



AGRICULTURAL RESEARCH CENTER - HAYS

# ROUNDUP 2022

**K-STATE**  
Research and Extension

Kansas State University Agricultural Experiment Station and Cooperative Extension Service



# ROUNDUP

## 2022

### Statement of Purpose

Roundup is the major beef cattle education and outreach event sponsored by the Kansas State University Agricultural Research Center - Hays. The 2022 program is the 106th staging of Roundup, due to cancellation of the in-person event in 2020 and 2021 from the COVID-19 pandemic. Because of the extent of recent wildfires that affected many producers and parcels of land in the northwest Kansas region, the return of the 2022 Roundup in-person program focused on the recovery and management of the rangelands involved in these wildfire events. The purpose for this report was to communicate to producers and extension personnel timely, applicable research information on other beef production and rangeland topics that were not included within the in-person wildfire recovery program.

The research program of the Agricultural Research Center - Hays is dedicated to serving the people of Kansas by developing new knowledge and technology to stabilize and sustain long-term production of food and fiber in a manner consistent with conservation of natural resources, protection of the environment, and assurance of food safety. Primary emphasis is on production efficiency through optimization of inputs in order to increase profit margins for producers in the long term.

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# The Effects of Intensive Early Stocking and Early Weaning on the Onset of Puberty and Reproductive Success in Beef Replacement Heifers

*Chance Fiehler, John Jaeger, Justin Waggoner, Keith Harmony, and K.C. Olson*

## Introduction

Management practices utilizing genetics, nutrition, and growth have commonly been studied to maximize the lifetime productivity of female beef cattle. However, heifers managed to have their first calf by 24 months of age have the greatest chance of achieving maximum lifetime productivity.

One way for a heifer to calve by 24 months of age is to decrease the age at which she reaches puberty. Heifers reaching puberty 1 to 3 months before exposure to breeding maximized conception success, as was shown when heifers bred during their third estrus were 21% more likely to conceive than heifers that were bred during their first or second estrus. Also, heifers fed a high-energy diet during the post-weaning period displayed a decreased age at puberty and an increased pregnancy rate. Additionally, early-weaned heifers fed a high-energy diet at an early age reached puberty at younger ages than those fed a low-energy control diet or those fed a high-energy diet beginning at six months of age.

We hypothesized that heifers that were weaned at 120 days of age and provided a high-energy diet compared to the diet consumed by heifers weaned at a more conventional time of 205 days of age would display puberty at an earlier age and have improved first service conception and overall pregnancy rate.

## Experimental Procedures

Angus and Angus × Hereford cross heifers ( $n = 166$ ) were used for this experiment. Heifers were the offspring of cows used in a 5-year project that measured cow and calf growth and performance when managed with traditional continuous season-long stocking compared to those managed with modified-intensive-early stocking, in which early season stocking density was increased to  $1.45 \times$  that of season-long stocking. Heifers for this experiment were born in 2018 and 2019 and were weaned from cows assigned to each stocking treatment. Each year, weaning took place in August for early-weaned calves (approximately 120 days of age) from the modified-intensive-early stocking treatment group while conventionally-weaned calves (approximately 205 days of age) were weaned from the season-long stocking cows in October. Each year, heifers from both treatments were maintained in drylot pens from weaning until February (approximately 185 days for early-weaned calves and 105 days for conventionally-weaned calves).

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Following the drylot weaning period, heifers were maintained as a single group on one of eight pastures, averaging 36.8 acres, that were rotationally grazed from February through May. Supplemental protein was provided via dry distillers grain to meet National Research Council recommended crude protein intake for growing heifers. The vegetation was typical of shortgrass prairie. Dominant species were western wheatgrass, buffalograss, and blue grama. Subdominant species were Japanese brome and western ragweed. Available herbage dry matter (DM) was estimated using a calibrated falling plate meter along established transects.

Body weight and body condition scores were recorded monthly from February through May. Two blood samples were collected each month. Monthly samples were collected via puncture of the caudal vein at 10-day intervals for later assessment of serum progesterone. Blood tubes were stored on ice, transported to the lab, stored at 40°F for 24 hours. After storage, samples were centrifuged at 1,000 × *g*, and the resulting serum was harvested and frozen at - 4°F for later analyses. Serum concentrations of progesterone from paired blood samples collected monthly from heifers were measured in duplicate. Progesterone concentrations were categorized as high ( $\geq 1$  ng/mL) or low ( $< 1$  ng/mL). Heifers with a high progesterone status on either sampling day were assumed to have achieved puberty, whereas heifers with low progesterone were considered prepubertal.

At the end of the pasture supplementation period, ovulation was synchronized using the 7 d Co-Synch + CIDR (EAZI-Breed CIDR, Zoetis, Parsippany, NJ) protocol. Heifers received 100  $\mu$ g of GnRH intramuscularly (d -10 relative to fixed-time breeding; 2 mL Cystorelin; Merial Animal Health, Duluth, GA) and a CIDR insert for 7 days, followed by an injection of 25 mg PGF<sub>2 $\alpha$</sub>  (5 mL of Lutalyse; Zoetis, Parsippany, NJ) intramuscularly and CIDR removal (d -3 relative to fixed-time breeding;). Fixed-time artificial insemination took place 54 h after the CIDR was removed and heifers received a second 100  $\mu$ g injection of GnRH (d 0). Heifers were exposed to fertile bulls 10 d after FTAI for the remainder of the 45-d breeding season.

At 35 d after AI, pregnancy was confirmed by transrectal ultrasonography (Aloka 500V, 5 MHz transrectal transducer, Wallingford, CT). A positive pregnancy outcome required the presence of an embryo and uterine fluid consistent with early term of pregnancy. A final pregnancy diagnosis (PR) was determined 35 d after the end of the breeding season via transrectal ultrasonography.

## Results and Discussion

Heifer body weight and body condition scores were not different between treatments at the end of each 28-day period during winter grazing of dormant native range (Table 1). All heifers lost weight during the first 28 days after being moved from drylot to pasture and transitioning from an energy-dense diet to a low-quality forage diet with protein supplementation. During the second 28-day period, body weights remained constant for all heifers. Heifers from both treatments displayed a modest weight gain during the last 28-day period before being moved to summer pasture for synchronization and breeding. Likewise, body condition scores decreased for heifers from both treatments following the transition to dormant native range pasture, and they continued to decline slightly during the remainder of the winter grazing period (Table 1).

