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Roundup 2011

Abstract

Roundup is the major beef cattle education and outreach event sponsored by the Agricultural Research Center-Hays. The 2011 program is the 98th staging of Roundup. The purpose is to communicate timely, applicable research information to producers and extension personnel. The research program of the Agricultural Research Southeast Agricultural Research Center 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. Roundup 2011 was held at the Agricultural Research Southeast Agricultural Research Center Center--Hays, KS, April 21, 2011

Keywords

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ROUNDUP 2011

Report of Progress 1050

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

Agricultural Research Center— Hays

ROUNDUP 2011

Report of Progress 1050

Statement of Purpose

Roundup is the major beef cattle education and outreach event sponsored by the Agricultural Research Center–Hays. The 2011 program is the 98th staging of Roundup. The purpose is to communicate timely, applicable research information to producers and extension personnel.

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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Case Study: Low-Input Bunker Storage of Wet Distillers Grains[1]

J.W. Waggoner[2] and J.R. Jaeger[3]

Introduction

Traditionally the use of wet distillers grains (WDG) as a feedstuff has been limited to livestock producers with the capability of utilizing 40,000 lb of WDG within 7 to 14 days due to the short shelf life of WDG. The high moisture content of WDG (65% moisture, 35% dry matter) has restricted the use of conventional methods of storing high-moisture feedstuffs because WDG alone cannot be compacted for storage. WDG has been successfully stored in silage bags or by combining WDG with forages in silage bags or concrete bunker silos. These storage methods require additional inputs such as the purchase of forages, mixing and bagging equipment, fuel, and labor. In addition, these inputs add expense to the process of storing WDG; therefore, storage methods that require fewer inputs and less labor must be explored.

The objectives of this case study were to determine: (1) the feasibility of storing WDG in concrete bunkers without the addition of forage as a bulking agent and (2) the effects of storing WDG alone in concrete bunkers on subsequent nutrient content of WDG.

Materials and Methods

On September 17, 2009, approximately 73 tons of corn WDG was received at the Agricultural Research Center–Hays and unloaded directly into two concrete bunker silos. Samples of WDG were obtained from each load to quantify nutrient quality prior to storage. After all loads had been delivered, the bunker silos of WDG were covered with 6 mil black plastic and tires.

Two temperature probes (PT956, Pace Scientific, Inc., Mooresville, NC) were inserted into each bunker silo at a depth of 24 in. An additional temperature probe was placed near each bunker to record ambient temperature. All temperature probes were connected to data loggers (XR440, Pace Scientific Inc., Mooresville, NC) to facilitate simultaneous temperature data collection.

Sampling to document nutrient compositional changes over time was initiated on October 1, 2009. Samples were obtained from 3 locations within each pile, composited, and frozen. Samples were obtained every 14 days, with the exception of the samples scheduled for December 10, as the surface of the stored WDG was frozen and could not be penetrated by the sample probe. All WDG samples were cataloged and submitted to a commercial laboratory (SDK Laboratories; Hutchinson, KS) for analysis of dry matter, crude protein, neutral detergent fiber, acid detergent fiber, acid detergent insoluble nitrogen, calcium, phosphorous, and sulfur content.

Mean nutrient composition and temperature were calculated using Microsoft Excel.

[1] This work was funded by a grant obtained from the Kansas Corn Commission.

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Results and Discussion

A thin layer of mold approximately 1 to 2 in. thick was observed across the surface of the WDG. The WDG beneath the surface layer of mold and throughout the pile appeared fresh and possessed no discoloration or off odor. Change in nutrient or mineral composition was minimal (Tables 1 and 2) between the initial samples obtained from the three loads of WDG upon arrival and the samples taken on April 15, 2010. The final product after 211 days in storage contained 30.76% crude protein, 13.67% acid detergent fiber, 4.07 % acid detergent insoluble nitrogen, 13.08% fat, and 2.95% starch on a dry matter basis. Initial vs. final pH of WDG also changed little (4.04 to 3.97, respectively).

The mean temperature of the stored WDG and ambient temperature recorded during storage is illustrated in Figure 1. The temperature of WDG was 139.8°F upon arrival, and an average temperature in excess of 100°F was maintained until October 12, 2009, 26 days after the WDG was placed in the bunkers.

Implications

The results of this project indicate that corn WDG may be stored in concrete bunkers without the addition of forage as a bulking agent for storage durations in excess of 200 days with minimal changes in nutrient composition when covered with 6 mil black plastic and sealed with tires. Thus we have effectively demonstrated that low-input storage of WDG is feasible and has the potential to increase the use of WDG in both large and small livestock operations in Kansas. Further research is necessary to determine the advantages and disadvantages associated with different covering systems.

Table 1. Mean analyzed chemical composition of corn wet distillers grains stored in concrete bunkers

	Chemical composition							
Date	DM[1]	CP[2]	ADF[3]	NDF[4]	ADIN[5]	Fat[6]	Starch[7]	pH
September 17, 2009	36.29	30.92	11.47	24.99	3.32	13.69	2.83	4.04
October 1, 2009	36.61	30.62	11.77	25.09	3.42	13.50	2.90	4.12
October 15, 2009	36.30	30.65	11.39	24.91	3.27	13.63	2.55	3.90
October 29, 2009	36.54	31.86	11.28	25.34	3.36	13.90	2.60	3.96
November 12, 2009	36.83	31.41	12.00	26.33	3.68	13.27	2.70	3.88
November 26, 2009	36.7	31.80	11.47	26.90	3.51	13.72	2.80	4.13
December 21, 2009	36.89	31.70	11.73	26.13	3.36	13.79	2.65	4.12
January 13, 2010	37.12	31.42	11.85	25.77	3.45	13.64	2.80	3.87
February 4, 2010	36.82	30.85	12.26	26.74	3.66	13.65	2.85	4.22
February 18, 2010	36.87	31.03	11.09	25.79	3.11	13.73	2.80	3.94
February 28, 2010	36.93	31.05	11.95	27.03	3.38	13.76	3.35	3.99
March 4, 2010	38.16	33.88	12.25	26.55	3.81	14.64	2.70	4.11
March 18, 2010	36.87	31.15	13.02	26.14	3.84	13.41	2.70	4.05
April 1, 2010	36.38	30.92	12.21	26.42	3.39	13.58	2.65	3.93
April 15, 2010	36.71	30.76	13.67	26.94	4.07	13.08	2.95	3.97

[1] DM = Dry matter.
[2] CP = Crude protein content, % DM.
[3] ADF = Acid detergent fiber, % DM.
[4] NDF = Neutral detergent fiber, % DM.
[5] ADIN = Acid detergent insoluble nitrogen, % DM.
[6] Fat = Fat content determined via ether extract, % DM.
[7] Starch = Total starch content, % DM.

Table 2. Mean analyzed mineral content of corn wet distillers grains stored in concrete bunkers

Date	Mineral content, % dry matter						
	Calcium	Phosphorous	Potassium	Magnesium	Sodium	Chloride	Sulfur
September 17, 2009	0.08	0.91	1.13	0.37	0.15	0.31	0.67
October 1, 2009	0.08	0.91	1.11	0.37	0.15	0.31	0.65
October 15, 2009	0.08	0.93	1.13	0.36	0.15	0.30	0.68
October 29, 2009	0.07	0.96	1.12	0.36	0.16	0.31	0.65
November 12, 2009	0.07	0.90	1.11	0.36	0.15	0.28	0.65
November 26, 2009	0.09	0.92	1.10	0.35	0.15	0.36	0.67
December 21, 2009	0.10	0.94	1.11	0.38	0.15	0.35	0.65
January 13, 2010	0.08	0.90	1.11	0.35	0.15	0.30	0.65
February 4, 2010	0.07	0.88	1.09	0.35	0.15	0.35	0.64
February 18, 2010	0.07	0.74	1.04	0.33	0.14	0.34	0.64
February 28, 2010	0.10	0.76	1.10	0.33	0.15	0.34	0.65
March 4, 2010	0.06	0.74	1.04	0.32	0.14	0.53	0.68
March 18, 2010	0.09	0.99	1.06	0.36	0.15	0.33	0.67
April 1, 2010	0.07	1.09	1.08	0.36	0.14	0.37	0.65
April 15, 2010	0.08	1.04	1.07	0.35	0.15	0.40	0.63

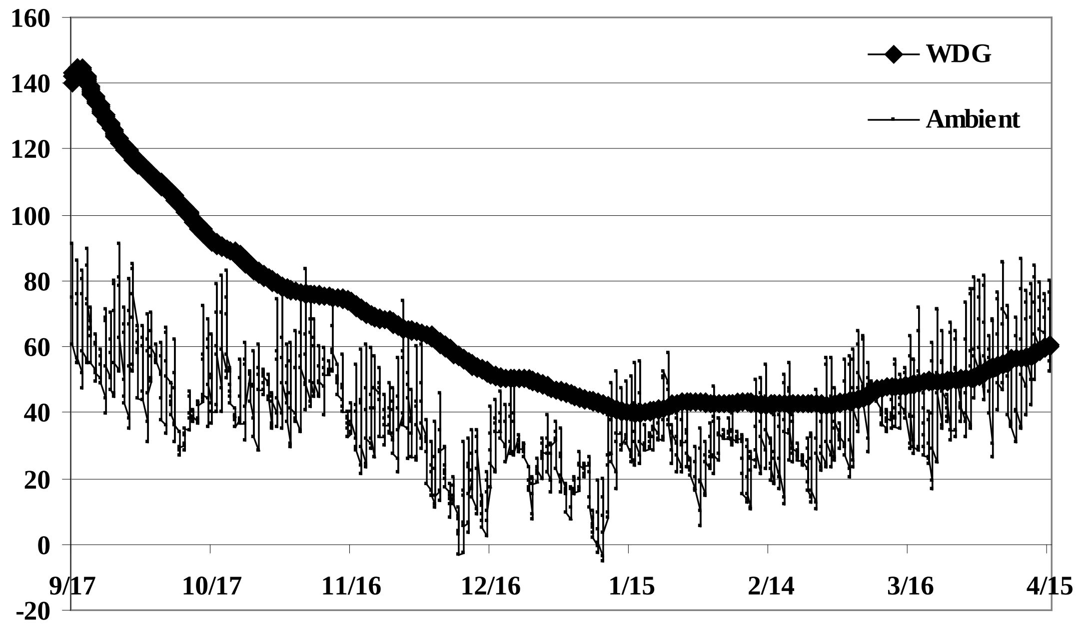

Figure 1. Mean temperature of wet distillers grains stored in concrete bunkers and recorded ambient temperature from September 2009 to April 2010.

Using Wet Distillers Grains as a Late-Season Protein Supplement for Grazing Steers

K. Harmoney[1] and J. Jaeger[1]

Introduction

Steers grazing on Kansas shortgrass rangelands achieve approximately 55% of their total season gain during the first half of the grazing season and 45% during the last half of the grazing season. To maintain a higher rate of gain during the last half of the season, protein supplementation may be necessary to improve the digestibility of late-season forage. We hypothesized that wet distillers grains (WDG) could be used as a replacement for a mixture of finely rolled milo and soybean meal supplement as a late-season crude protein (CP) source.

Materials and Methods

On Kansas shortgrass rangeland during the 2009-2010 growing seasons, steers were stocked continuously season-long at a rate of 3.5 a/steer, or 0.95 animal unit months (AUM)/a. Pastures were stocked with 10 steers per pasture from the first week of May through the first week of October for a 150-day grazing season. Animals were weighed the day of placement on pasture, halfway through the season in mid-July, and again following the last day of grazing in October. During the last half of the grazing season, animals were supplemented with a finely rolled milo and soybean meal mix in a 1:1 ratio, or were fed WDG as a late-season protein supplement. The milo:soybean meal mixture (30% CP) was fed in a bunk at a rate of 1.0 lb dry matter/head per day. The WDG (31% CP) was fed in two treatments, either in a bunk or on the ground on shortgrass vegetation, also at a rate of 1.0 lb dry matter/head per day. Pastures also were sampled for dry matter composition and dry matter yield estimates in mid-July and early October at the start and end of supplement feeding.

