January 2007

Dried Distillers Grains Substitute for Forage and Nitrogen on Pasture: N Dynamics and Use Efficiency

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Summary

Animal performance and N dynamics of different grazing management and supplementation strategies in cattle production systems were evaluated on smooth bromegrass pastures in eastern Nebraska. Steers supplemented with dried distillers grains with solubles (DDGS) on nonfertilized smooth bromegrass pastures gained more (0.58 lb/d) than steers on fertilized and nonfertilized smooth bromegrass. Nitrogen retention per steer supplemented with DDGS was 38.5% greater than non supplemented steers on fertilized smooth bromegrass and non-supplemented steers on nonfertilized smooth bromegrass stocked at 69% of the rate on fertilized pastures. Fertilized and supplemented pastures were stocked at equal densities. Nitrogen use efficiency based on the amount of N applied as either fertilizer or in DDGS was 3.2 times greater for supplemented steers than non-supplemented steers grazing fertilized pasture (26.38 % vs. 8.23%). Dried distillers grains can be used as a substitute for forage and N fertilizer by improving performance, reducing cost of gains, and increasing N retention in yearling steers.

Introduction

Usually, the amount of N applied as fertilizer to cool-season grasses is in excess of plant uptake. Historically, fertilization has increased forage production relative to the cost of application, but increases in energy and N costs may have negative implications. Previous research using pastures used for this experiment have shown fertilized (80 lb N/ac) pastures stocked at approximately 69% of nonfertilized pastures to be similar in animal and pasture performance. Apparent N recovery rates of fertilized grasses can be as low as 17 to 50%. The losses can create undesirable N sinks such as volatilization, losses to surface water runoff, and/or leaching into the ground water supplies.

Although difficult to accomplish with pasture cattle, N excretion can be minimized when both undegradable intake protein (UIP) and degradable intake protein (DIP) are fed to meet but not exceed requirements. Actively growing forages contain protein that is highly degradable in the rumen. Supplementing energy to ruminants on high quality forages can improve both N and energy efficiency by incorporating greater amounts of N in ruminal bacteria.

Dried distillers grains are a good source of both energy and UIP. Daily gain improvements are not exclusively related to UIP or fat, but both appear to contribute to the improved gain when supplemented to cattle grazing smooth bromegrass pastures. Accompanying improvements in cattle performance, DDGS supplementation has been shown to replace forage intake from 0.27 to 0.79 lb per lb of DDGS. The objective of this experiment was to measure animal performance and N dynamics (use efficiency) in cattle as affected by grazing management and supplementation strategies.

Procedure

Forty-five yearling steers (767 ± 22 lb) were used in a randomized complete block to evaluate performance, N use, and economic impact of supplementation and management strategies on smooth bromegrass pastures. Yearling steers were stocked at 4 AUM/acre for smooth bromegrass pastures fertilized with 72.78 lb N/acre (FERT), nonfertilized smooth bromegrass pastures stocked 69% of the FERT (CONT), or nonfertilized smooth bromegrass pastures stocked at the same rate as the FERT with 5 lb (DM) of DDGS supplemented daily (SUPP). Pastures were grazed from April 22 to Sept. 19, 2005, and blocked by location. Pasture represented the experimental unit and was replicated three times. Pastures were strip-grazed at the assigned stocking rate for 4 days/strip (6 strips/cycle) in cycles 1 and 5 and for 6 days/strip in cycles 2, 3, and 4. Midpoint diet samples were collected in one of the 6 strips for each cycle utilizing 6 ruminally fistulated steers. Diet DM, CP, and IVDMD were subsequently determined. In each strip selected for diet collection, standing crop was estimated immediately before and after each grazing period by a combination of hand clipping quadrants (0.38 m^2) and a calibrated drop disc method.

Nitrogen retention was estimated from weight gains using NRC (1996) equations which were a function of BW gain during the experimental period and final carcass composition.. Economic assumptions for evaluation of grazing management and supplementation strategies were: land costs $32/acre, yardage costs $0.10/head daily, fertilizer cost $0.3525/lb N ($324.30/ton 46-0-0), fertilizer application $4/acre, DDGS $110/T delivered to the bunk. Following the experimental period, steers were finished on a high concentrate diet containing high-moisture corn at 66% of DM, DRC at 16.5% of DM, alfalfa hay at 7.5% of DM, and a meal supplement at 5% of DM. Metabolizable protein, Ca, P, and K requirements were formulated to meet or exceed NRC (1996) requirements.