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Although not statistically different, a numerically greater proportion of early-weaned heifers from the modified intensive early cows, compared to conventionally-weaned heifers from normal stocking rate cows, were pubertal for most months during the winter grazing period (February-May) before exposure to estrous synchronization (Table 2). Any increase in the number of pubertal and estrus-cycling heifers in the months preceding their first breeding season improves final reproductive success and extends lifetime productivity. Additionally, 13.8% more early-weaned heifers conceived to first service during the breeding season compared to their conventionally-weaned contemporaries (55.1 vs. 41.3%, respectively; Table 2). Becoming bred early in the breeding season will help ensure there is a sufficient period after calving to reestablish estrual behavior, rebreed, and achieve the greatest lifetime productivity possible. Final pregnancy rate was not affected by time of weaning and averaged 84.9% for all heifers. Although similar proportions of heifers from each grazing and weaning strategy became pregnant, greater numbers of early-weaned heifers from cows managed in a modified intensive early stocking system became pregnant early in the breeding season. This management system should help ensure the majority of these early-weaned heifers will have greater longevity and productivity compared to conventionally-weaned heifers from cows managed in a conventional continuous stocking system.

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**Table 1. Body weight and body condition score of heifers following conventional weaning (weaned at 205 days of age) or early weaning (weaned at 120 days of age) during winter grazing of dormant native range after being fed a high-energy diet after weaning in drylot for 185 or 105 days**

	Treatment	
	Conventional weaned	Early weaned
Body weight, lb		
February	761	756
March	725	718
April	730	718
May	732	725
Body condition score*		
February	5.4	5.5
March	5.2	5.2
April	5.0	5.0
May	4.9	4.9

\*Body condition score using a 9-point scale (1 = emaciated, 9 = obese).

**Table 2. Reproductive performance of heifers following conventional weaning (weaned at 205 days of age) or early weaning (weaned at 120 days of age) during winter grazing of dormant native range after being fed a high-energy diet after weaning in drylot for 185 or 105 days**

	Treatment	
	Conventional weaned	Early weaned
Puberty, %		
February	52.5	62.7
March	63.2	62.0
April	70.2	72.2
May	70.7	75.6
June	71.3	74.7
First service conception rate	41.3*	55.1*
Final pregnancy rate	86.9	82.8

\*Indicates values in a row are significantly different at  $P \leq 0.10$ .

# Effect of Feeding Interval on Finishing Performance of Beef Steers

*Chance Fiehler, John Jaeger, Justin Waggoner, Keith Harmony, and K.C. Olson*

## Introduction

It has long been accepted that optimal performance in beef cattle occurs when cattle are fed at a similar time each day. In fact, in Frederick Mumford's *Syllabus of Illustrated Lecture on Profitable Cattle Feeding* published by the U.S. Department of Agriculture in 1905, Mr. Mumford stated, "Cattle should be fed at certain hours and in the same way. This cannot be varied 15 minutes without some detriment to the cattle." Little research has been conducted examining interval of feed delivery. Most feedlot research examining feed delivery has focused on the comparison of once or twice daily feed delivery on animal performance. The current research examined beef steer finishing performance with stable or variable once daily feed delivery.

## Experimental Procedures

Two hundred and forty crossbred steers (average initial weight =  $692 \pm 70.5$  lb) were purchased through an order buyer from multiple sale barns in Mississippi and Alabama and were transported approximately 17 hours to the Kansas State University Agricultural Research Center Feedlot in Hays, KS (KSU-ARCH). Upon arrival, cattle were individually tagged and weighed. Cattle were penned by truck lot and allowed free choice access to water and good quality grass hay for 24 hours. Cattle were then individually weighed, vaccinated for clostridial (Ultrabac 7, Zoetis, Parsippany, NJ) and respiratory pathogens (Bovi-Shield Gold, Zoetis, Parsippany, NJ), and administered an anti-microbial (Zuprevo, Merck, Madison, NJ). Steers also received a growth-promoting implant (Component E-S with Tylan, Elanco Animal Health, Greenfield, IN). Cattle were then stratified by truck and arrival weight and assigned randomly to one of 8 pens (27 or 28 head per pen). Steers were fed the facility's standard receiving ration and were observed twice daily for symptoms of bovine respiratory disease for a 60-d receiving period.

Following the receiving period, cattle were individually weighed and assigned randomly by pen to one of two treatments: pens assigned to the control were fed at 0900 each day, whereas pens assigned to variable feed-delivery timing were fed daily at a randomly generated time  $\pm 0$  to 60 min relative to the control group. Average difference in daily feed-delivery time for the control was  $0900 \pm 15$  min and for the variable feed delivery was  $0900 \pm 60$  min with the greatest variation being two hours.

Animals were maintained in 11,120 ft<sup>2</sup> dry lot pens with 9.5 inches of linear bunk space per head for the duration of the study. Cattle were fed once daily, using a slick-bunk management method, and feed calls were made each morning at 0700 before feed delivery. Cattle received 2 growth-promoting implants (Component; Elanco Animal Health, Greenfield, IN) during the study, and these were administered on day 115 (Component TE-IS with Tylan), and day 172 (Component TE-S with Tylan). Body weight measurements (BW) were collected monthly on days 28, 56, 85, and 113 of the experiment. Carcass characteristics of steers were measured with ultrasound on day 90

of the experiment, and pay weight, carcass weight, backfat thickness, loin muscle depth, rib eye area (REA; inch<sup>2</sup>), and marbling score were calculated by Cattle Performance Enhancement Company software using live body weight and the ultrasound measurements.

### Results and Discussion

Steer body weight was similar between treatments each month during the experiment (Table 1). Additionally, steer average daily gain was not affected by the intervals between feedings for the stable or variable feed delivery groups (Table 1).

Interval between daily feed delivery to beef steers did not affect pay weight, carcass weight, loin muscle depth, REA or backfat thickness (Table 2). However, steers fed using a variable ( $\pm 2$  hours from the previous day's feed delivery time) feed delivery time displayed marbling scores 0.5 greater than steers fed using a stable ( $\pm 15$  minutes from the previous day's feed delivery time) feed delivery time (Table 2).

