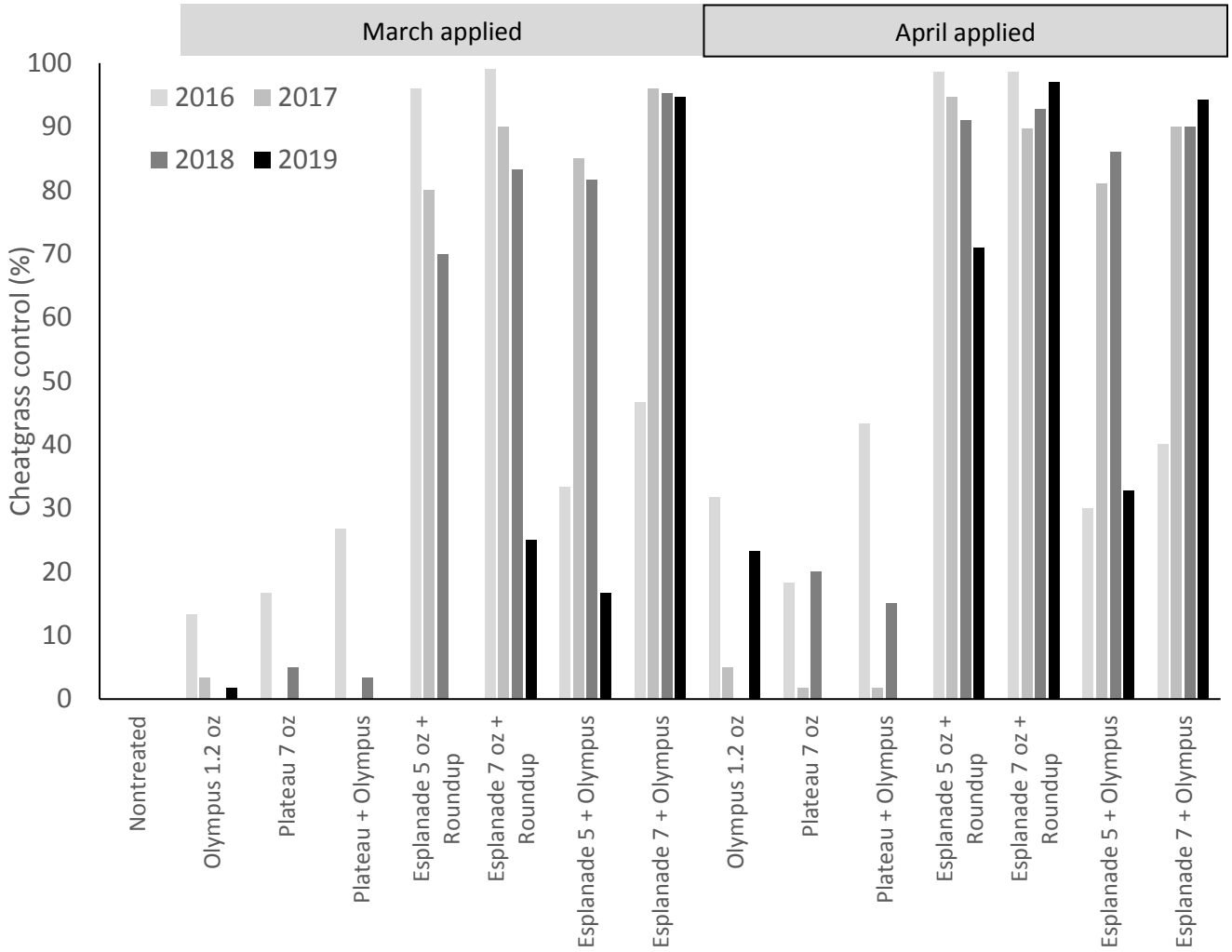

Figure 1. Cheatgrass control (%) across multiple herbicide treatments applied in March or April 2016.