Results and Discussion

During the early season in 2009 and 2010 before being fed any supplements, steer gains were similar among the groups, gaining between 1.25 and 1.42 lb/head per day (Table 1). During the last half of the grazing season, animal gains were significantly greater when fed the milo:soybean meal mixture or WDG in the bunk compared to gains from animals fed WDG on the ground (Table 1). During the last half of the season, average daily gains were 1.57, 1.71, and 1.37 lb/head per day for the groups fed milo:soybean meal, WDG in the bunk, and WDG on the ground, respectively. Steers fed WDG in the bunk gained 26 lb/head more than the steers fed WDG on the ground during the last 75 days of the grazing season. For the entire grazing season, total beef produced was 68, 74, and 68 lb/a for the milo:soybean meal, WDG in the bunk, and WDG on the ground groups, respectively (Table 1). Total dry matter available in the pastures was similar for all supplement treatments in mid-July at the start of the supplement period, and ranged from 1,595 to 1,675 lb/a (data not shown). Total dry matter residual forage left in pastures at the end of the grazing season was also similar between supplement

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treatments, and ranged from 1,790 to 1,910 lb/a (data not shown), so supplement treatment did not affect available forage dry matter in pastures.

On Kansas shortgrass rangeland during the 2002-2008 growing seasons, continuous season-long stocking of lightweight steers from May to October with a late-season milo:soybean meal protein supplement resulted in 234 lb/head of individual animal gain during the growing season. Results of 2009-2010 are similar to the previous seven years. WDG can be fed as a late-season protein supplement to replace a 1:1 mix of milo:soybean meal, but placement of the supplement in the pasture makes a difference in animal gains. Grazing animals gain significantly more when the supplement is fed in a bunk compared to being fed on ground vegetation. However, total individual animal gain was not different between the two WDG-fed groups over the course of the whole season because animals from the ground-fed WDG treatment pastures displayed better gains in the early season before the supplement was fed. Close observation and video evidence has shown that a thin layer of WDG may remain on the soil surface that animals are not able to consume, and thus lack dry matter and protein that animals of other treatments were able to consume. WDG serves as an adequate replacement for milo:soybean meal as a late-season protein supplement for stocker animals on shortgrass rangelands as long as the supplement is placed in a bunk, or extra distillers grains are fed on the ground to account for waste left unconsumed on the soil surface.

Implications

July to October animal gains from WDG and from a milo:soybean meal mix, both fed in a bunk, were greater than wet distillers grains fed on the ground. Animal gains can be maintained during the late grazing season on shortgrass rangelands using WDG in a bunk as a low-cost protein supplement to replace a more costly milo:soybean meal mixture as a protein supplement. At current prices and fed with similar crude protein content at similar dry matter amounts, the milo:soybean meal mixture will cost 60% more than WDG as a supplement.

Table 1. Individual animal performance of steers on shortgrass rangeland during the early grazing season of May to July, during the late grazing season of July to October while fed protein supplements, total season animal performance, and total animal productivity on a pasture basis from 2009 to 2010

Supplement		May-July steer ADG	July-October steer ADG	May-October steer ADG	May-July total gain	July-October total gain	May-October total gain	May-October beef gain
		---------lb/day-------			---------lb/head--------			lb/a
SBML	Bunk	1.25	1.57[a]	1.40	111	119[a]	230	68
WDG	Bunk	1.37	1.71[a]	1.53	122	129[a]	251	74
WDG	Ground	1.42	1.37[b]	1.40	127	103[b]	230	68

[ab] Values in columns followed by different letters are statistically different at $P<0.10$.

SBML = milo:soybean meal mixture.

WDG = wet distillers grains.

ADG = average daily gain.

Growth and Reproductive Performance of Beef Replacement Heifers Fed Winter Development Diets Containing Soybean Meal or Wet Distillers Grains

J.R. Jaeger[1], J.W. Waggoner[2], K.C. Olson[3], and J.W. Bolte[1]

Introduction
Wet distillers grains (WDG) are commonly used in beef cattle diets, especially in finishing diets. Due to increasing availability and relatively low cost per pound of protein on a dry matter basis, WDG is increasingly used as a winter protein supplement for beef heifers and cows; however, little information is available regarding the effects of WDG on reproduction.

Materials and Methods
Spring-born crossbred heifers (n = 172; initial body weight 702 ± 4 lb, age 282 ± 1 day) that were preconditioned, weaned, and fed a grower diet for 60 days were stratified by body weight and age in January. Heifers were then randomly assigned to be fed development diets containing either soybean meal (CON) or WDG as a protein supplement (Table 1). Heifers were allotted randomly to eight pens (four pens per treatment) and allowed to adapt to treatment diets for 14 days. Diets were formulated to contain similar quantities of protein and energy (Table 1) and were fed *ad libitum* for an additional 94 days.

Heifer body weight was measured every 28 days during the feeding period; paired serum samples were also collected at these times and analyzed for progesterone to determine proportion of pubertal heifers. Following the development period, heifers were removed from treatment pens and combined in native-range pastures. Equal proportions of heifers from each treatment were exposed to ovulation synchronization and bred by fixed-time artificial insemination (AI) either 23 or 51 days after development diets were terminated.

Results and Discussion
Although heifers were fed *ad libitum*, heifers fed development diets containing WDG consumed less feed. Total dry matter delivered during the 94-day feeding period was 10,350 lb lower (P<0.01) for heifers fed the WDG diet than for heifers fed the CON diet. Likewise, individual daily dry matter intake by heifers fed the WDG diet was 1.28 lb less (P=0.02) than that by heifers fed the CON diet. This resulted in greater (P<0.01) body weight change and average daily gain during each 28-day period and throughout the development period for CON-fed heifers than for WDG-fed heifers (Table 2). Proportion of pubertal heifers was greater (P<0.01) for CON compared to

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WDG after 28 and 56 days, but was not different (P>0.10) at 84 days or at initiation of ovulation synchronization for each breeding group of heifers (Figure 1). Conception to fixed-time AI (46%) and pregnancy rate (86%) were not different (P>0.50) between treatments. Under the conditions of our study, developing replacement heifers with WDG-containing diets had negative effects on growth performance during the feeding period and age at puberty; however, the proportion of heifers that had attained puberty was similar between treatments at the time of fixed-time AI.

Implications

Development cost for WDG-fed heifers was substantially less because they consumed less feed during the development period. In contrast, WDG-fed heifers attained puberty at an older age and conception rates could have been negatively affected if heifers had been exposed to breeding earlier in the year. Further research is needed to determine the effects of WDG inclusion rate, duration of feeding, and diet composition on reproductive performance of replacement heifers.

Table 1. Ingredient and nutrient composition of control and wet distillers grains (WDG) diets fed to replacement heifers

	%, dry matter basis	
Item	Control diet	WDG diet
Ingredient		
Ground forage sorghum hay	82.47	65.28
Ground sorghum grain	9.42	7.91
Soybean meal	7.07	-
WDG	-	25.72
Vitamin and mineral premix	0.52	0.44
Calcium carbonate	0.26	0.44
Salt	0.26	0.22
Nutrient analysis		
Crude protein, %	10.7	10.1
NEm, Mcal/lb	0.67	0.67
NEg, Mcal/lb	0.34	0.34
Neutral detergent fiber, %	47.4	41.1
Acid detergent fiber, %	35.3	35.4
Total digestible nutrients, %	60.60	60.55
Calcium, %	0.86	0.99
Phosphorus, %	0.21	0.25
Sulfur, %	0.17	0.23

Table 2. Body weight (BW) and average daily gain (ADG) of heifers fed development rations containing soybean meal (CON) or wet distillers grains (WDG) as the protein supplement

	Treatment means			
Item	CON	WDG	SE	P-value
Initial BW	711	721	7.3	0.31
ADG, 1st 28 days (1/29 to 2/26)	1.37	0.82	0.07	<0.0001
ADG, 2nd 28 days (2/26 to 3/26)	0.66	0.21	0.08	<0.0001
ADG, 3rd 28 days (3/26 to 4/23)	1.82	0.88	0.07	<0.0001
BW change, 94-day feeding period (1/29 to 5/3)	96.9	67.1	3.9	<0.0001
ADG, 94-day feeding period (1/29 to 5/3)	1.03	0.71	0.04	<0.0001
BW at breeding (Group 1; 5/24/10)	796	798	11.0	0.92
BCS[1] at breeding (Group 1; 5/24/10)	5.78	5.82	0.07	0.73
BW at breeding (Group 2; 6/21/10)	852	811	10.0	0.004
BCS[1] at breeding (6/21/10)	6.14	5.88	0.06	0.003

[1]BCS = body condition score; 1 = emaciated, 9 = obese.

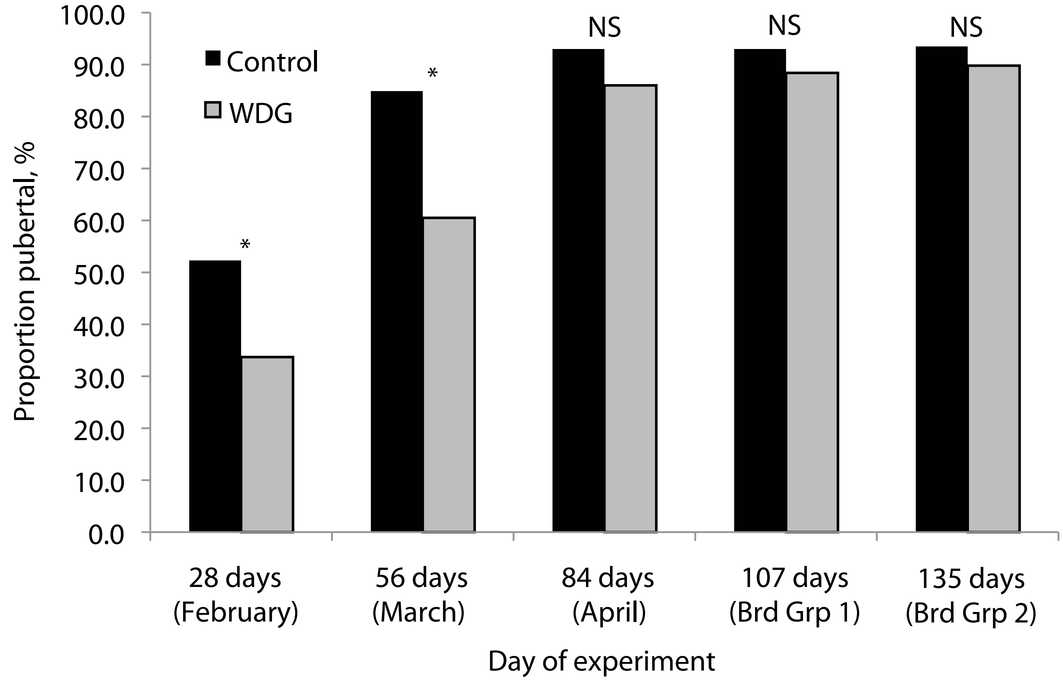

Figure 1. Proportion of heifers with serum progesterone concentrations ≥ 1.0 ng/ml in one or both blood samples collected 28, 56, or 84 days after feeding development rations containing soybean meal (CON) or wet distillers grains (WDG) as the protein supplement, and at breeding 23 days (Brd Grp 1) or 51 days (Brd Grp 2) after diets ended.
NS = not significant; * = significant at P≤0.01.

Effects of Wet Distillers Grains and a Direct-Fed Microbial on Finishing Performance and Carcass Characteristics of Beef Steers Fed a Sorghum-Based Finishing Diet

J.R. Jaeger[1], J.W. Waggoner[2], K.C. Olson[3], J.W. Bolte[1], and S.R. Goodall[4]

Introduction

A majority of the grain sorghum produced in the United States is currently utilized as livestock feed or in the production of ethanol. However, information is limited regarding the effects of including the ethanol byproduct wet distillers grains (WDG) in sorghum-based rations on animal performance and carcass characteristics. Additionally, recent fluctuations in commodity prices have stimulated interest in technologies such as direct-fed microbials (DFM) that may improve animal performance during the feeding period. Therefore, the objective of this study was to evaluate the effects of WDG and DFM inclusion on feedlot performance and carcass quality attributes in steers fed sorghum-based finishing rations.