A variable daily feed delivery of up to  $\pm 2$  hours was not sufficient to elicit a change in animal performance or most carcass characteristics compared to performance of steers fed at a similar ( $\pm 15$  minutes of the previous day's feed delivery) time each day. Although variable feed time steers did have a statistically greater marbling score, this difference was likely not biologically or economically significant. Additional research should be conducted to determine the variable time interval when beef cattle performance is affected by an inconsistent interval of feed delivery.

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**Table 1. Body weight and average daily gain of beef steers exposed to a stable (Control) or variable (Variable) interval of feed delivery for once daily feeding during the feedlot finishing phase**

	Treatment	
	Control	Variable
Date, 2021	BW, lb	
1/08	916	919
2/06	996	997
3/05	1100	1107
4/02	1208	1197
4/07	1214	1218
Day	ADG, lb	
Day 1–28	2.77	2.69
Day 28–56	3.72	3.93
Day 56–84	3.84	3.21
Day 0–90	3.31	3.33

**Table 2. Steer carcass characteristics after exposure to a stable (Control) or variable (Variable) interval of feed delivery for once daily feeding during the feedlot finishing phase. Carcass characteristics were measured with ultrasound on day 90 of the experiment, and pay weight, carcass weight, backfat thickness, loin muscle depth, rib eye area (REA; inch<sup>2</sup>), and marbling score were calculated by Cattle Performance Enhancement Company software using live body weight and the ultrasound measurements.**

	Treatment	
	Control	Variable
Pay weight, lb	1206	1210
Carcass weight, lb	758	761
Backfat thickness, inch	0.39	0.43
Loin muscle depth, inch	2.44	2.52
REA, inch <sup>2</sup>	14.0	14.5
Marbling score*	5.05 <sup>†</sup>	5.55 <sup>†</sup>

\*Marbling score: 30 = Slight<sup>00</sup>, 40 = Small<sup>00</sup>, 50 = Modest<sup>00</sup>.

<sup>†</sup>Indicates values in a row are significantly different between feed delivery intervals at  $P \leq 0.05$ .

# Vegetation and Animal Production in Pastures Sprayed for Western Ragweed Control

*Keith Harmony and John Jaeger*

## Introduction

Western ragweed (*Ambrosia psilostachya*) is a common native forb found throughout Kansas native rangelands and in some seeded pastures. Over time, western ragweed can form dense colonies from growth of lateral creeping rootstalks with multiple buds that can initiate new growth and form an upright stem and plant. Past research has shown that western ragweed does not compete with native grass production until ragweed contributes over approximately 35% of the forage dry matter of a pasture area. Cattle have utilized western ragweed in past long-term historical grazing trials. In a previous long-term trial at Hays, KS, western ragweed was the most common forb found in light and moderately stocked pastures. Frequency of western ragweed was greatest in pastures with light stocking rates, and frequency of western ragweed declined by nearly 50% in moderately stocked pastures because animals utilized the western ragweed. In heavy stocking rate pastures, western ragweed was found in only trace amounts because of greater animal use. However, producers still question if cattle utilize western ragweed and achieve adequate gains in pastures with high western ragweed populations. Therefore, we conducted a grazing trial to determine if controlling western ragweed in pasture improved stocker animal gains compared to pastures with no ragweed control.

## Experimental Procedures

The 8 pastures in the study averaged 35 acres in size and mostly consisted of limy upland ecological sites. Pastures were grouped in pairs to form a replicate, and one pasture of each replicate was treated with dicamba at 6 oz/acre shortly after animal stocking to control western ragweed. High percentage Angus and Angus crossbred steers and heifers were stocked at 0.9 AUM/acre for the typical season-long stocking period of May 1 through October 1. Stocking entailed 11 or 12 lightweight heifers per pasture in two replications, and 11 or 12 lightweight steers per pasture in two replications, depending on pasture size. Steer and heifer body weights were collected in May at the start of the grazing season, in mid-July at mid-season, and again in October at the end of the grazing season. Animals were corralled at dusk in pens to stand overnight without food or water and were weighed at sunrise the next morning to collect a shrunk body weight for each weigh period. Standing available herbage biomass was collected from pastures at the grazing season midpoint in July, and again at the end of the grazing season in October by clipping 10 samples from a 2-ft<sup>2</sup> frame along a transect in each pasture and separating western ragweed from grasses. Furthermore, western ragweed plant density was measured within 10 frames measuring 2-ft<sup>2</sup> along each transect at the start of grazing in May, at the midpoint in July, and at the end of grazing in October. Western ragweed was also clipped from within 5 frames measuring 2-ft<sup>2</sup> along each transect every 2 weeks from the midpoint of grazing in July to the end of grazing in October to quantify the accumulated growth of western ragweed during the last half of the grazing season.

## Results and Discussion

Western ragweed densities in the study pastures during the year prior to the study were very high, were not different between pasture treatment groups, and averaged 11.1 plants/ft<sup>2</sup>. After dicamba was applied to half of the pastures in 2021, western ragweed control was successful. Ragweed density was much lower in sprayed pastures compared to unsprayed pastures (1.2 vs. 4.5 ragweed plants/ft<sup>2</sup>, respectively). Western ragweed plants that did survive in sprayed pastures were substantially injured and stunted, and essentially stopped growth and were desiccated prior to the end of the season. On a per acre basis, available western ragweed yield, grass yield, and total yield was not different between spray treatments in July at the mid-season (Table 1). However, western ragweed yield increased linearly as the late grazing season progressed (Figure 1). In October, at the end of the season, available ragweed yield was greater in unsprayed pastures compared to sprayed pastures (317 lb/acre vs. 0 lb/acre, respectively), as was total ragweed dry matter as a percentage of total dry matter available (14.4% vs. 0%, respectively; Table 1). Meanwhile, available grass yield (1976 lb/acre) and total yield (2135 lb/acre) were not different between spray treatments in October.

Grazing animals from both spray treatments had similar weights when placed on pasture in May, averaging 453 lb/hd (Table 2). Animals in sprayed and unsprayed pastures had similar early season gains and late season gains. Total season gain (211 lb/hd) was also similar between spray treatments, and animals averaged 664 lb/hd when removed from pasture in early October (Table 2).