Alfalfa Weevil Growing-Degree Day Calculator Part 2 – Invalidation of the Harcourt 1981 Model for Wyoming

Scott Schell[1], Jeremiah Vardiman[2] and Blake Hauptman[3]

Introduction

Alfalfa is a very important crop in Wyoming and alfalfa weevil (*Hypera postica*) is currently its worst insect pest. It is important to know when the best time to survey crop pest populations. Survey too early in the growing season and you are either wasting effort or obtaining false negative data. Survey too late and you may suffer a severe crop loss or miss the best pest stage for control.

Because alfalfa weevils start their damage inconspicuously, as tiny larvae feeding inside the tightly folded leaves of stem tips, it is useful to have tool to predict the best date to sample a crop in order to make management decisions. Plant and insect growth is correlated to environmental temperatures. Temperature data is now freely available online and can be used to predict pest and crop development.

D. Harcourt (1981) developed a growing degree-day (GDD) model based on the minimum known temperature for alfalfa weevil larval development in southern Ontario, Canada. It was found to be a useful predictor for alfalfa weevil seasonal occurrence in the Rocky Mountain region in the early 1990s. It has been made available as a web based application that allows a user to get GDD outputs based on temperature data from weather stations closest to their alfalfa fields. However, the accuracy of the Harcourt GDD model had not been tested in WY recently.

Objectives

We continued work on testing the accuracy of the now internet-based Harcourt GDD alfalfa weevil development calculator. If accurate, it will allow alfalfa producers to use their local weather station data to predict alfalfa weevil larval development.

Materials and Methods

Validation testing of the GDD calculator started in 2017 and was completed in 2018. We compared the Harcourt 1981 GDD model predictions of alfalfa weevil larval developmental stages available at https://pnwpest.org/cgi-bin/ddmodel.us to actual stages observed in pest population samples taken from producers' fields in the Bighorn, Washakie, Fremont, Campbell, Crook, and Sheridan counties over the course of 2 growing seasons.

Results and Discussion

The Harcourt 1981 alfalfa weevil GDD calculator did not accurately predict alfalfa weevil development. The 2017 and 2018 alfalfa weevil samples consistently contained larvae later in development than the model predicted. For example, the same field at the Powell Research and Extension Center had larvae over 200 degree days ahead of the model prediction in both 2017 and 2018.

It is doubtful that the base temperature of 48 F to trigger alfalfa weevil development has changed to a lower temperature since 1981. We tried changing the parameters of the model to start on Jan.1st instead of March 1st. This resulted in little change of GDD accumulations at the time of the sampling. This rules out milder winter weather allowing weevil egg to develop then.

One explanation for faster than predicted alfalfa weevil development is made by comparing what we have observed in the samples to what is reported about the pest from more eastern and lower elevation states. In states like Oklahoma, adult alfalfa weevil become active during mild fall weather and will deposit eggs in plant stems then. The eggs can then start accumulating

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GDD (i.e. begin embryonic development) towards hatch. This quote from an Oklahoma State Univ. factsheet on alfalfa weevil may explain what we are now observing in Wyoming- "During fall, adults leave over-summering sites and enter alfalfa fields to feed and deposit eggs in stems of alfalfa plants. Egg deposition occurs from November to the following April when temperatures exceed 40°F." (Mulder P. 2017). It has been observed that the eggs may die in temperatures below 10°F during the winter if there is no snow cover to insulate them. The variability and the severity of the fall and winter weather greatly influences the timing alfalfa weevil populations in Oklahoma. If it is a severe winter, only adult alfalfa weevil survive it to start depositing eggs when temperature warm up. The Oklahoma State Extension service conducts alfalfa weevil egg surveys at 7 sites across the state in mid-February each year (Seuhs, K., 2019). In mild winter years, they can find viable egg densities of over 400 per square foot during the survey. At this time, we recommend that Wyoming forage alfalfa producers sample their fields for alfalfa weevil starting when the crop is between 10 to 15 inches high with the bucket method as described in the "When and How to Scout" section of this 2018 extension bulletin from NDSU https://www.ag.ndsu.edu/publications/crops/integrated-pest-management-of-alfalfa-weevil-in-north-dakota The sample alfalfa stem tips should be closely examined for the tiny first stage of alfalfa weevil. If damaging numbers of alfalfa weevil are found at this stage of alfalfa growth, all methods of control are available to the grower to use before harvest or extensive damage to the crop is done by the pest.