Materials and Methods

Animals, Facilities, and Treatments. Angus crossbred steers (n = 428; initial body weight = 970 ± 68 lb) were used for this experiment. Steers originated from three livestock markets and were maintained in 1,033 m^2 earth-floor pens (about 27 head per pen) for the duration of the study. Steers were received and processed at the Kansas State University Agricultural Research Center–Hays (ARCH) feedlot. At processing steers were weighed, implanted with a Synovex-Choice (Fort Dodge Animal Health, Overland Park, KS) implant, and measured with ultrasound to determine 12th rib fat thickness, longissimus muscle depth, and marbling score. Steers were stratified by body weight, measured ultrasonically for carcass characteristics, and assigned randomly to one of four ration treatments (4 pen replicates per treatment). Ration treatments were: (1) soybean meal protein supplement (CON); (2) control plus direct-fed microbial (CON+DFM; (NovaCell) Nova Microbial Technologies, Omaha, NE); (3) wet distillers grains plus solubles (WDG; 15% of diet dry matter); and (4) WDG plus direct-fed microbial (WDG+DFM). The DFM was dissolved in 90°C water and top-dressed to the ration immediately after feeding.

All cattle were fed a common receiving diet for 7 days and were then gradually adapted to the finishing diets (Table 1) and fed for 106 days until harvest. Cattle were fed using a slick-bunk method and feed calls were made each morning at 6:30 a.m. prior to feed delivery. Cattle were evaluated daily by KSU-ARCH feedlot personnel for clinical signs of morbidity.

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Data Collection. Steers were weighed approximately every 28 days during the finishing period and carcass characteristics (12th rib fat thickness, longissimus muscle depth, and marbling score) were determined by ultrasound using an Aloka 500V (Aloka Co., Ltd, Wallingford, CT) B-mode instrument equipped with a 3.5-MHz general purpose transducer array (UST 5021-125 mm window) on day 0 and day 56 during the finishing period. Ultrasound images were collected with Cattle Performance Enhancement Company (CPEC, Oakley, KS) software. Harvest date was determined by the day 56 scan to meet an average carcass endpoint of 11mm of fat depth over the 12th rib.

Cattle were transported approximately 3 hours to a commercial abattoir (National Beef Packing Company, Dodge City, KS) on the harvest date. Carcass characteristics were measured by camera and automated software and included 12th rib fat thickness; 12th rib longissimus muscle area; kidney, pelvic, and heart fat; USDA maturity grade; USDA yield grade; USDA quality grade; and marbling score. Data were validated by a trained evaluator. Due to software error, actual data for 12th rib fat thickness and marbling score were omitted.

Statistical Analysis. Data were subjected to ANOVA using the GLM procedure of SAS (SAS Institute Inc., Cary, NC). All steers that exhibited clinical signs of morbidity or expired during the course of the study were removed from the analysis. Class variables included pen, treatment WDG, and DFM. The model included terms for WDG and DFM and their interaction. F-tests were constructed using the type-3 error mean squares. Least squares means were considered to be different when $P \leq 0.05$ and trends occurred when $P \leq 0.10$.

Results and Discussion

During the course of the study, 22 steers were removed due to morbidity or mortality. Steer average daily gain (ADG) was only affected by DFM inclusion during period 2 when steers receiving the DFM had greater ($P<0.01$) ADG compared to steers receiving no DFM (2.95 ± 0.09 vs. 3.33 ± 0.09 lb/day, respectively). Steer ADG during the majority of the feeding periods of the finishing phase and for the entire feeding period was greater ($P<0.01$) for WDG than for CON (Table 2). As a result, harvest body weight was greater ($P<0.01$) for steers receiving WDG compared to steers receiving the control diet (1,305 vs. 1,254 ± 7 lb, respectively; Table 3). Diets and DFM had no effect ($P>0.10$) on gain:feed ratios.

Although the treatment diets were nearly isoenergetic (0.53 [CON] vs. 0.52 [WDG] Mcal/lb NE_g), steers fed WDG gained 0.51 lb/day more and were 51 lb heavier at harvest than steers fed the control diet (Table 3). Additionally, steers fed WDG also exhibited a greater increase in backfat deposition during the first 70 days on feed. These differences, in part, may be due to a conditioning effect of WDG inclusion in the ground sorghum-based ration, which may have increased total dry matter intake and subsequent energy intake.

The increase in backfat thickness was greater ($P=0.005$) for steers receiving WDG compared to those receiving the control diet during the first 70 days on feed (1.95 ± 0.11 vs. 1.54 ± 0.10 mm, respectively). In addition, during the first 70 days on feed the observed increase in backfat thickness tended ($P<0.10$) to be greater for steers receiving DFM compared to those receiving no DFM (1.87 ± 0.11 vs. 1.62 ± 0.10 mm, respectively). Increase in longissimus muscle depth was greater ($P<0.001$) for cattle receiving DFM compared those receiving no microbial treatment (16.46 ± 0.34 vs. 13.85 ± 0.34 mm, respectively). Change in marbling score was similar ($P=0.44$) among treatments.

Hot carcass weight was similar in steers fed WDG+DFM compared to WDG, but was greater than CON steers and steers fed CON+DFM (WDG x DFM; $P=0.01$; Table 4). The reason DFM fed in conjunction with a sorghum-based soybean ration resulted in reduced hot carcass weight is unclear. However, the majority of previous trials likely utilized corn-based rather than sorghum-based finishing rations. Dressing percent and longissimus muscle area were similar ($P>0.30$) between treatments (Table 4). USDA yield grade ($P=0.41$) and quality grade ($P=0.45$) were also similar among treatments (Table 4), with 69.0% of steers grading choice or better. The lack of difference in yield and quality grade among steers fed CON and WDG diets may be due to the relatively low inclusion (15.8% of diet dry matter) of WDG in this study.

Implications

Use of WDG in sorghum grain-based finishing rations resulted in an increase in ADG compared to sorghum grain rations containing soybean meal. This resulted in greater harvest weights for steers fed WDG. Addition of DFM to the diets containing WDG resulted in greater hot carcass weight compared to steers consuming only WDG diets. Addition of DFM to diets containing soybean meal or WDG improved ADG only during an early period of the finishing phase. Use of DFM did increase longissimus muscle depth and tended to increase 12th rib fat thickness during the first 70 days on feed. Further research is required to elucidate the optimal timing of use and potential economic benefits of feeding a DFM in combination with WDG.

Acknowledgments

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Table 1. Ingredient and nutrient composition of ground sorghum-based finishing diets

Item	Treatment	
	Control	WDG[1]
Ingredient, % dry matter		
Sorghum, ground	71.5	65.7
Sorghum sudan hay	15.7	15.8
WDG	-	15.8
Soybean meal	10.5	-
Calcium carbonate	1.4	1.8
Ammonium sulfate	0.2	0.2
Salt	0.2	0.2
Vitamin and mineral premix[2]	0.5	0.5
Nutrient concentration		
CP, % dry matter	11.8	14.8
NEm, Mcal/lb	0.86	0.84
NEg, Mcal/lb	0.53	0.52
Ca, % dry matter	0.70	1.07
P, % dry matter	0.28	0.37
S, % dry matter	0.14	0.23

[1] Wet distillers grains plus solubles.

[2] Supplied 299.2 mg Rumensin per head.

Table 2. Average daily gain (ADG) of steers fed finishing diets containing soybean meal (CON) or wet distillers grains plus solubles (WDG), with and without a direct-fed microbial (DFM)

Item	Treatment				
	CON	CON+DFM	WDG	WDG+DFM	SEM
Finishing period ADG, lb/day					
Days 0 to 35[1]	3.24[a]	3.33[a]	4.08[b]	3.99[b]	0.09
Days 36 to 56[1,2]	2.67[a]	3.04[ab]	3.26[bc]	3.62[c]	0.13
Days 57 to 84	4.43	4.32	4.65	4.41	0.13
Days 85 to 101[3]	1.57[d]	0.95[e]	1.48[de]	1.94[d]	0.18
Overall ADG, lb/day[1]	3.17[a]	3.13[a]	3.64[b]	3.68[b]	0.07

[1] Main effect of WDG ($P<0.001$).

[2] Main effect of direct-fed microbial ($P=0.005$).

[3] Interaction of wet distillers grains plus solubles and direct-fed microbial ($P=0.002$).

[abc] Within a row, means without a common superscript differ ($P<0.01$).

[de] Within a row, means without a common superscript differ ($P\leq0.05$).

Table 3. Performance characteristics and feed costs of average daily gain (ADG) of steers fed finishing diets containing soybean meal (CON) or wet distillers grains plus solubles (WDG), with and without a direct-fed microbial (DFM)

	Treatment				
Item	CON	CON+DFM	WDG	WDG+DFM	SEM
Initial body weight, lb	976.9	968.0	972.0	974.2	6.8
Final body weight, lb[1]	1261.3[a]	1247.8[a]	1300.5[b]	1310.9[b]	9.7
ADG, lb/day[1]	3.17[a]	3.13[a]	3.64[b]	3.68[b]	0.15
Gain:feed, lb gain/lb dry matter	0.12	0.12	0.11	0.11	0.01

[1] Main effect of WDG ($P<0.001$).

[ab] Within a row, means without a common superscript differ ($P<0.001$).

Table 4. Carcass characteristics of beef steers following a 106-day finishing period with diets containing soybean meal (CON) or wet distillers grains plus solubles (WDG), with and without a direct-fed microbial (DFM)

	Treatment				
Item	CON	CON+DFM	WDG	WDG+DFM	SEM
Hot carcass weight, lb	787.4[ab]	766.7[a]	810.9[bc]	827.6[c]	7.59
Dressing, %	62.6	64.7	62.6	63.3	1.35
Longissimus area, cm^2	85.5	86.7	87.3	88.6	1.22
USDA quality grade Choice, %	68.9	62.0	69.7	73.7	-
USDA yield grade	1.98	2.87	2.20	2.19	0.40

[abc] Within a row, means without a common superscript differ ($P<0.01$).

The Relative Importance of Weaning Management and Vaccination History on Performance by Ranch-Direct Beef Calves during Weaning and Receiving

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Introduction

Preconditioning is a term used in the beef industry to describe management practices that are applied during the weaning period to optimize calf nutrition, health, and growth performance during the feedlot receiving period. The primary goal of preconditioning is to minimize damage to growth potential and carcass merit that occurs as a result of the bovine respiratory disease (BRD) complex. Generally, preconditioned cattle have reduced mortality and morbidity and increased feedlot performance compared to cattle that are not preconditioned. However, the effects of preconditioning on calf growth and health can be variable due to interactions between management, year, and ranch of origin. BRD has been reported to be the leading cause of morbidity and mortality in United States feedlots.

Many BRD vaccination strategies are practiced by domestic cow-calf producers. The most cautious strategy involves vaccination against BRD pathogens 2 to 4 weeks prior to maternal separation followed by a booster at weaning. This strategy is used in instances where time, labor, and facilities are available to gather and process calves while they are still suckling. Another strategy is to defer vaccination until after calves have been shipped to a feedlot. Deferring BRD vaccination to the receiving period is thought to increase BRD incidence compared to vaccination that is implemented on the ranch of origin; however, this assumption has not been widely scrutinized for cattle that are moved directly from their ranch of origin to a feedlot and undergo little or no commingling with market-sourced cattle.

Previous research by the Kansas State University Department of Animal Sciences and Industry and the Agricultural Research Center–Hays has demonstrated that length of the ranch-of-origin weaning period influenced growth and health of beef calves during the receiving period at a feedlot. Therefore, it is reasonable to expect that vaccination strategy and the length of the ranch-of-origin weaning period may have synergistic effects on calf performance during the receiving phase. The objective of our experiment was to compare the effects of BRD vaccination administered prior to weaning on the ranch of origin or after arrival at a feedlot for calves weaned 45, 15, or 0 days prior to feedlot arrival.

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Materials and Methods

Angus x Hereford calves (n = 437; average initial body weight = 459 ± 55 lb) were used for this experiment. Calves originated from Kansas State University Commercial Cow-Calf Unit in Manhattan (n = 263) and the Agricultural Research Center–Hays (n = 174). At the time of maternal separation, calves were 175 to 220 days of age. All calves were dehorned and steer calves were castrated before 60 days of age.