Western ragweed is often viewed as a weedy forb in Kansas rangelands. Past research has shown that dense stands of ragweed can contribute up to 35% of pasture dry matter before affecting grass growth and yields. In the current study, ragweed production was greater in unsprayed pastures at the end of the grazing season, but ragweed production had no effect on grass yield or total pasture yield. Western ragweed also had no effect on stocker animal gains during the early or late grazing season. Although the spray treatment used to control western ragweed in this study was an ultra-low-cost treatment, the money spent to control the ragweed became an added production cost with no significant financial return.

## Implications

Western ragweed populations may vary from year to year according to weather patterns. In the current instance, the naturally occurring reduction in western ragweed density from the prior year in unsprayed pastures resulted in ragweed populations that were not great enough to produce differences in pasture yields or animal gains. Unless western ragweed composition in pastures nears the 35% level of previous research, producers will likely experience little benefit from spraying for western ragweed alone in pasture.

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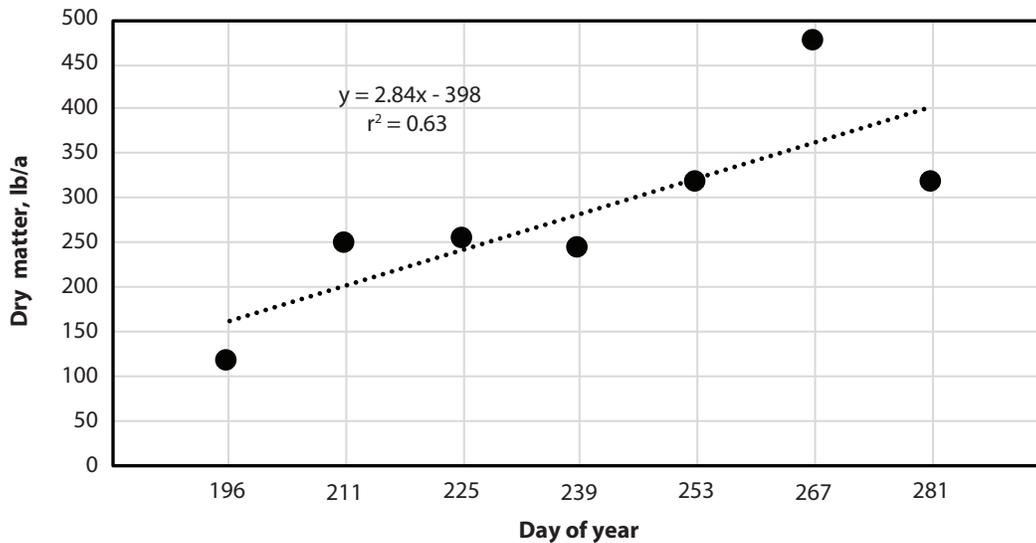
**Table 1. Western ragweed, grass, and total available dry matter in July and October of 2021 of pastures sprayed for western ragweed control or left unsprayed. Also shown is western ragweed as a percentage of the total dry matter composition.**

	July			October					
	Ragweed	Grass	Total	Ragweed	Ragweed	Grass	Total	Ragweed	
	----- Dry matter, lb/a -----			%		----- Dry matter, lb/a -----			%
Sprayed	3	1725	1728	0.2	*0	2003	2003	*0.0	
Unsprayed	117	1703	1820	6.6	*317	1950	2268	*14.0	
Average	60	1714	1774	3.4	159	1976	2135	7.0	

\*Indicates values in a column are significantly different between spray treatments at  $P \leq 0.10$ .

**Table 2. Animal body weight and body weight gain during the 2021 grazing season in pastures sprayed for western ragweed control or left unsprayed**

	Animal weights			Animal gains		
	May	July	October	Early	Late	Total
	----- lb/hd -----					
Sprayed	453	573	665	92	120	213
Unsprayed	454	573	663	90	119	209
Average	453	573	664	91	120	211



**Figure 1. Western ragweed dry matter accumulation in unsprayed pastures during the last half of the grazing season in 2021.**

# Interseeding Sorghum-Sudangrass into Perennial Cool-Season Western Wheatgrass Pasture

*Keith Harmony and John Guretzky<sup>1</sup>*

## Introduction

Conversion of pastureland into cropland has occurred at a rapid rate on the Great Plains. A reduction in total acreage of pastureland from this conversion has resulted in a decline of total numbers of beef cows in the same region. One method to mitigate the decline in cow numbers is to increase the carrying capacity of the remaining pastureland acres. To achieve this goal, a study was conducted to introduce warm-season annual grass species into perennial cool-season grass pastures to increase dry matter production during the mid-summer time period that perennial cool-season grasses would be most dormant. An increase in production during this time period could result in a significant overall increase in total land area production.

## Experimental Procedures

Three warm-season annual grasses (sorghum-sudangrass, crabgrass, and teff) were no-till drilled at three seeding rates (0.5X, 1.0X, and 1.5X) into perennial cool-season western wheatgrass pasture within a randomized complete block design experiment with three replications. Western wheatgrass was harvested at a 4-inch height with a self-propelled harvester with load cells in June of each year to determine forage yield. Subsamples were collected by hand from the harvester, were dried in a forced air oven for 72 hours, and weighed. Following wheatgrass harvest, warm-season annual grasses were seeded with a no-till drill in 12-inch spaced rows, and the plots were then fertilized with 60 lb N/acre. The base rates for 1.0X seeding rates were 40, 11, and 6.5 lb/acre for sorghum-sudangrass, teff, and crabgrass, respectively. Population density of the warm-season annual grasses was measured within a 2-ft<sup>2</sup> frame from three locations (total of 6 feet of row) in each plot following emergence, and warm-season annual grasses were harvested for yield determination at a 4-inch height at 90 days after planting. Warm-season annual grass samples were dried in a forced air oven for 72 hours, and weighed. The following spring, western wheatgrass was fertilized early with 60 lb N/acre and was harvested with a self-propelled harvester in late spring to see if warm-season annual grass growth during the prior year had an effect on subsequent perennial cool-season grass growth.