Acknowledgments
We are grateful for the farmers who allowed the collection of samples from their fields. We also appreciate Allied Seed staff and personnel from the Sheridan and Powell R&E centers for their time and effort with sampling.

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Keywords: alfalfa weevil, growing degree-day calculator, pest management

PARP: n/a

Relative competitive ability of bulbous bluegrass (*Poa bulbosa*) and cheatgrass (*Bromus tectorum*) with perennial grasses

Jordan Skovgard[1,2] and Brian Mealor[1,3]

Introduction

Bulbous bluegrass is an invasive cool season perennial that exists over much of Wyoming's rangelands. Bulbous bluegrass' invasive tendencies could have implications for desirable perennial vegetation. However, little is known about its ecology or its effect on grass species in areas where it has invaded.

Objectives

Our objective was to evaluate bulbous bluegrasses competitive ability compared to cheatgrass, a known competitor, when grown with perennial grasses.

Materials and Methods

This experiment was conducted in the Greenhouse at the Sheridan Research and extension center. We used a replacement series design where we planted different species at varying proportional densities with eight individuals in each ratio: 0:8, 2:6, 4:4, 6:2, 8:0. We used field soil for 6 replicates in this experiment. After 12 weeks we harvested aboveground biomass to calculate the relative yield of each species. Relative Yield (RY) compares the amount of biomass produced when grown with other species to biomass produced when grown alone, which standardizes the data and allows for comparison across different species (Fig.1).

Our target species were bulbous bluegrass and cheatgrass – both undesirable invasive grasses common in northeast Wyoming. Our desirable species were 4 native perennial grasses including western wheatgrass (*Pascopyrum smithii),* bluebunch wheatgrass (*Pseudoroegneria spicata),* bottlebrush squirreltail (*Elymus elymoides),* and Idaho fescue (*Festuca idahoensis),* and 1 introduced perennial grass - crested wheatgrass (*Agropyron cristatum).*

Results and Discussion

All desirable species were suppressed by the presence of cheatgrass on a species level and when pooled together, but bulbous bluegrass had varying impact based on the grass species it was grown with. Western wheatgrass, bottlebrush squirreltail, and crested wheatgrass were not suppressed by bulbous bluegrass presence. This may indicate they could be good species to plant on rangeland restoration or reclamation sites where bulbous bluegrass is prevalent. Poor competitive ability was displayed by bluebunch wheatgrass and Idaho fescue when grown with both cheatgrass and bulbous bluegrass.

Bulbous bluegrass exhibited a neutral impact on perennial grasses when they were pooled as a group (Fig. 2), indicating weak competitive interactions. Cheatgrass showed superior competitive ability when grown directly with bulbous bluegrass when testing their interaction. Although bulbous bluegrass does not have the same high competitive ability as cheatgrass it could potentially displace desirable perennial grasses depending on species composition and other factors (resource availability, disturbance).

Acknowledgments

We thank the ShREC team member for assistance and support in this project.

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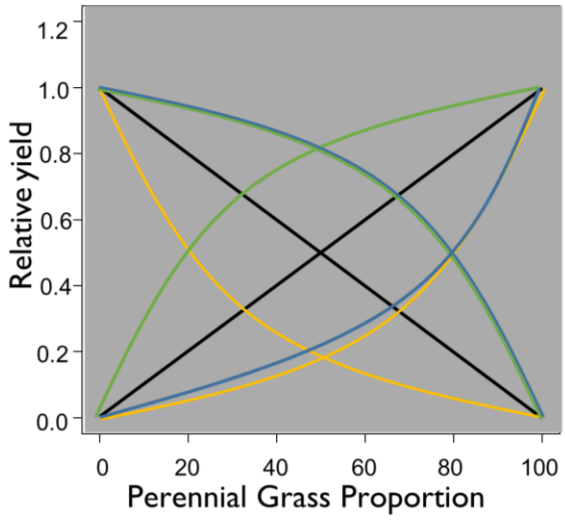
Keywords: Invasive weeds, native plants, competition, range management