Approximately 60 days before weaning, animals were stratified by weight, sex, and birth date and assigned randomly to a pre-shipment weaning period (i.e., 45,15, or 0 days). Within each pre-shipment weaning period, calves were assigned randomly to one of two BRD vaccination treatments. One group was vaccinated 14 days prior to maternal separation and again at weaning (PRE). A second group was vaccinated on the day of arrival at the feedlot and again 14 days later (POST).

Initial and booster vaccinations against IBR, BVD, PI3, and BRSV were administered using a modified live product (Bovi-Shield Gold FP, Pfizer Animal Health, New York, NY). All calves were treated for internal and external parasites using Dectomax (Pfizer Animal Health) and were vaccinated against clostridial diseases (Vision 7 with SPUR, Intervet Inc., Millsboro, DE) at the time of weaning. Calves were then transported a short distance (< 30 miles) to a central home-ranch weaning facility. Calves were weaned in earth-floor pens (4 pens per treatment) and fed a common weaning diet that was formulated to achieve an average daily gain (ADG) of 2 lb at a dry matter intake of 2.5% of body weight (Table 1). Feed intake was recorded daily on a pen basis.

Calves were monitored for symptoms of respiratory disease at 7:00 a.m. and 2:00 p.m. daily during the ranch-of-origin weaning period. Calves with clinical signs of BRD, as judged by animal caretakers, were removed from home pens and evaluated. Each calf with clinical signs of BRD was weighed and had its rectal temperature measured and a clinical illness score assigned (scale: 1 to 4; 1 = normal, 4 = moribund). Calves with a clinical illness score greater than 1 and a rectal temperature greater than 104°F were treated. Cattle were evaluated 72 hours post-treatment and re-treated based on observed clinical signs.

All calves were individually weighed and transported 4 hours from their respective ranch-of-origin weaning facilities to an auction market located in Hays, KS, on a common shipping date. Calves from both origins were commingled with respect to gender and treatment and were maintained on the premises of the auction market for 12 hours. This commingling was employed to simulate the pathogen exposure typically encountered by market-ready calves.

The following day, calves were shipped a short distance (< 15 miles) to a feedlot. Upon arrival, calves were weighed individually and assigned to a receiving pen based on their weaning and vaccination treatments. The cattle were adapted to a receiving ration (Table 2) and daily dry matter intake was recorded throughout a 60-day receiving period. Calves were monitored for symptoms of BRD daily at 7:00 a.m. and 2:00 p.m. Clinical symptoms of disease were evaluated and treated as during the ranch-of-origin weaning phase. Calf body weight was measured 60 days after arrival at the feedlot.

Results and Discussion

Health. Incidence of undifferentiated fever during the 15 days immediately after maternal separation was greater (P<0.01) for calves assigned to the 45-day weaning treatment compared to those assigned to the 15-day weaning treatment (Table 3). Reasons for this response were unclear. In contrast, length of the ranch-of-origin weaning period did not affect (P=0.73) incidence of undifferentiated fever during the receiving period (Table 4). In previous research at this location, similar calf health responses during receiving were observed for calves weaned 15, 30, 45, or 60 days prior to feedlot placement.

Undifferentiated fever during the pre-shipment period was similar (P=0.66) between PRE and POST calves (Table 5). Evidently, the pathogen challenge and the stress associated with maternal separation were insufficient to increase incidence of BRD among unvaccinated calves during the ranch-of-origin weaning periods.

Incidence of undifferentiated fever during the receiving period was similar (P=0.80) between calves that were vaccinated against BRD-causing organisms on the ranch of origin and those that were not vaccinated until feedlot arrival (Table 6). The calves in our study had excellent overall health during the receiving period; only 4 of 437 calves on our study were treated for presumptive BRD during this period. This result was surprising and seemed to indicate that labor and time savings might be realized by deferring BRD vaccination until feedlot arrival without sacrificing animal performance; however, more research is needed to confirm this finding. In addition, these ranch-direct calves could be considered lower risk than is typical for market-sourced cattle.

Growth Performance. Pre-shipment ADG was greater (P<0.01) for calves weaned 45 days before shipping to the feedlot compared to calves weaned either 15 or 0 days before shipping to the feedlot (Table 3). This occurred because calves weaned for 45 days before shipping consumed, on average, a more energy-dense diet than calves that suckled their dams for all or part of this period. Calf ADG during the pre-shipping period was similar (P=0.66) between PRE and POST calves (Table 5).

Calf ADG during the 60-day feedlot receiving period was similar (P=0.62) between calves weaned for 45 or 15 days prior to feedlot placement; however, both groups of calves tended to have greater (P<0.07) ADG during the receiving period than those shipped directly to the feedlot after maternal separation (i.e., the 0-day weaning treatment; Table 4). Previous research at this location reported that calves weaned for 15, 30, 45, or 60 days before feedlot placement had similar ADG during receiving; however, calves weaned for any length of time prior to feedlot placement had greater ADG than calves placed in a feedlot immediately after maternal separation. Likewise, calf ADG during the 60-day feedlot receiving period was similar (P=0.51) between calves vaccinated on their ranch of origin or calves not vaccinated until feedlot arrival (Table 6).

Intake. Feed intake (dry matter basis) by calves weaned for 45 days was greater (P<0.01) during the pre-shipment period than that by calves weaned for 15 days (Table 3). Similarly, dry matter intake increased (P<0.03) successively with length of the weaning period during receiving; however, gain:feed was not affected (P≥0.36) by length of the weaning period (Table 4). Experience consuming dry diets from a feed bunk prior to shipping translated to greater feed intake and greater ADG during the receiving period.

Furthermore, the timing of vaccination against BRD-causing organisms did not affect (P≥0.35) feed intake or feed efficiency during the receiving period (Table 6).

Implications

Ranch-of-origin weaning periods that were at least 15 days in length improved receiving dry matter intake and growth performance during receiving of cattle that were moved from their ranch of origin to a feedlot within 16 hours and were not commingled with market-sourced cattle. Significantly, receiving performance was similar during receiving for calves weaned 15 days or 45 days before shipping. This study raised the possibility that pre-shipment BRD vaccination may not improve health or performance of ranch-direct cattle relative to BRD vaccination that is deferred until feedlot receiving. Further research will be necessary to verify this finding.

Table 1. Ingredients and nutritional composition of the weaning diet

Ingredient composition*	Dry matter %
Alfalfa extender pellets	41.82
Corn gluten feed	18.22
Wheat middlings	14.68
Cracked corn	10.78
Cottonseed hulls	7.68
Dried distillers grains	3.01
Molasses	1.67
Limestone	1.85
Nutrient composition	**Amount**
Crude protein, % dry matter	15.31
Calcium, % dry matter	0.56
Phosphorus, % dry matter	1.43
NEm, Mcal/lb	0.65
NEg, Mcal/kg	0.39

* Diet also contained salt, zinc sulfate, and Rumensin 80 (Elanco Animal Health, Greenfield, IN).

Table 2. Average ingredient and nutritional composition of the receiving diet

Ingredient composition*	Dry matter, %
Ground sorghum grain	59.43
Sorghum silage	25.47
Soybean meal	11.04
Limestone	2.08
Ammonium sulfate	0.44
Urea	0.06
Salt	0.06

Nutrient composition	Amount
Crude protein, % dry matter	15.90
Calcium, % dry matter	1.01
Phosphorus, % dry matter	0.33
NEm, Mcal/lb	0.79
NEg, Mcal/lb	0.51

* Diet also contained Rumensin 80, Tylan 40 (Elanco Animal Health, Greenfield, IN), and trace minerals.

Table 3. Performance of beef calves during ranch-of-origin weaning periods lasting 0, 15, or 45 days

	Length of weaning period, days				
Item	0	15	45	SEM	P-value
Incidence of undifferentiated fever (weaning to day 15), %	-	0.00[a]	0.70[b]	-	< 0.01
Average daily gain (weaning to shipping), lb	1.28[a]	1.10[a]	2.05[b]	0.031	< 0.01
Dry matter intake (weaning to shipping), lb/day	-	8.36[a]	11.62[b]	0.133	< 0.01
Gain:feed (weaning to shipping)	-	0.49[a]	0.23[b]	0.001	< 0.01
Shrinkage (shipping to feedlot arrival), % body weight	8.86[a]	5.29[b]	8.79[a]	0.749	< 0.01

[ab] Treatment means within row that share common superscript are similar.

Table 4. Performance of beef calves weaned for 0, 15, or 45 days before shipping during a 60-day receiving period

	Length of weaning period, days				
Item	0	15	45	SEM	P-value
Incidence of undifferentiated fever, %	1.37	0.00	1.40	-	0.73
Average daily gain, lb					
Arrival to day 30	2.43[a]	2.78[b]	2.91[b]	0.038	< 0.01
Arrival to day 60	2.78[a]	2.91[b]	2.87[b]	0.025	0.07
Dry matter intake, lb/day	16.25[a]	17.31[b]	17.84[c]	0.072	< 0.01
Gain:feed	0.17	0.17	0.16	0.005	0.36

[abc] Treatment means within row that share common superscript are similar.

Table 5. Performance of beef calves vaccinated against respiratory-disease pathogens prior to shipping or at feedlot arrival during a ranch-of-origin weaning period

	Vaccination timing			
Item	Pre-shipment	Feedlot arrival	SEM	P-value
Shrinkage (shipping to feedlot arrival), % body weight	8.14[a]	7.16[b]	0.606	0.02
Incidence of undifferentiated fever (weaning to day 15), %	1.40	0.90	-	0.66
Average daily gain (weaning to shipping), lb	1.50	1.48	0.025	0.17
Dry matter intake (weaning to shipping), lb/day	9.55[a]	10.45[b]	0.141	0.03
Gain:feed (weaning to shipping)	0.36	0.36	0.015	0.64

[ab] Treatment means within row that share common superscript are similar.

Table 6. Performance of beef calves vaccinated against respiratory-disease pathogens prior to shipping or at feedlot arrival during a 60-day receiving period

	Vaccination timing			
Item	Pre-shipment	Feedlot arrival	SEM	P-value
Incidence of undifferentiated fever, %	0.93	0.90	-	0.80
Average daily gain, lb				
Receiving to day 30	2.58[a]	2.80[b]	0.029	0.02
Receiving to day 60	2.87	2.82	0.020	0.51
Dry matter intake, lb/day	17.17	17.11	0.059	0.72
Gain:feed	0.16	0.17	0.004	0.35

[ab] Treatment means within row that share common superscript are similar.

The Relative Importance of Weaning Management and Vaccination History on Finishing Performance and Carcass Characteristics of Beef Calves

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Introduction

Bovine respiratory disease (BRD) decreases the profitability associated with cattle feeding. The cost of BRD includes death loss, expense associated with BRD treatment, and reduced growth performance. Respiratory disease also has resulted in decreased carcass weights, USDA quality grade, and longissimus area of feedlot cattle. Treatment for apparent BRD has been associated with decreased carcass weights, fat thickness, and ribeye area (REA) compared to untreated animals, whereas reduced incidence of BRD resulted in higher carcass merit. Pre-shipment weaning and vaccination has previously been reported to reduce the incidence and severity of BRD in feedlot steers.

Previous research at this location has demonstrated that length of the pre-shipment weaning period influenced carcass characteristics and time on feed during finishing. Therefore, we hypothesized that vaccination strategy and the length of the pre-shipment weaning period interact to influence calf performance during finishing and subsequent carcass characteristics. The objective of our experiment was to compare the effects of BRD vaccination administered prior to weaning on the ranch of origin or after arrival at a feedlot for calves weaned 45, 15, or 0 days prior to feedlot arrival.

Materials and Methods

Angus x Hereford calves (n = 437; average initial body weight = 459 ± 55 lb) were used for this experiment. Calves originated from the Kansas State University Commercial Cow-Calf Unit at Manhattan, KS, and the Agricultural Research Center–Hays. Approximately 60 days prior to maternal separation, animals were stratified by body weight, sex, and date of birth, and assigned randomly to a pre-shipment weaning period (i.e., 45, 15, or 0 days). Within each weaning treatment calves were assigned randomly to one of two BRD vaccination treatments. One vaccination treatment group was vaccinated 14 days prior to maternal separation and again at weaning; the second vaccination treatment group was vaccinated on the day of arrival at the feedlot and again 14 days later.