## Results and Discussion

Western wheatgrass yields prior to seeding warm-season annual grasses ranged from 1740–3070 lb/acre in 2020 and 1250–1790 lb/acre in 2021 and were not different among treatments. The lack of rainfall in June 2021 reduced forage yield potential of western wheatgrass compared to 2020. Following wheatgrass harvest in June, soil was dry in both years, and precipitation was not adequate for germination of annual warm-season grasses. Sorghum-sudangrass was the only warm-season annual grass that established and maintained acceptable stands in either year (Table 1). At 90 days after seeding, sorghum-sudangrass plots averaged 6600 lb/acre additional forage in 2020, but just over 800 lb/acre additional forage was produced in 2021 (Table 2). Sorghum-

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sudangrass seeded at the 1.5X rate produced more forage in 2021 than the 0.5X rate. Productive crabgrass and teff plants were rare and resulted in no additional harvestable forage in either year. In spring of 2021, plots with sorghum-sudangrass in 2020 had western wheatgrass yields that averaged 440–730 lb/acre less than the control plot and the averages of the failed teff and crabgrass seedings (Table 3). This resulted in a net forage increase of 5870–6160 lb/acre over the two years of production.

### Implications

Establishing sorghum-sudangrass in cool-season western wheatgrass pasture improved total forage production over two years with a net increase of nearly 3 tons of forage/acre compared to the cool-season grass alone. Vast improvements in production on limited pastureland resources are possible during years of greater precipitation. Greater forage production in turn increases the total number of beef cows the land area could support through grazing or haying.

**Table 1. Annual warm-season grass plant populations three weeks after seeding into western wheatgrass pasture in 2020 and 2021**

<b>Warm-season grass species and seeding rate</b>	<b>2020</b>	<b>2021</b>
	----- plants/acre -----	
Crabgrass 0.5X	21780	7260
Crabgrass 1.0X	36300	19360
Crabgrass 1.5X	75020	65340
Sorghum-sudan 0.5X	65340	41140
Sorghum-sudan 1.0X	111320	55660
Sorghum-sudan 1.5X	162140	77440
Teff 0.5X	12100	12100
Teff 1.0X	24200	12100
Teff 1.5X	38720	21780

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**Table 2. Annual warm-season grass yield in 2020 and 2021 after seeding into harvested western wheatgrass pasture. Teff and crabgrass did not establish well and did not result in harvestable forage.**

Warm-season grass species and seeding rate	2020	2021
	----- lb/acre* -----	
Sorghum-sudan 0.5X	7180	670 b
Sorghum-sudan 1.0X	5950	750 ab
Sorghum-sudan 1.5X	6670	1020 a
Average	6600	810

\* Values in a column with different letters are significantly different at  $P \leq 0.05$ .

**Table 3. Western wheatgrass pasture yield in 2021 following seeding of annual warm-season grasses in 2020**

Warm-season grass species and seeding rate	2021	Species average
	----- lb/acre* -----	
Crabgrass 0.5X	3070 abc	
Crabgrass 1.0X	2740 bcd	
Crabgrass 1.5X	3130 abc	2977
Sorghum-sudan 0.5X	2840 abcd	
Sorghum-sudan 1.0X	2520 cd	
Sorghum-sudan 1.5X	2250 d	2538
Teff 0.5X	3190 ab	
Teff 1.0X	3140 abc	
Teff 1.5X	3460 a	3267
Unseeded control	3170 abc	

\* Values in a column with different letters are significantly different at  $P \leq 0.05$ .

# Herbicide Activity on Old World Bluestems

*Keith Harmony*

## Introduction

Two main species of old world bluestems (OWB), yellow bluestem (*Bothriochloa ischaemum*) and Caucasian bluestem (*Bothriochloa bladhii*), have encroached on rangelands, pastures, and road right-of-ways in Kansas. Patches of these OWB have been shown to reduce species diversity and abundance at multiple trophic levels, and pose a long-term threat to native plant, insect, rodent, and grassland bird populations. These OWB species are utilized by cattle early in the growing season, directly following prescribed burns, and during droughts when other forages lack water uptake and may go dormant. However, these OWB species mature more quickly than native grass species and quickly form stem tissue, thus losing palatability to grazing animals rather rapidly compared to native grass species. In native pastures where OWB has invaded, native species may become overutilized because animals avoid the OWB. This weakens the native grasses and allows OWB to have a competitive advantage for moisture and nutrient resources. Over time, patches of OWB have expanded from 2.5 to 3.5 times their original patch size in 9 years, or a 15% annually compounded patch growth rate, when left uncontrolled. Several herbicides have been analyzed for OWB control, but glyphosate and imazapyr are the two herbicides that in the past have been shown to reduce OWB abundance most effectively in pastures. However, other herbicides with new label information for use in different forms of grassland or recreation areas may also have some activity on OWB and provide control. This study was performed to test several alternative herbicides with no known prior history of evaluation for control of OWB.

## Experimental procedures

Herbicide test plots were evaluated in nearly solid stands of yellow bluestem and Caucasian bluestem. Plots were evaluated for OWB frequency, or the presence of OWB rooted within 100 small squares, each 4 × 4 inches in size within a square 40 × 40 inch frame, prior to herbicide application, and were also evaluated for OWB control 60 days following herbicide treatment. Control ratings were based on the amount of injury and the reduced production compared to untreated OWB plants. One year after herbicide treatment, OWB control and frequency were evaluated again to see if control observed during the year of treatment carried over into the next year. Herbicides were applied to plots arranged in a randomized complete block design with four replications. New locations of separate yellow and Caucasian bluestem stands were used in 2019 and 2020, for a total of four distinct and complete experiment locations. Herbicide treatments included the following rates of active ingredient: 1) fluazifop-P 6.0 oz/acre, 2) glyphosate 2.0 lb/acre, 3) halosulfuron 0.9975 oz/acre, 4) imazapyr 0.5 lb/acre, 5) mesotrione 3.0 oz/acre, 6) rimsulfuron 0.75 oz/acre, 7) sulfosulfuron 0.9975 oz/acre, and 8) untreated control. All herbicides were sprayed at 30 psi with an equivalent of 17 gallons/acre water carrier, and included a non-ionic surfactant at 0.5% v/v.