PARP: III.5, VI.3



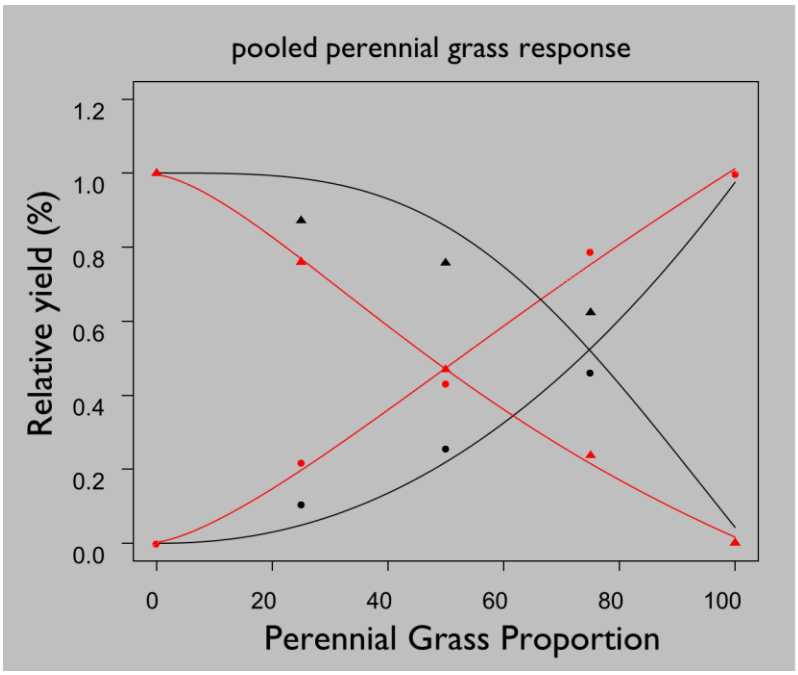
Straight lines indicate lack of competition OR equal competitive abilities.

Concave/convex response indicates one species (concave) more competitive than the other.

Concave/concave response indicates potential facilitation (mutualistic) relationship.

Convex/convex response indicates mutual antagonism - both species reduced.

Figure 1. Conceptual potential responses from our replacement series experimental design demonstrating interpretation of results.



Bulbous bluegrass

Perennial with bulbous

Cheatgrass

Perennial with cheatgrass

Figure 2. Relative yield pooled for five perennial grass species with bulbous bluegrass and cheatgrass (downy brome) across 6 mixture/monoculture ratios. Lines are regression lines fit to raw data (6 replicates). Points are means for each ratio/species combination.

Evaluating Efficacy of Various Herbicides on Bulbous Bluegrass

Jordan Skovgard[1,2] Beth Fowers[1], and Brian Mealor[1,3]

Introduction

Bulbous bluegrass is an invasive cool season perennial that exists over much of Wyoming's rangelands. Although it has been present (and likely spreading) in Wyoming for many years, we know relatively little about its ecology and management in natural systems.

Identifying suitable chemical control options may be especially difficult for this species since removing a perennial grassy weed from a rangeland system primarily composed of desirable grass species requires selectivity through chemistry, rate, or timing.

Objectives

Our objective evaluate multiple herbicides for their efficacy in controlling bulbous bluegrass while maintaining desirable vegetation.

Materials and Methods

We established randomized complete block field experiments at two locations (Sheridan and Rozet, Wyoming) in April 2018. We applied 11 residual herbicide treatments crossed with and without 10 oz/acre Roundup Weathermax ® to 10 x 30 foot plots in four replicates at each site. Roundup was applied to 1/3 of each plot following the other herbicide applications.