Initial and booster vaccinations against IBR, BVD, PI3, and BRSV were administered using a modified live product (Bovi-Shield Gold FP, Pfizer Animal Health, New York, NY). All calves were treated for internal and external parasites using Dectomax (Pfizer

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Animal Health) and were vaccinated against clostridial diseases (Vision 7 with SPUR, Intervet Inc., Millsboro, DE) at the time of weaning. Calves were transported a short distance (< 30 miles) to a home-ranch weaning facility. Calves were weaned in earth-floor pens (4 pens per treatment) and fed a common weaning diet during the preconditioning period. Feed bunks were read daily and intake was recorded.

All calves were individually weighed and transported 4 hours from their respective ranch-of-origin weaning facilities to an auction market on a common shipping date. Calves from both origins were commingled with respect to gender and treatment and were maintained on the premises of the auction market for 12 hours. This commingling was employed to simulate the pathogen exposure typically encountered by market-ready calves. The following day, calves were shipped a short distance (< 5 miles) to the feedlot. At arrival, calves were weighed and assigned to a receiving pen based on their weaning and vaccination treatments. The cattle were adapted to a receiving ration and dry matter intake was recorded daily over a 60-day receiving period.

Calves were monitored for symptoms of respiratory disease at 7:00 a.m. and 2:00 p.m. daily during the receiving period. Calves with clinical signs of BRD, as judged by animal caretakers, were removed from home pens and evaluated. Each calf with clinical signs of BRD was weighed, had its rectal temperature measured, and was assigned a clinical illness score (scale: 1 to 4; 1 = normal, 4 = severe illness). Calves with a clinical illness score greater than 1 and a rectal temperature greater than 104°F were treated and returned to their home pens. Cattle were evaluated 72 hours post-treatment and re-treated based on observed clinical signs.

Calf body weights were measured 60 days after arrival at the feedlot. Following the receiving phase, calves were adapted to a common finishing ration over a 21-day period (Table 1). Steers remained in their respective receiving pens during finishing. After 165 days on feed, steers were scanned ultrasonically to determine subcutaneous fat thickness over the 12th rib. Steers were assigned to one of three harvest dates based on this scan to meet an average carcass endpoint of 0.45 in. of fat depth over the 12th rib.

Calves were transported approximately 3 hours to a commercial abattoir on their respective harvest date. At the abattoir, lungs were examined for lesions and livers were examined for presence of abscesses. After carcasses were chilled for 48 hours, carcass characteristics were measured by a trained evaluator unaware of treatments and included 12th rib fat thickness; 12th rib longissimus muscle area; kidney, pelvic, and heart fat; USDA maturity grade; USDA yield grade; USDA quality grade; and marbling score.

Results and Discussion

Growth Performance. Calf average daily gain (ADG) during finishing was greater ($P<0.01$) for calves weaned for 45 or 15 days before shipping than calves weaned for 0 days before shipping (Table 2), whereas ADG was similar ($P=0.26$) between calves vaccinated for BRD-causing organisms before shipping and those vaccinated for BRD-causing organisms at feedlot arrival (Table 3). This differed from a previous study at another location where preconditioned calves had greater receiving ADG, but finishing gains were similar to non-preconditioned animals. Calves weaned 45 days before shipping required fewer (P=0.02) days on feed than those calves weaned 15 or 0 days before shipping (Table 2). Previous research at this location also found that longer weaning periods were associated with fewer days on feed. Consequently, calves weaned 45 days before shipping had greater (P<0.01) harvest body weights than calves weaned 15 or 0 days before shipping (Table 2). Timing of BRD vaccination did not affect feedlot growth performance in this experiment.

Carcass Merit. Hot carcass weight was greater (P<0.02) for calves weaned 45 and 15 days prior to shipping than for calves weaned 0 days before shipping (Table 4). This increase was attributed to increased performance in the feedlot. Marbling score, USDA yield grade, 12th rib fat thickness, REA, and kidney, pelvic, and heart fat were similar (P≥0.22) between weaning and vaccination treatments (Tables 4 and 5). This is contrary to the findings of previous research at this location in which yield grade, kidney, pelvic, and heart fat, and fat thickness increased with longer weaning periods. Deposition of internal or external fat for our ranch-direct calves was not influenced by pre-shipment weaning length or timing of BRD vaccination. Likewise, incidence of liver abscesses was similar (P<0.47) between weaning and vaccination treatments. Incidence of lung lesions was not affected (P>0.81) by weaning treatment; however, cattle vaccinated for BRD at feedlot arrival tended (P<0.09) to have greater incidence of lung lesions than cattle vaccinated for respiratory disease before shipping. Deferring BRD vaccination until feedlot arrival may allow subclinical BRD incidence to occur in such animals; however, more investigation is needed.

Implications

A preconditioning period was found to increase steer ADG and harvest weights; this increase in growth reduced the length of time on feed to a harvest endpoint. However, effects on carcass traits were minimal. Carcass weight, carcass merit, and growth performance during finishing were similar between calves weaned for 45 days or 15 days before shipping. Pre-shipping BRD vaccination did not improve growth performance or carcass merit of ranch-direct cattle relative to BRD vaccination deferred until feedlot arrival. Length of pre-shipment weaning period had greater interactions on performance and carcass merit than BRD vaccination timing. Deferred BRD vaccination potentially caused an increase in observed lung lesions upon slaughter. More research is necessary to clarify any findings.

Table 1. Average ingredient and nutrient composition of the finishing diet

Ingredient composition	% of dry matter
Ground sorghum grain	80.86
Sorghum silage	14.81
Soybean meal	3.23
Limestone	0.50
Rumensin 80[a]	0.30
Ammonium sulfate	0.11
Salt	0.10
Tylana	0.09
Nutrient composition	**Amount**
Crude protein, % dry matter	13.43
Calcium, % dry matter	0.32
Phosphorus, % dry matter	0.33
NEm, Mcal/lb	0.86
NEg, Mcal/lb	0.57

[a] Elanco Animal Health, Greenfield, IN.

Table 2. Performance of beef calves weaned for 0, 15, or 45 days before shipping during finishing

	Length of weaning period, days				
Item	0	15	45	SEM	P-value
Average daily gain, lb	3.48[a]	3.64[b]	3.70[b]	0.022	< 0.01
Days on feed	220[b]	217[b]	209[a]	3.047	0.02
Body weight at harvest, lb	1248[a]	1270[b]	1305[c]	6.120	< 0.01

[abc] Treatment means within row that share common superscript are similar.

Table 3. Performance of beef calves vaccinated against respiratory-disease pathogens prior to shipping or at feedlot arrival during a 60-day receiving period

	Vaccination timing			
Item	Pre-shipment	Feedlot arrival	SEM	P-value
Average daily gain, lb	3.57	3.64	0.018	0.26
Days on feed	216	215	2.251	0.85
Body weight at harvest, lb	1274	1274	4.783	0.99

[ab] Treatment means within row that share common superscript are similar.

Table 4. Carcass characteristics of beef calves following ranch-of-origin weaning periods lasting 0, 15, or 45 days

	Length of weaning period, days				
Item	0	15	45	SEM	P-value
Hot carcass weight, lb	743[b]	765[c]	783[d]	4.493	0.02
Marbling score[a]	47.9	46.6	49.1	1.033	0.22
USDA yield grade	3.3	3.2	3.4	0.081	0.33
12th rib fat thickness, in.	0.54	0.50	0.54	0.474	0.20
Longissimus area, in.^{2}	12.3	12.4	12.5	1.144	0.74
Kidney, pelvic, and heart fat, %	2.66	2.56	2.64	0.081	0.56
Calves with > 1 liver abscess, %	18.68	23.38	25.35	-	0.47
Calves with > 1 lung lesion, %	34.38	32.14	29.73	-	0.81

[a] Marbling score: 30 = Slight[00], 40 = Small[00], 50 = Modest[00]; ex. 55 = Modest[50].

[bcd] Treatment means within row that share common superscript are similar.

Table 5. Carcass characteristics of beef calves vaccinated against respiratory-disease pathogens prior to shipping or at feedlot arrival

	Vaccination timing			
Item	Pre-shipment	Feedlot arrival	SEM	P-value
Hot carcass weight, lb	765	761	3.320	0.73
Marbling score[a]	47.4	48.4	0.763	0.36
USDA yield grade	3.3	3.3	0.060	0.59
12th rib fat thickness, in.	0.52	0.54	0.352	0.23
Longissimus area, in.^{2}	12.4	12.4	0.850	0.90
Kidney, pelvic, and heart fat, %	2.59	2.65	0.060	0.50
Calves with > 1 liver abscess, %	24.79	19.67	-	0.63
Calves with > 1 lung lesion, %	27.20	37.21	-	0.09

[a] Marbling score: 30 = Slight[00], 40 = Small[00], 50 = Modest[00]; ex. 55 = Modest[50].

Effects of Degree of Respiratory Disease Vaccination on Health and Growth Performance of Ranch-Direct Beef Calves during Weaning and Receiving

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Introduction

Reducing incidence of bovine respiratory disease (BRD) is a common goal of a preconditioning program. In a survey of United States feedlots, BRD was found to be the leading cause of calf morbidity and mortality. Previous ranch-of-origin weaning periods have been found to influence health and growth of beef calves upon feedlot reception. Practices of vaccination, dehorning, castration, and adapting cattle to feed and water before shipment to a feedlot have been shown to reduce incidence of BRD. Vaccination against BRD pathogens is thought to improve the health of newly weaned calves, and differing strategies are utilized when administering BRD vaccination. Vaccination at weaning followed by a revaccination is usually recommended. Our objective was to determine the effect of 0, 1, 2, or 3 vaccinations (14 days apart) for BRD on health and growth performance of ranch-preconditioned, market-sourced beef steers.

Materials and Methods

Angus x Hereford calves (n= 430; initial body weight = 507 $\pm$ 70 lb) were used for this experiment. Calves originated from the Kansas State University Commercial Cow-Calf Unit in Manhattan, KS, and the Agricultural Research Center–Hays. Calves were stratified by body weight, sex, and birth date, and assigned randomly to a BRD vaccination treatment of 0, 1, 2, or 3 vaccinations (NOVACC, VACC1, VACC2, or VACC3, respectively).

All calves were removed from their dams at an approximate average age of 180 days and transported (< 30 miles) to a home ranch weaning facility. Calves were individually weighed, tagged, treated for internal and external parasites using Dectomax (Pfizer Animal Health, New York, NY), and vaccinated against clostridial diseases (Vision 7 with SPUR, Intervet Inc., Millsboro, DE) and Haemophilus somnus (Somubac, Pfizer Animal Health). Initial and booster vaccinations against IBR, BVD, PI3, and BRSV were administered using a modified live product (Bovi-Shield Gold FP, Pfizer Animal Health).

Vaccination against BRD agents was administered to VACC1, VACC2, and VACC3 calves on day 0. On day 14, all calves were revaccinated with Haemophilius somnus,

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individual body weight was recorded, and VACC2 and VACC3 calves received the booster BRD vaccine. Twenty-eight days following maternal separation, all calves were revaccinated against clostridial diseases and VACC3 calves received their final BRD vaccination.

Calves were maintained in earth-floor pens separated by sex and treatment throughout the ranch-of-origin weaning period. Animals were adapted to a common weaning diet (Table 1) and daily intake was recorded. Calves were monitored for symptoms of respiratory disease at 7:00 a.m. and 2:00 p.m. daily. Calves with clinical signs of BRD were evaluated by animal caretakers, who measured the calves' rectal temperature and assigned a clinical illness score (scale: 1 to 4; 1 = normal, 4 = severe illness). Calves with a clinical illness score greater than 1 and a rectal temperature greater than 104°F were treated and returned to their home pens. Calves were re-evaluated 72 hours post-treatment and re-treated based on observed clinical signs. Drug therapy costs were calculated as cost per treatment throughout the experiment.