### Results and Discussion

The frequency of OWB plants prior to herbicide application was not different between any of the herbicides. Combined across years, yellow bluestem frequency within the large frame was 93% and Caucasian bluestem frequency was 80% prior to herbicides being applied. Sixty days following application, glyphosate tended to display the greatest control of both yellow and Caucasian bluestem, followed by fluazifop-P and rimsulfuron (Table 1). Control of OWB 60 days after treatment with imazapyr was highly variable, with poor control in 2019 but much improved control, more closely resembling glyphosate control in 2020. Imazapyr variability was unexpected as it is one of the two primary herbicide recommendations for OWB spot control in pasture. During the year of treatment, fluazifop-P and rimsulfuron showed as much potential for OWB control as imazapyr. However, that control was short-lived and did not extend to the next growing season. One year after herbicide application, glyphosate provided much better control of both yellow and Caucasian bluestem than all other herbicides applied in the trial (Table 2). Glyphosate control 1 year after treatment was significantly greater in plots treated in 2019 than 2020; however, in both years of treatment, control with glyphosate was much greater than with any other herbicide. Greater control of both OWB species 1 year after treatment with glyphosate also translated into lower frequency of both OWB species 1 year after treatment. Frequency of both OWB species was below 26% when treating with glyphosate (Table 3). All other herbicides had an OWB frequency of near 90% or greater 1 year after treatment. Imazapyr has provided adequate control of OWB during the year after treatment in multiple prior experiments and in actual production pastures. The lack of control and the high OWB frequency with imazapyr during the year after treatment was unexpected in the current experiment.

### Implications

Glyphosate continues to be the most reliable herbicide for control of OWB. However, glyphosate is non-selective and will also kill all other desirable pasture vegetation if treated. Imazapyr was variable in this trial, but has also provided adequate OWB control in prior experiments and in general production pastures. Most native tall and mid-grasses show tolerance and survival to low rates of imazapyr that are able to provide some control of OWB. Fluazifop-P and rimsulfuron showed initial OWB injury and control that was as good as imazapyr, although control did not extend into the next season in this trial. These two herbicides may have potential for further experimentation to control OWB.

### Acknowledgments

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**Table 1. Control of yellow and Caucasian old world bluestems 60 days after herbicide treatment in 2019 and 2020**

Herbicide	Yellow bluestem			Caucasian bluestem		
	2019	2020	Avg. †	2019	2020	Avg.
	<b>Control %</b>					
Fluazifop-P	76	76	76 b	75	83	79 a
Glyphosate	99	97	98 a	99	*75	87 a
Halosulfuron	1	28	14 de	0	3	1 d
Imazapyr	8	*81	44 c	4	*78	41 c
Mesotrione	3	*23	13 de	0	*21	11 d
Rimisulfuron	82	75	78 b	61	66	64 b
Sulfosulfuron	31	18	24 d	41	41	41 c
Untreated	4	13	8 e	3	0	1 d

\* Indicates control values for the herbicide are statistically different at  $P \leq 0.05$  than the same herbicide in the prior year.

† Averages with different letters indicate control values are statistically different at  $P \leq 0.05$ .

**Table 2. Control of yellow and Caucasian old world bluestems 1 year after herbicide treatment in 2019 and 2020**

Herbicide	Yellow bluestem			Caucasian bluestem		
	2019	2020	Avg. †	2019	2020	Avg.
	<b>Control %</b>					
Fluazifop-P	0	3	1 b	0	8	4 b
Glyphosate	100	*82	91 a	99	*70	84 a
Halosulfuron	1	0	0 b	0	0	0 c
Imazapyr	0	*16	8 b	0	*13	6 b
Mesotrione	1	0	0 b	0	0	0 c
Rimisulfuron	3	0	1 b	0	0	0 c
Sulfosulfuron	1	0	1 b	0	0	0 c
Untreated	0	0	0 b	0	0	0 c

\* Indicates control values for the herbicide are statistically different at  $P \leq 0.05$  than the same herbicide in the prior year.

† Averages with different letters indicate control values are statistically different at  $P \leq 0.05$ .

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**Table 3. Frequency of yellow and Caucasian old world bluestems 1 year after herbicide treatment in 2019 and 2020**

Herbicide	Yellow bluestem			Caucasian bluestem		
	2019	2020	Avg. †	2019	2020	Avg.
	Frequency %					
Fluazifop-P	99	94	96 b	92	86	89 b
Glyphosate	0	*32	16 a	3	*48	26 a
Halosulfuron	99	100	99 b	100	*89	95 b
Imazapyr	98	100	99 b	100	*85	93 b
Mesotrione	99	99	99 b	100	90	95 b
Rimisulfuron	100	97	98 b	99	88	93 b
Sulfosulfuron	99	99	99 b	99	90	95 b
Untreated	99	87	93 b	100	91	95 b

\* Indicates frequency values for the herbicide are statistically different at  $P \leq 0.05$  than the same herbicide in the prior year.

† Averages with different letters indicate frequency values are statistically different at  $P \leq 0.05$ .

# Reclaiming Old World Bluestem Pasture with Imazapyr Application and Native Grass Overseeding

*Keith Harmony*

## Introduction

Old world bluestems (OWB), mainly Caucasian bluestem (*Bothriochloa bladhii*) and yellow bluestem (*Bothriochloa ischaemum*) introduced from parts of eastern Europe, Asia, Africa, and Australia, have been shown to reduce abundance and diversity of some insect and wildlife species compared to native grasses when these OWB grasses form dense stands. These OWBs have been invading native pastures in the southern Great Plains and are rapidly increasing in the amount of area occupied in Kansas. Two landowners purchased pasture property in Ellsworth County, KS, and observed that Caucasian old world bluestem had increased in the pasture significantly over the course of several years. They developed a plan with local partners to reclaim the pasture back to native grass and forb dominance in an effort to improve wildlife habitat and cattle grazing on the property.