We collected posttreatment data 30 days after treatment (30 DAT) and 1 year after treatment (1 YAT). Data collected include plant canopy cover by species and visual control for bulbous bluegrass and injury for desirable species. We only present control data from Sheridan in this bulletin due to space limitations.

Results and Discussion

Within-season bulbous bluegrass control (30 DAT) was very good for all treatments when Roundup was included in the treatment (Figure 1). All herbicides except Esplanade at 5 and 7 oz/acre exceeded 90% control in the first season.

By 2019 (1 YAT), the direct effects of Roundup had deteriorated (Fig 1; "Check – Roundup = N"), and bulbous bluegrass control was not distinguishable from the nontreated check. All other treatments except Esplanade (5 and 7 oz) and Plateau still provided excellent control 1 YAT (Fig. 1). Desirable perennial plant injury (primarily crested wheatgrass at this site) was greatest for treatments containing Landmark XP (data not shown).

Acknowledgments

We thank the ShREC team member for assistance and support in this project.

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PARP: III.5, VI.3

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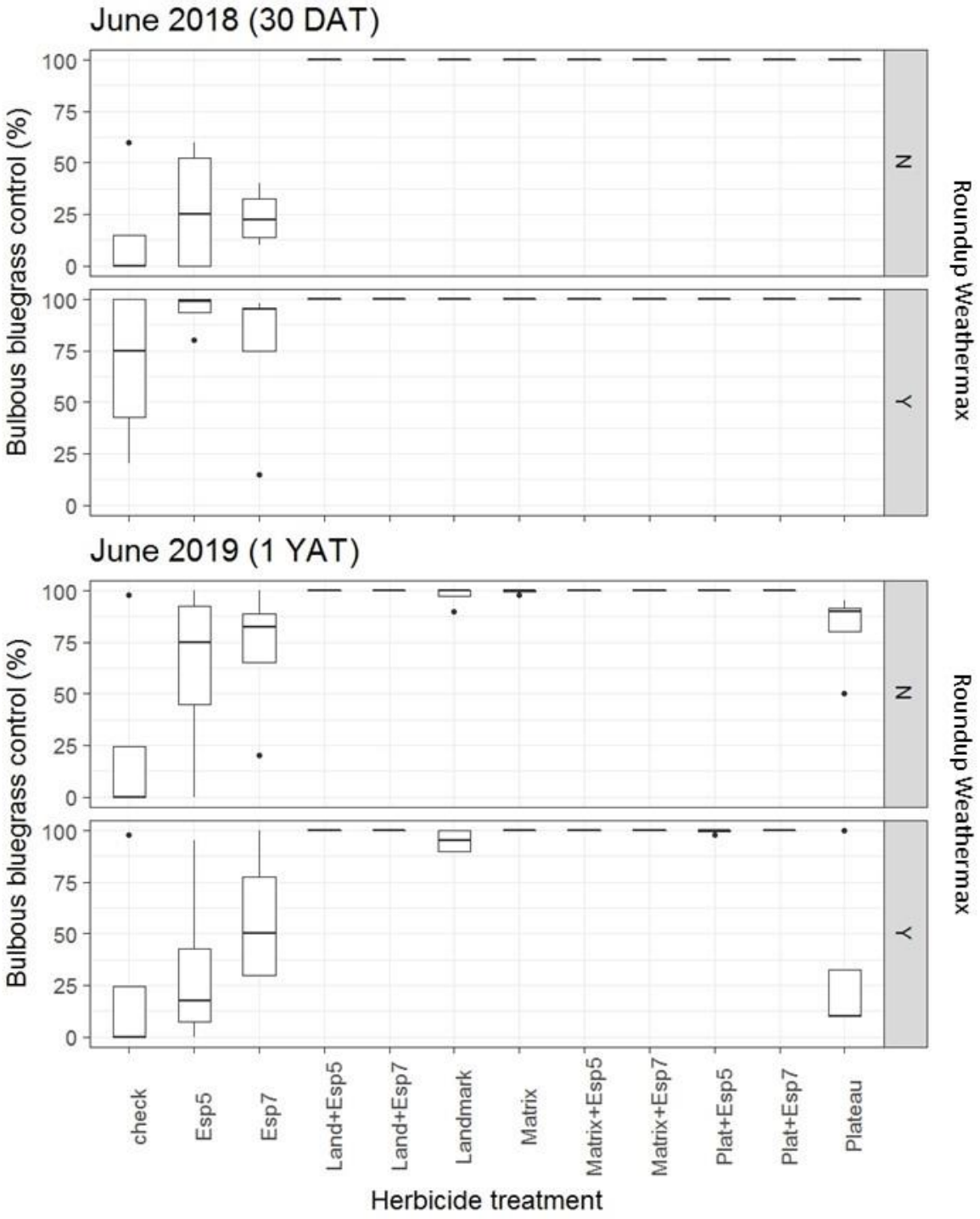