Following the 28-day weaning period, calf body weight was recorded and animals were transported 4 hours from their respective ranch-of-origin weaning facilities to an auction market. Calves from both origins were commingled and held on the premises of the auction barn for 16 hours. This pathogen exposure during commingling is typical of market-ready calves. Calves were then transported (< 5 miles) to a feedlot. Upon arrival, calves were weighed and assigned to a receiving pen according to sex and vaccination treatment. Calves were adapted to a common receiving ration (Table 2) and daily feed intake was recorded throughout a 55-day receiving period. Calves continued to be monitored for BRD symptoms daily at 7:00 a.m. and 2:00 p.m. Clinical illnesses were treated in the same manner as during the ranch-of-origin weaning period. Individual body weight was recorded after 27 and 55 days on feed.

Results and Discussion

Growth Performance. Calf body weights were not affected by treatment during the weaning period ($P \geq 0.53$; Table 3) or during the feedlot receiving phase ($P \geq 0.48$; Table 4). Calf average daily gain (ADG) during PRESHIP was similar ($P=0.61$) between vaccination groups. Similarly, other researchers also have observed no difference in receiving ADG between vaccinated and unvaccinated calves. Furthermore, dry matter intake and gain:feed during the PRESHIP period were similar ($P \geq 0.61$) between treatments (Table 3).

Loss of body weight due to transit to the auction market and feedlot was similar ($P=0.32$) among all BRD treatment groups (Table 3). Daily gains during receiving were not affected ($P \geq 0.84$) by vaccination treatment at day 27 and day 55. Degree of BRD vaccination had no effect ($P \geq 0.71$) on dry matter intake or gain:feed during the receiving period (Table 4). Calves experienced consistent growth performance throughout the experiment. Similar results have been reported by other researchers with similar growth traits between vaccination treatment groups.

Health. Incidence of fever during the 30-day weaning (PRESHIP) period tended ($P=0.06$) to be greater for NOVACC calves than VACC1, VACC2, or VACC3 groups. Consequently, NOVACC calves had greater ($P<0.01$) drug-therapy costs

PRESHIP than other treatments (Table 5). This reduction in clinical BRD among vaccinated calves is consistent with findings of previous research by others. Surprisingly, VACC2 calves had greater incidence of fever ($P<0.01$) than that among NOVACC, VACC1, or VACC3 calves during the receiving period; therefore, drug-therapy costs for VACC2 cattle were greater ($P<0.01$) than for NOVACC, VACC1, and VACC3 cattle. Reasons for this are unclear; however, BRD incidence previously has been found to be variable. Additional studies are needed to elucidate the relationships between vaccination timing and frequency and calf growth performance.

Implications

Vaccination for BRD, regardless of degree, improved the health of calves during the ranch-of-origin preconditioning period. However, feed intake, ADG, or gain:feed ratio during preconditioning or feedlot receiving was not affected by level of vaccination when compared with untreated herdmates. However, due to the variation in outcomes from similar experiments, vaccination effects on growth performance should be evaluated further. Improved animal health was observed with a single BRD pathogen vaccination, but added benefits with subsequent treatment will need to be further investigated.

Table 1. Ingredient and nutritional composition of the weaning diet

Ingredient composition*	% dry matter
Extender pellets (Alfalfa)	33.00
Corn gluten feed	18.18
Wheat middlings	14.63
Dried distillers grains	11.52
Cracked corn	10.94
Cottonseed hulls	7.75
Molasses	2.00
Limestone	1.85
Salt	0.10
Nutrient composition	**Amount**
Crude protein, % dry matter	17.68
Calcium, % dry matter	1.19
Phosphorus, % dry matter	0.74
Acid detergent fiber, % dry matter	20.64
Neutral detergent fiber, % dry matter	38.14
Ash, % dry matter	8.12
NEm, Mcal/lb	0.68
NEg, Mcal/lb	0.42

* Diet also included Bovatec 91 (Alpharma Animal Health, Bridgewater, NJ), vitamin A 650, and zinc sulfate.

Table 2. Ingredient and nutritional composition of the receiving diet

Ingredient composition*	% dry matter
Rolled milo	48.95
Hay	33.47
Wet distillers grains	15.08
Nutrient composition	**Amount**
Crude protein, % dry matter	14.90
Calcium, % dry matter	0.82
Phosphorus, % dry matter	0.37
Acid detergent fiber, % dry matter	20.10
Neutral detergent fiber, % dry matter	28.43
Ash, % dry matter	5.74
NEm, Mcal/lb	0.69
NEg, Mcal/lb	0.42

* Diet also included salt, Rumensin 80 and Tylan 40 (Elanco Animal Health, Greenfield, IN), and trace minerals.

Table 3. Performance of beef calves during ranch-of-origin weaning period

	Vaccination treatment					
Item	NOVACC	VACC1	VACC2	VACC3	SEM	P-value
Body weight, lb						
Maternal separation	511	494	503	507	5.85	0.53
14 days	509	493	500	511	3.86	0.55
Shipping	549	531	536	547	6.70	0.57
Average daily gain, lb	1.32	1.32	1.21	1.45	0.05	0.61
Dry matter intake, lb/day	9.72	9.63	9.61	9.94	0.08	0.56
Gain:feed	0.13	0.14	0.13	0.14	0.01	0.59
Transport shrinkage, % body weight	6.21	4.90	6.20	4.52	1.08	0.32

Table 4. Performance of beef calves during feedlot receiving period

	Vaccination treatment					
Item	NOVACC	VACC1	VACC2	VACC3	SEM	P-value
Body weight, lb						
Receiving	514	505	505	522	4.373	0.48
27 days	584	580	580	593	4.332	0.69
55 days	657	653	650	666	4.871	0.71
Average daily gain, lb						
27 days	2.65	2.76	2.82	2.65	0.183	0.84
55 days	2.60	2.67	2.67	2.65	0.073	0.92
Dry matter intake, lb/day	25.26	25.22	25.26	25.18	0.025	0.72
Gain:feed	0.10	0.11	0.11	0.11	0.006	0.91

Table 5. Incidence of fever and cost of treatment during weaning and receiving

	Vaccination treatment					
Item	NOVACC	VACC1	VACC2	VACC3	SEM	P-value
Incidence of fever, %						
Weaning period	14.41	5.61	7.41	5.77	-	0.06
Receiving period	0.00[a]	0.00[a]	4.63[b]	0.00[a]	-	0.01
Overall	14.41	5.61	10.18	5.77	-	0.19
Treatment cost, $/head						
Weaning period	3.40[b]	1.21[a]	1.72[a]	1.32[a]	0.629	< 0.01
Receiving period	0.21[a]	0.00[a]	1.32[b]	0.00[a]	0.318	< 0.01
Overall	3.77[b]	1.21[a]	3.04[b]	1.32[a]	0.773	< 0.01

[ab] Within a row, means without a common superscript differ ($P<0.05$).

Effects of Prepartum Ruminally Protected Choline Supplementation on Performance of Beef Cows and Calves

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Introduction

Prepartum supplementation of spring-calving beef cows is a vital part of cow-calf enterprises that often affects subsequent reproductive success. Supplements can vary in content and range from those high in energy, protein, or fat, all of which can be utilized effectively if managed properly. However, little focus has been applied to the use of micronutrients in supplements and their effects. One such micronutrient is choline. Choline is generally classified as a B vitamin and is an essential nutrient. It is commonly found in feedstuffs and forages but is highly degraded in the rumen. Thus, for choline to be effectively supplemented, it must be offered in a form that will allow it to bypass the rumen. This can be achieved by encapsulating the choline in fat.

Choline is most often found in specialized fat molecules known as phospholipids, the most common being phosphatidylcholine. Choline and products derived from choline serve a number of biological functions. Specifically, phosphatidylcholine and other choline-containing lipids help form the structural integrity of cell membranes. Choline-containing phospholipids are also important precursors for intracellular messenger molecules and cell-signaling molecules. Choline is important to nerve impulse transmission because it is a precursor to acetylcholine. Choline also can be used as a methyl donor.

Lipid transport and metabolism is largely dependent on choline. Fat consumed in the diet is transported to the liver via chylomicrons. After fat enters the liver it is packaged into lipoproteins called very low-density lipoproteins (VLDL), which are transported through the blood to tissues that need them. Phosphatidylcholine is a required component of VLDL. Therefore, supplementing ruminally protected choline to cows prepartum could aid in fat metabolism in the liver in times of nutritional stress. The objective of our study was to evaluate the effect of ruminally protected choline supplementation on cow and calf productivity.

Materials and Methods

Animals, Treatments, and Diet. Angus crossbreed cows and heifers (n = 438; initial body weight 1,173 ± 9 lb) were blocked by age, body condition score (BCS; 1 = emaciated, 9 = obese), and expected calving date. Cows and heifers were managed in two locations with 190 cows and 43 heifers being managed at the Rufus F. Cox Cow-Calf Unit at Kansas State University in Manhattan, KS. The remaining 149 cows and 56 heifers

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were managed at the Kansas State University Agricultural Research Center–Hays (ARCH). At the beginning of January, females were blocked and randomly assigned to one of two supplement treatment groups: (1) a 40% crude protein mix of corn and soybean meal (1:3) containing ruminally protected choline, or (2) a control supplement of 40% crude protein containing corn and soybean meal (1:3). Nutrient composition of supplements are summarized in Table 1. The base supplement at ARCH contained rolled milo in place of cracked corn. Treatments were applied during a 60-day period that immediately preceded the earliest predicted calving date; each cow was fed 5.25 lb/head per day of CON or RPC 6 times per week. The feeding rate of choline averaged 4.5 g/cow per day. The mature cows in Manhattan were evenly distributed by treatment, BCS, and expected calving date into four native tallgrass prairie pastures with approximately 47 cows per pasture (23 or 24 per treatment group per pasture). Cattle were gathered from their pastures at 7:00 a.m., sorted into pens by treatment, fed their allotted amount of supplement, and allowed one hour to consume the supplement. Females that calved prior to the expected calving date did not complete the treatment period of 60 days and were statistically analyzed separately. After the trial period was over, cows were no longer sorted by treatment and were fed a commercial supplement in one bunk in their respective pastures. Cows were fed the common supplement until May 15.

Data Collection. Cow body weight, BCS, and ultrasound measurements were taken at the beginning and end of the supplementation period. Backfat (BF) thickness, longissimus muscle depth (LMD), and intramuscular fat (IMF) measurements were taken between the 12th and 13th rib interface using an Aloka 500V (Aloka Co., Ltd, Wallingford, CT) B-mode instrument equipped with a 3.5-MHz general purpose transducer array (UST 5021-125 mm window). Software used to generate images was obtained from Cattle Performance Enhancement Company (CPEC, Oakley, KS). Cow body weight and BCS were taken at calving, prior to estrous synchronization, estrous synchronization, artificial insemination (AI) pregnancy determination, weaning, and final pregnancy determination. Calf weights were also recorded at this time.

Estrous Synchronization and Breeding. Ovulation was synchronized using the Co-synch + CIDR (controlled internal drug release) protocol (Figure 1) and then mass-mated. Cows were exposed to bulls 10 days after AI for the remainder of a 60-day breeding season. First service conception rate was determined via ultrasound 30 days after AI and final pregnancy determination was determined via rectal palpation 60 days after the breeding season.

Statistics. Response variables for cow performance were treated as a completely randomized block design and analyzed with the GLM Procedure in SAS. Reproductive responses were analyzed via CATMOD procedures in SAS.

Results and Discussion

Cow Performance. Cow body weight, BCS, BF, and IMF were similar between treatments at the onset of supplementation and at final pregnancy diagnosis ($P \geq 0.25$). Cows fed ruminally protected choline tended ($P=0.10$) to lose 0.87 ± 0.45mm more LMD between the onset of the trial and the conclusion of the supplementation period. Conversely, ruminally protected choline-supplemented cows tended ($P=0.07$) to have a greater body weight of 1,274.8 ± 8.2 lb at AI pregnancy determination compared to CON supplemented cow body weight of 1,246.6 ± 8.2 lb. Within parity class, AI pregnancy rates and overall pregnancy rates were not affected (P≥0.14) by treatment. Furthermore, ruminally protected choline and CON supplemented AI and overall pregnancy rates were not different (P≥0.19; Table 2). Cow performance responses are depicted in Table 2.

Calf Performance. Calf body weight from birth to weaning was not different (P≥0.39) between treatments (Table 3). Similarly adjusted calf 205-day body weights were not different (P=0.51) between treatments. Calf average daily gain (ADG) from birth to dam estrous synchronization and birth to weaning were not different (P≥0.09); however, calf ADG from AI pregnancy diagnosis to weaning tended to be greater (P=0.06) for calves from cows that were supplemented ruminally protected choline; these calves gained 0.15 ± 0.04 lb more per day than CON calves.