## Procedures

The pasture reclamation project took place on a 240-acre tract in east-central Ellsworth County, KS. The pasture consisted of nearly equal halves of native, untilled pasture and cropland seeded back to native grasses in the 1950s. Twelve sample transects were established in both the native pasture and the converted cropland portion of the pasture (six in each portion). In 2016, these transects were sampled for Daubenmire cover classes of all vegetative species to show the extent of Caucasian OWB invasion within the two land areas (Figure 1). The two pasture areas were treated with imazapyr for three consecutive years to reduce the OWB population and to reclaim the pasture areas to native warm-season grass species. In 2017 and 2018, the entire pasture area was prescribed burned in late spring to remove old dead standing vegetation, and then imazapyr was broadcast sprayed at 0.5 lb/acre in early to mid-June. In 2019, imazapyr was applied at the same time period but the pasture was not burned prior to herbicide application. In 2020, dicamba at 0.25 lb/acre was applied to control maretail rosettes in early March, and then the pasture was overseeded in mid-April with a native grass mix consisting of big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparium*), sideoats grama (*Bouteloua curtipendula*), and switchgrass (*Panicum virgatum*) at a combined grass seeding rate of 7.9 lb pure live seed/acre. In 2019–2021, seedling density, Daubenmire cover, modified step point basal cover, OWB plant frequency from a 100-grid frame, Robel visual obstruction, and falling plate meter biomass estimates were also collected along the transects.

## Results and Discussion

In 2016, OWB cover along transects within the native portion of the pasture ranged from 0–53%, while OWB cover within the revegetated cropland portion of the pasture ranged from 7–94%. Combined, OWB provided 51% of the vegetative cover (Table 1) and formed many large patches with near monoculture stands within the two sample areas.

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In 2017 and 2018, OWB seedlings had opportunity to emerge, but imazapyr treatment after seedling emergence likely controlled those seedlings. The OWB seedling emergence along transects in 2019 was very low prior to imazapyr application, and new seedlings were rarely found in 2019 or 2021 (Table 1). The percentage of squares occupied by OWB in a 100-grid frame, or the frequency, also gives an indication of the density of OWB because of the known large frame sample area. In the case of May 2019, the frequency of OWB was 1.1%, or stated another way, 1.1% of the transect area sampled contained an OWB plant. Following the imazapyr treatment in June 2019, the frequency of OWB in May 2020 and 2021 remained rather similar at 0.8% and 1.2% frequency. Daubenmire vegetative cover of OWB in 2019, following 3 years of imazapyr treatment, was significantly lower than in 2016 at less than 1% cover (Table 2). Shortgrass cover [blue grama (*Bouteloua gracilis*) and buffalograss (*Bouteloua dactyloides*)] also significantly declined with annual imazapyr application, while cover of native tallgrasses was similar or slightly increased through 2019 (Table 2). After 3 years of imazapyr treatment, marestalk (*Conyza canadensis*) and western ragweed (*Ambrosia psilostachya*) cover greatly increased where OWB used to be prevalent, accounting for 42.9% of the canopy cover of the treated pasture in 2019. Western ragweed and marestalk dominated the plant canopy in areas of bare soil once occupied by the OWB (Table 2). Most native grasses were not able to expand into these bare areas as quickly as the herbicide was able to decrease the OWB from 2017 to 2019.

The significant loss of total grass cover and the surge of western ragweed and marestalk cover by the end of 2019 prompted the need to re-establish native grasses on the area once occupied by OWB. Native grass seeding was highly successful, with 0.4–3.1 native seedlings/ft<sup>2</sup> establishing along the sampled transects. Native seedling establishment tended to be greater along transects that had greater OWB cover in 2016 and was eventually controlled by imazapyr (Figure 2). Most native grasses increased in cover percentage and basal composition from 2019 to 2021 following the overseeding (Table 2). Successful native grass seedling establishment was somewhat surprising because native grass seedling growth has been severely depressed by an allelopathic effect in soils where OWB were currently or once growing. In 2020 and 2021, cover of OWB increased to near 5%, despite relatively little or no increase in OWB plant frequency (0.8% and 1.2% frequency in 2020 and 2021, respectively). This is likely the result of no herbicide treatment in 2020 to suppress growth of OWB plants that had survived imazapyr treatments from 2017–2019. These surviving OWB plants were suppressed from previous imazapyr treatments when cover estimates were collected in 2019, and thus lacked the vigorous foliage cover observed in 2020. Some new native grass seedlings nearly reached maturity by the end of the 2020 season. Cover increased for most native grass species in 2020 and 2021 compared to 2019, likely a result of both successful overseeding and the lack of significant OWB competition with native grasses that were already established and present before overseeding (Table 2). This result indicates new native grass establishment can be successful within 3 years of OWB reduction, and that allelopathic effects of OWB on native grass seedling growth likely diminish within a 3-year time period.

### Implications

Old world bluestem dominated pastures can be greatly transformed back into pasture that more closely reflects native grasslands. Although OWB was significantly reduced by 3 years of imazapyr application, OWB did not completely disappear and still poses a long-term risk if efforts to reduce or contain OWB are not continued. Continued

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herbicide treatment of smaller mapped patches or the combination of herbicides and growing season summer prescribed burns may help to reduce OWB further, or may at least help to significantly slow the rate of OWB spread within the pasture.

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**Table 1. Caucasian old world bluestems (OWB) cover by transect in 2016 prior to imazapyr treatment, and in 2019, 2020, and 2021 after treatment. Also shown is seedling recruitment of OWB prior to and after native grass seeding, and of native grasses the year of reseeding.**

Transect	OWB Daubenmire cover %				OWB seedlings/ft <sup>2</sup>		Native seedlings/ft <sup>2</sup>
	2016	2019	2020	2021	2019	2021	2020
1	46.5	1.2	13.3	0.3	0.1	0.1	1.4
2	41.5	0.3	7.5	0.0	0.0	0.0	1.3
3	93.5	0.0	2.5	8.5	0.0	0.2	2.5
4	72.8	0.0	0.0	0.0	0.1	0.3	1.4
5	14.7	0.0	11.0	4.2	0.0	0.0	0.9
6	71.3	0.0	0.0	0.0	0.0	0.4	1.8
7	6.8	0.2	0.0	0.0	0.0	0.1	0.4
8	92.8	0.0	8.2	6.8	0.0	0.1	3.1
9	89.5	1.0	19.5	17.2	0.0	0.4	1.6
10	0.0	0.0	0.0	0.0	0.0	0.0	0.8
11	30.2	0.2	0.0	16.3	0.0	0.0	2.0
12	52.8	0.0	4.7	6.5	0.0	0.0	1.5
Avg.	51.1	0.2 *	5.6 *	5.0	<0.1	0.1	1.5