Figure 1. Boxplots of bulbous bluegrass control 30 days (30 DAT) and one year (1 YAT) after treatment for 11 herbicides crossed with and without Roundup Weathermax ® herbicide applied in April 2018. Treatments include Esplanade (5 and 7 oz/acre), Landmark (1.3 oz/acre), Matrix (3 oz/acre), Plateau (7 oz/acre) and the combinations of each with Esplanade.

Production and Forage Quality of Alfalfa Varieties in Sheridan 2018

Daniel Smith[1], Beth Fowers[1], Brian Mealor[1,2]

Introduction

Alfalfa is one of the most important agricultural crops grown in Wyoming, and is of particular interest for both cattle and hay producers in the northeastern portion of the state. Prolific breeding programs have resulted in multiple varieties specifically bred to do well under local conditions. While many producers grow alfalfa, direct comparisons of commercially-available varieties in our area have not been common.

Objectives

The objective of this study was to evaluate commercially-available alfalfa varieties for forage production and quality in a demonstration setting.

Materials and Methods

In Spring of 2017, we seeded six commercially available alfalfa varieties (Nexgrow "6497R" and "6427R," Croplan "Graze-n-Hay 3.10 RR," "RR Tonnica" and "HVX Driver," and Genuity "4R-416") at 15 lb/acre into a non-irrigated field in Sheridan, WY. We planted each variety into a single, non-replicated strip approximately ½ acre in size. Soils on the site are a Wyarno clay loam that receives some natural subirrigation due to slope position of the field.

We collected yield data from three subplots of each strip at each harvest event in 2018. We evaluated forage quality for each variety and cutting and report crude protein, total digestible nutrients, and relative feed value in this report. The climatic year was such that a third small cutting was collected in September.

Results and Discussion

Since this was a non-replicated demonstration planting, within-plot averages are presented for each variety. Yields ranged from 4.4-5.23 tons/acre among the varieties, with Geunity "4R-416" providing the highest yield (Table 1). Yield from the first two harvest dates, which would be the normal harvest in most years, was over 4 tons per acre for Croplan "Graze-n-Hay 3.10 RR," "RR Tonnica," and Genuity "4R-416."

Forage quality data from all varieties was very good, especially for the second and third cuttings (Table 1). We plan to expand variety comparisons and evaluations in Sheridan in future years.

Acknowledgments

We thank our cooperators who provided alfalfa seed for the trial and the ShREC field crew for collecting and processing samples.

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Keywords: forage production, hay quality, plant varieties

PARP: VII.6

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Table 1. Dry matter yield and forage quality characteristics for 6 alfalfa varieties on dryland in Sheridan, WY.