Implications

Supplementation of ruminally protected choline to prepartum beef cows had no effect on body weight, body weight change, BF, or IMF. However, choline supplementation negatively affected cow LMD. Furthermore, calves from choline-supplemented cows tended to have increased ADG. Cow pregnancy rates were not affected by choline supplementation. The increase in fertility associated with choline supplementation found in other studies was not apparent in this work. The lower reproductive response could be associated with higher milk yield from cows supplemented ruminally protected choline. These data suggest that choline may improve liver function, thus increasing milk yield, but may lower reproductive efficiency.

Table 1. Nutrient analysis of supplements

Item	RPC	CON
Corn, %	50	50
Soybean meal, %	50	50
Dry matter, %	89.22	88.59
Crude protein, %	40.66	37.12
Calcium, %	0.3	0.22
Phosphorus, %	0.57	0.54
Neutral detergent fiber, %	10.26	9.91
Acid detergent fiber, %	4.27	4.45
Starch, %	12.35	15.78

Table 2. Cow performance response

Item	RPC	CON	SE	P-value
Cow body weight change, lb				
Overall (01/22 to 10/05)	16.5	10.2	4.05	0.80
Cow BCS change[1]				
Overall	0.44	0.53	0.038	0.25
Cow ultrasound measurement change, mm				
Backfat	-0.02	-0.04	0.05	0.88
Muscle depth	-1.09	-0.22	0.45	0.10
Marbling score[2]	-0.36	-0.44	0.03	0.39
Timed-AI pregnancy, %	45.8	44.7	-	0.83
Overall pregnancy, %	87.5	91.6	-	0.19

[1] BCS = body condition score; 1 = emaciated, 9 = obese.
[2] Marbling scores were coded such that 4.0 = slight00 (low select) and 5.0 = small00 (low choice).

Table 3. Calf performance response

Item	RPC	CON	SE	P-value
Calf performance, lb				
Early ADG[1] (birth to 08/01)	2.36	2.43	0.02	0.09
Late ADG (08/02 to 10/05)	2.31	2.16	0.02	0.05
Overall ADG (birth to 10/05)	2.31	2.29	0.01	0.64
Adjusted 205-day weight	577.6	572.3	3.5	0.51

[1] ADG = average daily gain.

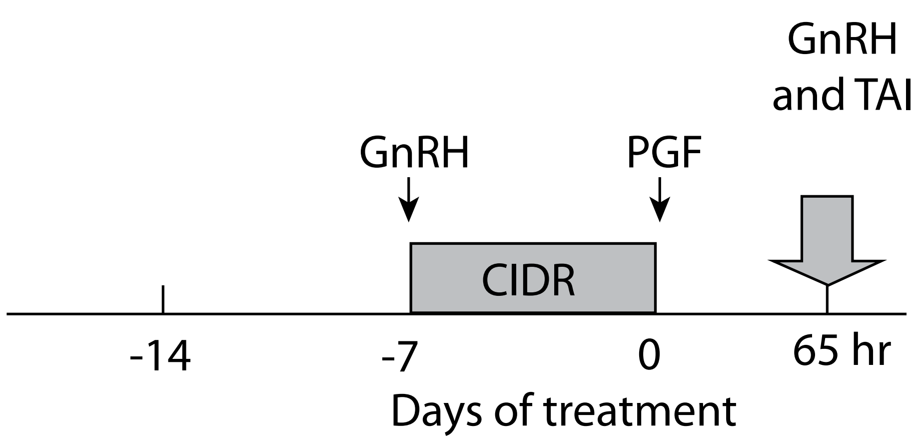

Figure 1. Co-synch + CIDR (controlled internal drug release) synchronization protocol. GnRH=gonadotropin releasing hormone; PGF=prostaglandin; TAI=fixed-time artificial insemination.

Establishing Different Legumes in Grass: An On-Farm Research Trial

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Introduction

Research from Missouri and eastern Kansas has shown that adding legume forages to cool-season pastures is a highly desirable practice. Little research has evaluated legume interseeding into cool-season grasses in north central Kansas, especially west of U.S. Highway 81. Climatic conditions between north central Kansas and eastern Kansas vary significantly, with a possible precipitation gradient of 15 in. The objective of this study was to establish one or more of eight desired legumes into a mature stand of smooth bromegrass used in an intensive rotational grazing program.

Materials and Methods

Eight legumes [purple-flowered alfalfa (*Medicago sativa* ssp. *sativa*), yellow-flowered alfalfa (*Medicago sativa* ssp. *falcata*), yellow sweetclover (*Melilotus officinalis*), ladino white clover (*Trifolium repens*), birdsfoot trefoil (*Lotus corniculatus*), Korean lespedeza (*Kummerowia stipulacea*), cicer milkvetch (*Astragalus cicer*), and hairy vetch (*Vicia villosa*)] were freshly inoculated and seeded separately into two paddocks of an existing smooth bromegrass (*Bromus inermis*) pasture using a 10-ft.-wide Great Plains no-till drill with 7.5-in. row spacings. Legumes were seeded March 19, 2009, with a target of at least 20 pure live seeds (PLS)/ft^2. Each species was seeded into four replicated individual strips with the drill across upland and lowland landscape positions across both paddocks. Each strip of the four strips seeded for a legume species was in a separate block so that all four strips were separated from each other to take into account any field variability from one side of the pasture to the other. A strip with no legumes seeded, which served as a control plot, was left between each replicated block of legumes seeded. Perpendicular to the strips of seeded legumes, pastures were fertilized with one 40-ft.-wide strip of urea (40 lb N/a) at each landscape position to test legume establishment under N-fertilized and unfertilized conditions. Seeding rates for each of the legumes were as follows:

1) Magnagraze purple flowered alfalfa (*sativa*), 10.5 lb/a PLS
2) Yellow flowered alfalfa (*falcata*), 7.5 lb/a PLS
3) Yellow sweetclover, 10.5 lb/a PLS
4) Birdsfoot trefoil, 9.5 lb/a PLS
5) Cicer milkvetch, 9.1 lb/a PLS
6) Korean lespedeza (unhulled), 21.4 lb/a PLS
7) Ladino white clover, 4.9 lb/a PLS
8) Hairy vetch, 21.1 lb/a PLS

In 2009 and 2010, at each species, landscape, and nitrogen combination, stands were evaluated in June and September using two large 40-in. by 40-in. frequency frames.

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Each large frame was divided into 100 smaller 4-in. by 4-in. subsquares. Each subsquare that contained a new rooted legume seedling was counted, so a frequency score of 100% indicated that all small squares of a large frame contained a legume seedling. A total of eight large frames were counted in each treatment combination on each date. In 2010, the year after legume seedling establishment, stands also were hand harvested for yield just prior to each of three grazing occupancy dates.

Results and Discussion

A frequency of at least 21% was set as the criterion for successful establishment. By dividing the frequency percentage by 10.76 (the number of square feet within the frequency frame), a conservative density estimate of established legumes/ft^2 can be calculated. Successful establishment with 21% frequency subsequently translates into a plant density of at least 2 plants/ft^2, because more than one seedling was present within some of the subsquares that were counted.

Examination of the data reveals a number of important and interesting findings. First and foremost, some legumes had consistently greater establishment at each of the nitrogen fertilizer and landscape position combinations (Tables 1 and 2). Legumes that showed acceptable overall establishment at both landscape positions were Korean lespedeza, yellow-flowered alfalfa (*falcata*), and purple-flowered alfalfa (*sativa*). However, establishment on the upland site was greater than on the lowland site for these legumes (Table 1). Yellow sweetclover established successfully on the upland site in 2009, but frequency was reduced in 2010. The remaining legumes did not establish consistently well at either landscape position. Averaged over all legume species, upland sites had approximately 40% greater legume establishment than lowland sites.

Fertilization also affected stand establishment. Legumes that showed acceptable overall establishment with or without added N fertilizater were Korean lespedeza, yellow-flowered alfalfa (*falcata*), and purple-flowered alfalfa (*sativa*; Table 2). However, establishment was greater for these legumes and for yellow sweetclover and white clover on sites without added N fertilizer in both 2009 and 2010. Averaged over all legume species, unfertilized sites had 44% greater establishment than fertilized sites.

Stands improved over the first growing season for some legumes (Table 3). Frequency counts in September 2009 were consistently higher than the June counts for both alfalfas and yellow sweetclover. In 2010, yellow sweetclover frequency was lower in the fall than in the spring.

Lowland sites in general had greater yield in 2010 than upland sites (Table 4). Fertilization with 40 lb N/a did not increase season forage yield. However, on upland sites, unfertilized areas with purple alfalfa and yellow alfalfa had greater yield than fertilized areas. Purple- and yellow-flowered alfalfa on the unfertilized uplands also had greater yield than the grass-only control sites. On lowland sites that were fertilized, purple and yellow alfalfa also had greater yield than the grass-only control.

Each of the established legumes offers unique opportunities and challenges. The two alfalfas, as perennials, offer the possibility of long-term survival and production without having to worry about frequent re-seeding. The biennial yellow sweetclover may present a long-term maintenance problem depending on timing of grazing. Pasture rest during flowering and seed set should allow natural reseeding to occur. Yellow sweetclover had completed its life cycle and seed set by late summer 2010. New seedlings had not germinated from the biennial species by the September sampling period, and thus it had a low frequency in the fall of 2010. New biennial sweetclover seedlings may appear in spring of 2011, but likely will not contribute much to spring forage yield. Korean lespedeza, a summer annual, may present a problem with maintenance and reseeding at northern locations. It is a major component in most cool-season pastures in southeast Kansas, and it did set seed in 2009 to successfully reestablish itself in 2010. As long as grazing management allows rest or plants are allowed to flower and set seed without heavy defoliation, Korean lespedeza most likely will produce seed annually, or at least periodically, to maintain stands indefinitely. However, the lespedeza appeared to contribute little to the overall yield of the pastures even though plant frequency values were well above 21%. Of the four legumes with the most successful establishment, purple alfalfa and yellow alfalfa on the upland unfertilized and lowland fertilized sites showed the greatest potential to increase forage yield.

Implications

Adding legumes to smooth bromegrass pasture could reduce the amount of commercial fertilizer needed to attain optimal forage production. Furthermore, adding legumes to brome pasture could extend the brome-grazing season by increasing the quantity and quality of forage produced in mid-summer, and could improve animal weight gain and profitability potential. Purple-flowered alfalfa and yellow-flowered alfalfa no-till seeded into smooth bromegrass pasture established at acceptable plant densities of more than 2 plants/ft^2. Both alfalfa types provided increased forage quantity above that of fertilized or unfertilized smooth bromegrass pasture. At current approximate cost of $53.00/a to seed the purple-flowered alfalfa, $67.00/a to seed the yellow-flowered alfalfa, and $27.80/a to apply 40 lb N/a, savings in N fertilizer application alone could pay for alfalfa seeding in two to three growing seasons. Purple- and yellow-flowered alfalfas seeded into smooth bromegrass pasture have potential to contribute to greater season forage quantity and quality within two years of seeding.

Table 1. Average frequency, or number of 4-in. by 4-in. subsquares containing at least one desired (target) legume rooted at each landscape position in 2009 and 2010. Values are averaged across both fertilized and unfertilized plots, and averaged across both spring and fall sampling

	2009		2010	
	Upland	Lowland	Upland	Lowland
	-----------------Frequency (%)-----------------			
Birdsfoot trefoil	6	3	1	1
Cicer milkvetch	7	3	6	4
Hairy vetch	3	3	0	0
Korean lespedeza	80	76	58	39
Purple alfalfa	48	23	55	33
Yellow sweetclover	30	15	13	7
White clover	13	14	10	19
Yellow alfalfa	48	31	56	35
LSD[1] $_{0.05}$		7		
Average	29	21	25	17

[1] LSD0.05 = Least significant difference. Values compared within rows or columns that differ by more than the LSD value are statistically different.