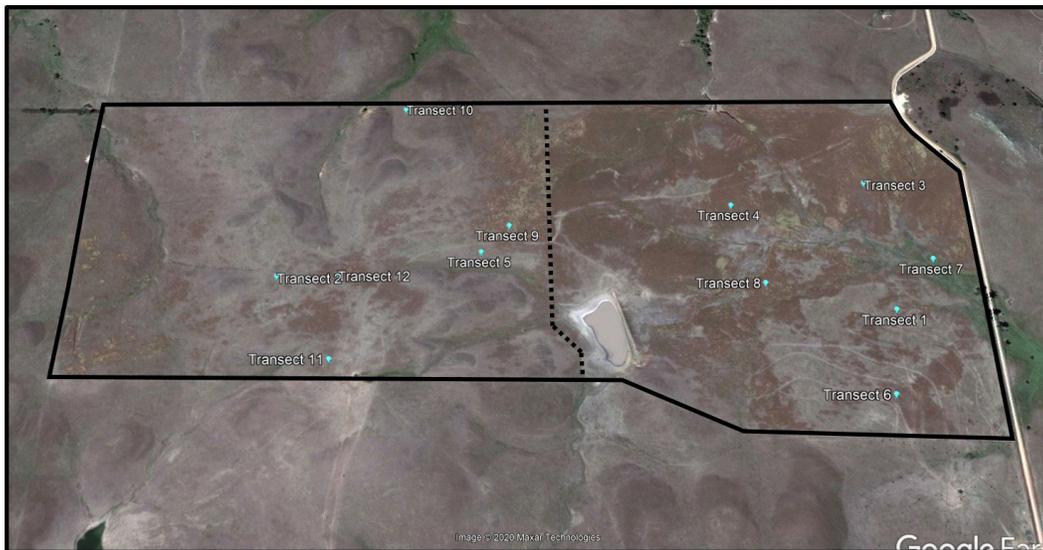
\* Indicates values in a column are statistically different at  $P \leq 0.05$  than the same attribute in the prior year.

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**Table 2. Daubenmire species cover in 2016 before imazapyr treatment, in 2019 following the third year of imazapyr application, and in 2020 and 2021 following reseeding. Species basal composition in 2019 and 2021 of the combined pasture areas is also included.**

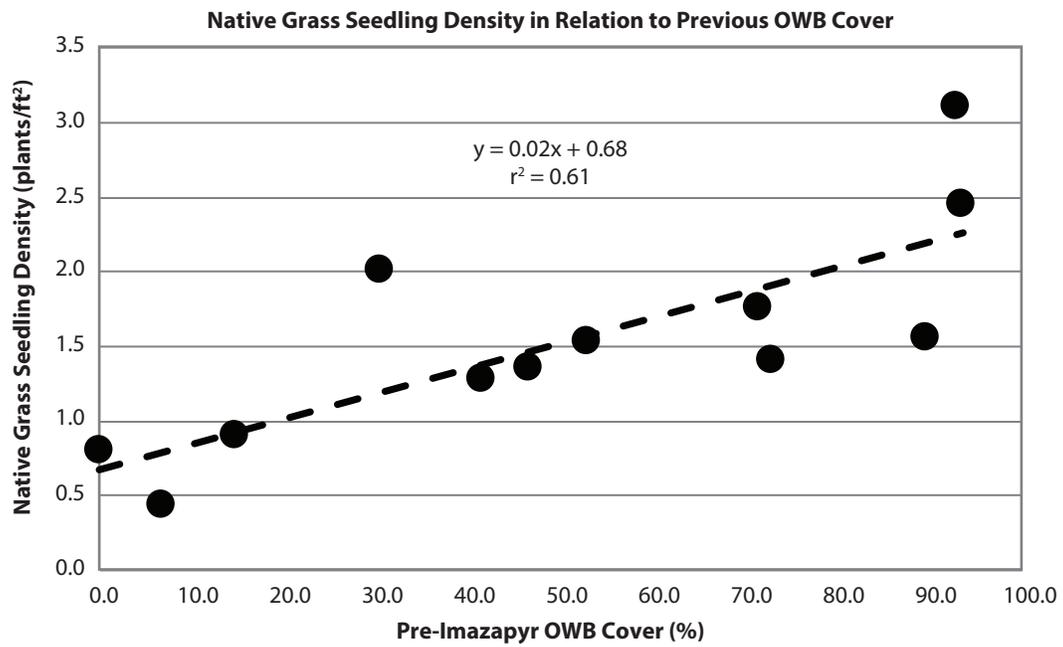
Species	Daubenmire cover %				Step-point composition %	
	2016	2019	2020	2021	2019	2021
OWB	51.1	0.2*	5.6*	5.0	0.2	3.3
Indiangrass	1.9	5.0	13.5*	13.3	5.9	11.5*
Big bluestem	0.4	4.9*	18.0*	16.6	4.9	16.6*
Little bluestem	7.0	16.1*	27.2*	17.0*	19.7	17.1
Sideoats grama	0.1	0.4	5.7*	4.2	1.8	5.9*
Blue grama + buffalograss	14.1	1.1*	3.5	5.1*	3.7	6.1*
Western ragweed	0.1	17.5*	8.9*	7.5	21.2	7.5*
Marestail	0.0	25.5*	5.1*	0.0*	35.8	0.0*

\* Indicates values in a column are statistically different at  $P \leq 0.05$  than the same attribute in the prior year.



**Figure 1. Study pasture in Ellsworth County, KS, approximately 230 acres in size. Land area to the right of the dashed line was cropland converted to pasture in the 1950s or 1960s. Brighter red and tan patches indicate areas of high density Caucasian OWB invasion in this northern pasture region. Diamonds mark locations of permanent transects established for collecting data.**

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**Figure 2. The relationship of OWB in 2016 prior to imazapyr control treatments and the native warm-season grass seedling density after reseeding. Seedlings tended to establish better in areas that had the greatest OWB cover prior to imazapyr treatment.**



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