Cultivar	**2018 Hay Harvest at Sheridan Research and Extension Center**			
	1st (6/6/18)	*2nd (8/9/18)*	*3rd (9/10/18)*	*Total Yield/Mean Quality*
Nexgrow "6497R"				
dry matter yield (ton/ac)	**2.36**	**1.17**	**0.84**	**4.37**
crude protein (%)	17.6	24.5	23.4	21.83
total digestible nutrients (%)	59.5	68.5	68.4	65.47
relative feed value (RFV)	119.9	201.8	191.9	171.20
Croplan "Graze-n-Hay 3.10 RR"				
dry matter yield (ton/ac)	**2.70**	**1.56**	**0.66**	**4.92**
crude protein (%)	19.7	23.5	24.9	22.70
total digestible nutrients (%)	62.9	67.9	69.6	66.80
relative feed value (RFV)	141.2	189.9	208.7	179.93
Nexgrow "6427R"				
dry matter yield (ton/ac)	**2.42**	**1.39**	**0.84**	**4.65**
crude protein (%)	18.9	23.9	24.3	22.37
total digestible nutrients (%)	61.1	67.1	68.6	65.60
relative feed value (RFV)	129.4	183.7	192.9	168.67
Croplan "HVX Driver"				
dry matter yield (ton/ac)	**2.50**	**1.43**	**0.79**	**4.73**
crude protein (%)	19.5	23.6	23.7	22.27
total digestible nutrients (%)	61.9	67.5	68.1	65.83
relative feed value (RFV)	134.6	184.4	187.9	168.97
Genuity "4R-416"				
dry matter yield (ton/ac)	**2.82**	**1.66**	**0.79**	**5.26**
crude protein (%)	19.2	22.2	24.9	22.10
total digestible nutrients (%)	61.5	66.5	69.8	65.93
relative feed value (RFV)	132.9	175.7	211.1	173.23
Croplan "RR Tonnica"				
dry matter yield (ton/ac)	**2.76**	**1.39**	**0.78**	**4.93**
crude protein (%)	24.4	23.2	18.5	22.03
total digestible nutrients (%)	67.9	67.3	60.1	65.10
relative feed value (RFV)	191.7	183.6	127.3	167.53

Nitrogen requirements of ancient grains in Wyoming

Authors: Caitlin Youngquist, Carrie Eberle, Thomas Foulke, Mark Sorrells, Steve Zwinger

Introduction: The state of Wyoming is a challenging place to farm due to low soil fertility and quality, saline and alkaline soils, arid conditions, high crop evapotranspiration demands, and isolation from markets. The soil, climate, geographical, and sociopolitical conditions have historically limited crop diversity and adoption of more common sustainable farming practices like low input alternative crops, reduced tillage, cover crops, and water conservation.

Goal: This project will study the nitrogen and water demands of ancient grains (spelt, emmer, and einkorn), evaluate crop performance in three growing regions of the state, and assess the impact of growing conditions on grain quality.

Objectives:

1. Identify best practices for growing einkorn, emmer, and spelt in Wyoming.
2. Communicate best practices for growing einkorn, emmer, and spelt grain in Wyoming.

Expected Impacts: Results of the study will provide recommendations of ancient grains best adapted for growing regions and optimal nitrogen requirements for crop production. Final publications will be completed in the spring of 2021.

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Keywords: ancient grains, Neolithic, Wyoming First Grains, Spelt, Emmer, Einkorn

PARP: I.2, I.19, IX.10, IX.11

Bulbous bluegrass stand demographics

Authors: Jordan Skovgard, Brian Mealor

Introduction: Bulbous bluegrass (*Poa bulbosa)* is an invasive, weak perennial grass that occurs over much of Wyoming. This grass produces bulblets rather than seeds - a trait shared by few other species. Although this plant has existed in our local systems historically, little is known about its population dynamics.

Goal: To learn more about the reproductive strategy of invasive bulbous bluegrass.

Objectives: Our objective with this experiment is to determine which proportion of a population regenerates from mature adult plants versus what proportion of the population results from bulblets overwintering in the soil.

Expected Impacts: Summer of 2019 will be the first data collection for this experiment. We will learn about basic reproductive biology in our region, which will inform management practices for trying to control bulbous bluegrass.

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Keywords: invasive grass, weed management, plant biology

PARP: III.5, VI.3