Table 2. Average frequency, or number of 4-in. by 4-in. subsquares containing at least one desired (target) legume rooted at each fertilization level in 2009 and 2010. Values are averaged across both upland and lowland plots, and averaged across both spring and fall sampling

	2009		2010	
	40 lb/a N	0 lb/a N	40 lb/a N	0 lb/a N
	-----------------Frequency (%)-----------------			
Birdsfoot trefoil	5	5	1	1
Cicer milkvetch	5	5	4	6
Hairy vetch	3	3	0	0
Korean lespedeza	71	85	37	60
Purple alfalfa	29	43	28	61
Yellow sweetclover	13	32	4	16
White clover	5	23	3	26
Yellow alfalfa	31	48	26	65
$LSD_{0.05}$[1]		7		
Average	20	30	13	29

[1] $LSD_{0.05}$ = Least significant difference. Values compared within rows or columns that differ by more than the LSD value are statistically different.

Table 3. Average frequency, or number of 4-in. by 4-in. subsquares containing at least one desired (target) legume rooted at each spring or fall sample period in 2009 and 2010. Values are averaged across both upland and lowland plots, and averaged across both fertilized and unfertilized sites

	2009		2010	
	Spring	Fall	Spring	Fall
	-----------------Frequency (%)-----------------			
Birdsfoot trefoil	8	1	1	1
Cicer milkvetch	7	3	9	2
Hairy vetch	5	0	0	0
Korean lespedeza	77	79	49	48
Purple alfalfa	29	42	45	44
Yellow sweetclover	17	28	20	0
White clover	16	12	16	13
Yellow alfalfa	34	45	43	48
LSD1 0.05		8		
Average	24	26	23	19

[1] $LSD_{0.05}$ = Least significant difference. Values compared within rows or columns that differ by more than the LSD value are statistically different.

Table 4. Average total yield (lb/a) of legume-bromegrass mixtures at two landscape positions and two N fertilizer levels one year following legume interseeding. Yields are the sum of two spring harvests and one fall harvest in 2010. Due to poor establishment, trefoil, milkvetch, and hairy vetch plots were similar to the grass-only control and were not harvested

	Lowland		Upland	
	40 lb/a N	0 lb/a N	40 lb/a N	0 lb/a N
	-------------------Yield (lb/a)-------------------			
Grass-only control	5173	4784	2893	2688
Korean lespedeza	6067	5059	3384	2740
Purple alfalfa	7524	6456	3124	5348
Yellow sweetclover	5781	5523	3931	3739
White clover	5667	5357	2938	1927
Yellow alfalfa	7824	4776	3007	4864
$LSD^1_{0.05}$		1552		
Average	6339	5326	3213	3551

[1] $LSD_{0.05}$ = Least significant difference. Values compared within rows or columns that differ by more than the LSD value are statistically different.

Conservation Reserve Program Land Management for Biomass Feedstock Production

K. Harmoney[1] *and H. Jansonius*[1]

Introduction

Kansas had approximately 3.1 million conservation reserve program (CRP) acres at the start of 2009, and about 50% of those acres expire from September 2009 through 2011. In 1985 when CRP was initiated, the focus was on soil conservation, but now the focus has shifted to include water quality and wildlife habitat. Land from expired contracts often stays in grass and is used for pasture or hay, remains for wildlife habitat, or is tilled and put back into crop production. Another future option may be harvesting the biomass as a feedstock for biofuels. The Natural Resources Conservation Service estimated that the average yield from hay on CRP acres in the Ellis county region would be 1,470 lb/a. This study was initiated to test the biomass potential of north central Kansas CRP acres.

Materials and Methods

This study, sponsored by the U.S. Department of Energy and Sun Grant Initiative, was started in 2008 on 18 acres of CRP four miles west of Hays, KS. This study investigated the production potential of a fully mature and well established CRP grass stand that was seeded into a typical five-species native warm-season grass mix under three different fertilizer treatments. Dominant grasses are sideoats grama, indiangrass, little bluestem, switchgrass, and big bluestem. A significant yellow sweetclover population also was present. Plots were fertilized with urea at rates of 0, 50, or 100 lb nitrogen (N)/a, and the biomass was harvested at one of two different time periods, at peak standing crop near the end of July or first part of August, or at first frost near the end of October. The end of the Kansas grassland bird-nesting season set by the Kansas Deptartment of Wildlife and Parks is July 15, so these harvest times occur after that date for the benefit of wildlife. The stand was cut at a height of 6 in., so a 6-in. stubble was left intact after harvest to maintain soil and water erosion protection of the grass stand. The study included three replications of each fertilizer and harvest combination that resulted in a total of 18 plots, each 1 acre in size. This was larger than typical research plots, so conventionally sized equipment for windrowing and baling the grass was used. After each harvest, bales were rolled into large rounds, and the bales from each plot were weighed. Core samples from the bales were collected to test for moisture and dry matter content to calculate yield, and the core samples were sent to a laboratory to test the material for biomass quality. Soil samples from each plot were collected in 6-in. increments to a depth of 24 in. each spring prior to fertilization, and plant composition was sampled using a dry-weight rank method each year in mid- to late June prior to the peak standing crop harvest.

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Results and Discussion

Fertilizing with 50 or 100 lb N/a statistically increased yield over the non-fertilized treatment in 2009 and 2010, and fertilizing with100 lb N/a increased yield over 50 lb N/a during the same years (Table 1). In 2008, fertilizer had little influence on yield. However, the overall increase in yield from fertilization was not as efficient as expected. Combined over the two years (2009-2010) and the two harvest timings, fertilizing with 50 lb N/a resulted in 10.4 lb dry matter/lb N added, whereas fertilizing with 100 lb N/a resulted in 8.5 lb dry matter/lb N added. Averaged over all fertilizer treatments and years, peak standing and after-frost harvest periods have resulted in similar dry matter yield (Table 2). However, in 2008, the peak standing crop harvest during the summer had greater yield than the after-frost harvest in the fall. By fall, some leaves already may have dropped off plants, and many nutrients have translocated from the leaves and upper stems to the roots and the crown base for new bud formation and storage for winter survival. Seed produced by plants also may have fallen from the seedhead by the time of first frost, which would account for another small loss of yield in the fall.

The dry weight rank sampling that occurred each June indicated that switchgrass and sweetclover composition was different from 2008 to 2010 for the peak standing crop and the after-frost harvests. Switchgrass composition was directly related to yield, especially at the peak standing crop harvest. Switchgrass composition increased with increased fertilizer rates (Figure 1), and greater switchgrass composition resulted in greater dry matter yield (R=0.84 in 2008, R=0.69 in 2009, and R=0.70 in 2010; data not shown). Sweetclover composition in 2009 and 2010 was greatest in plots without N fertilizer and declined linearly with added fertilizer (Table 3).

Implications

Fertilization with 50 and 100 lb N/a increased biomass yield, but may not be cost-effective. Fertilizing with 50 lb N/a was more efficient than fertilizing with 100 lb N/a, but neither rate was as efficient at producing dry matter as desired. Using central Kansas average custom rates and urea fertilizer cost of $0.30/lb N, the cost per ton of dry matter harvested at peak standing crop, baled, and stacked was $35.41, $50.26, and $61.09 for the 0, 50, and 100 lb N/a treatments. At a urea fertilizer cost of $0.45/lb N, the cost per ton of dry matter was $35.41, $56.86, and $73.50. The N fertilization was not as cost-effective at producing dry matter. On a per-acre basis, at $0.30/lb N or $0.45/lb N, the biofuel purchase price would have to be $102.50/ton and $132.50/ton for the 50 lb N/a fertilization treatment to be more profitable than not fertilizing at the current production level and at other current costs of production. Because N fertilizer was inefficient at increasing biomass, at current rates of production and returns, harvesting biomass from CRP without adding N fertilizer is more profitable.

Table 1. Dry matter yields of warm-season grass stands on Conservation Reserve Program lands when fertilized at different nitrogen rates from 2008-2010. Yields are averaged over two harvest timings. Yields followed by similar letters are similar at the P>0.05 level

	N rate (lb N/a)		
Year	0	50	100
	Yield (lb/a)		
2008	1,246[f]	1,374[ef]	1,422[ef]
2009	1,497[e]	2,167[d]	2,463[c]
2010	2,286[cd]	2,653[b]	3,023[a]
Avg.	1,676	2,065	2,303

Table 2. Dry matter yields of warm-season grass stands on Conservation Reserve Program lands when harvested at two different time periods from 2008-2010. Yields are averaged over three nitrogen fertilizer levels. Yields followed by similar letters are similar at the P>0.05 level

Year	Peak standing crop	After frost
	Yield (lb/a)	
2008	1,860[b]	834[c]
2009	1,869[b]	2,216[ab]
2010	2,769[a]	2,538[a]
Avg.	2,166	1,863

Table 3. Dry matter composition of warm-season grass stands on Conservation Reserve Program lands when fertilized at different nitrogen rates and harvested at two different time periods from 2008-2010

		Harvest timing		N rate (lb N/a)		
Species	Year	Peak standing	After frost	0	50	100
		-----Proportion (%)------				
Sideoats grama	2008	20.1	22.1	20.9	18.2	24.2
	2009	24.1	24.6	28.6	19.4	25.1
	2010	14.6	15.2	9.2	14.5	21.0
Switchgrass	2008	15.4	14.8	14.4	16.2	14.7
	2009	18.7	17.5	13.6	21.2	19.6
	2010	8.8	13.1	7.3	11.7	13.9
Little bluestem	2008	19.4	19.8	22.8	18.7	17.3
	2009	12.1	18.9	14.2	14.2	18.1
	2010	8.4	11.6	7.3	12.1	10.6
Yellow sweet clover	2008	27.2	19.8	23.4	23.9	23.1
	2009	8.9	11.2	16.9	7.9	5.4
	2010	39.3	32.9	59.0	32.4	16.9

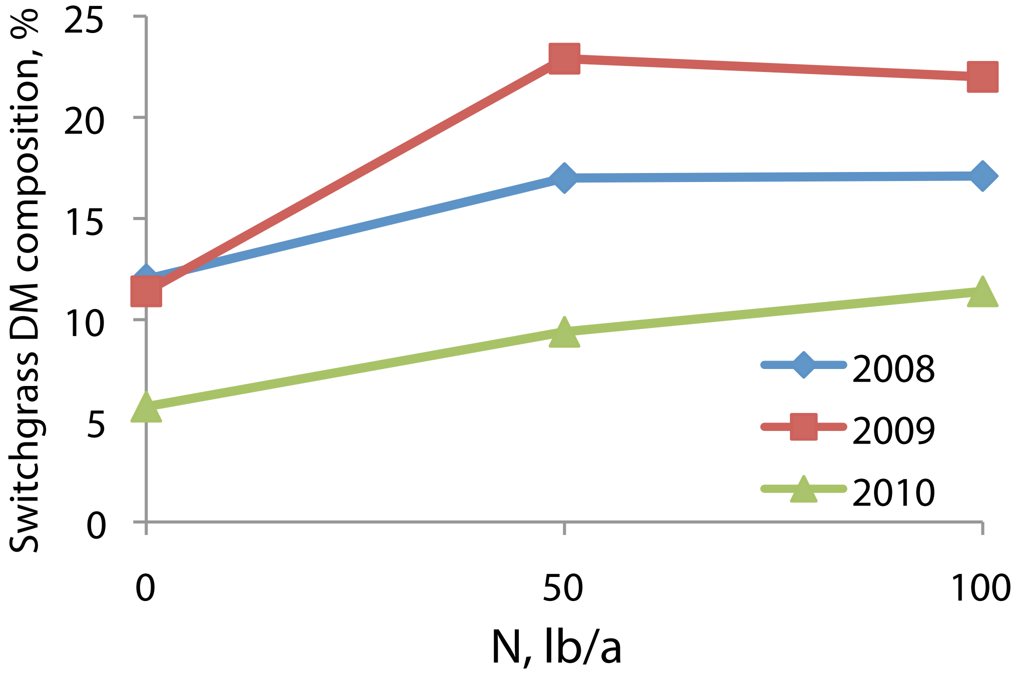

Figure 1. Switchgrass dry matter (DM) composition of total yield from mixed grass stands on Conservation Reserve Program lands when fertilized at different nitrogen rates and harvested at peak standing crop in midsummer from 2008-2010.

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