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Results

Steers on FERT gained the same as CONT (P=1.0, 1.37 lb/d and 1.37 lb/d for FERT and CONT, respectively; Table 1) but had greater costs of gain ($0.35/lb gain vs $0.28/lb gain; Table 3) due to additional costs of N being greater than the additional cost of land use. Previous studies at this site suggested equal animal and pasture performance can be obtained by reducing the stocking rate of the nonfertilized pastures to 69% of the fertilized pastures. In this experiment, the additional land use at $32/acre produced lower cost of gain than the addition of fertilizer at $0.3525/lb of N (application rate 72.78 lb/acre). Steers supplemented with DDGS gained more (P<0.01) than FERT or CONT (1.95 lb/day vs 1.37 lb/day; Table 1). Supplemented steers maintained their BW advantage during the feedlot phase with significantly (P<0.05) greater final weights than the FERT and CONT steers (Table 1). Individual intakes and F:G were not available for these steers in the feedlot.

The cost of gain for SUPP steers was $0.31/lb gain (DDGS was $0.055/lb, delivered). Nitrogen retention for SUPP steers was approximately 38.4% greater than FERT and CONT (P<0.01, 8.21 lb/head vs 5.94 lb/head; Table 2). These values estimated from the NRC (1996) equations show that the increase in N retention is a function of BW gain and final carcass composition. Increases in BW can be attributed to both the energy from fat and UIP when cattle are supplemented with DDGS. A portion of this response may be due to correcting a metabolizable protein deficiency.

Nitrogen inputs were highest for the FERT system, but N retention was greatest for the SUPP steers. This is mainly due to the inefficiencies between fertilization and plant uptake. Nitrogen use efficiency, based on the amount of N applied as either fertilizer or in DDGS, was 3.2 times greater for SUPP steers than FERT steers (26.38 % vs 8.23%; Table 2) which makes the total amount of potential

Table 1. Pasture and feedlot performance for grazing management and supplementation strategies of steers grazing smooth bromegrass.

	Treatment			
Item	CONT	FERT	SUPP	SEM
Pasture performance				
Days	153	153	153	
Initial BW, lb [a]	766	767	767	2
End BW, lb[a]	977[c]	977[c]	1065[d]	9
ADG, lb	1.37[b]	1.37[b]	1.95[c]	0.06
Forage disappearance, lb[d]	15.63	14.47	13.5	2.78
Forage disappearance, % of BW	1.79	1.66	1.47	0.83
Feedlot performance				
Days	115	115	115	
Final wt, lb[e]	1368[b]	1367[b]	1491[c]	20
ADG, lb	3.4	3.4	3.71	0.17

[a]Shrunk weight.
[bc]Means without a common superscript differ (P<0.01).
[d]Estimated from pre and post grazing biomass measurements for forage utilization within a grazing strip for each cycle.
[e]Calculated from hot carcass weight, adjusted to a 63% common dressing percentage.

Table 2. Nitrogen balance for grazing management and supplementation strategies of steers grazing smooth bromegrass [a].

	Treatment			
Item	CONT	FERT	SUPP	SEM
N inputs, lb[b]		69.71	31.17	
N intake from forage, lb	52.17	57.79	51.19	6.23
N intake total, lb	52.17[c]	57.79[c]	82.36[d]	8.14
N retention, lb[e]	5.95[c]	5.93[c]	8.21[d]	0.24
N excretion, lb[f]	46.22[c]	51.86[c]	74.15[d]	8.9
N use efficiency, %[g]		8.51	26.33	

[a]Items are based on the total lb of N/hd for the entire grazing period.
[b]N inputs include fertilizer and DDGS. Pastures were fertilized with urea at 72.78 lb/acre of N. Steers were supplemented with 5 lb (DM) of DDGS (24.6% CP) daily for the entire gazing period.
[cd]Means without a common superscript differ (P<0.05).
[e]N retention calculated from NRC (1996) equations.
[f]Difference between N intake total and N retention.
[g]System use efficiency, calculated by dividing N retention by N system inputs*100.

Table 3. Economic evaluation of grazing management and supplementation strategies for steers grazing smooth bromegrass.

	Treatment		
Item	CONT	FERT	SUPP
Number of steers	15	15	15
Total gain, lb/head[a]	218	217	309
Acres	21.49	14.88	14.88
Fertilizer lb/acre		72.78	
Supplement (as-is) lb/head daily			5.55
Costs, $/head[b]			
Land	45.84	31.73	31.73
Yardage	15.84	15.84	15.84
Fertilizer		25.44	
Fertilizer application		3.97	
DDGS			48.35
Total	61.68	76.98	95.92
Cost of gain, $/lb[c]	0.28	0.35	0.31
Cost of gain above CONT, %	—	25	10.71

[a]Total weight gain includes additional cattle used to graze during peak forage production times (27 days total). Cattle were of the same weight and type.
[b]Economic assumptions for evaluation of grazing management and supplementation strategies, land costs $32/acre, yardage costs $0.1/head daily, fertilizer cost $0.3525/lb N, fertilizer application $4/acre, DDGS $110/T delivered to the bunk.
[c]Calculated by dividing total cost by total gain.

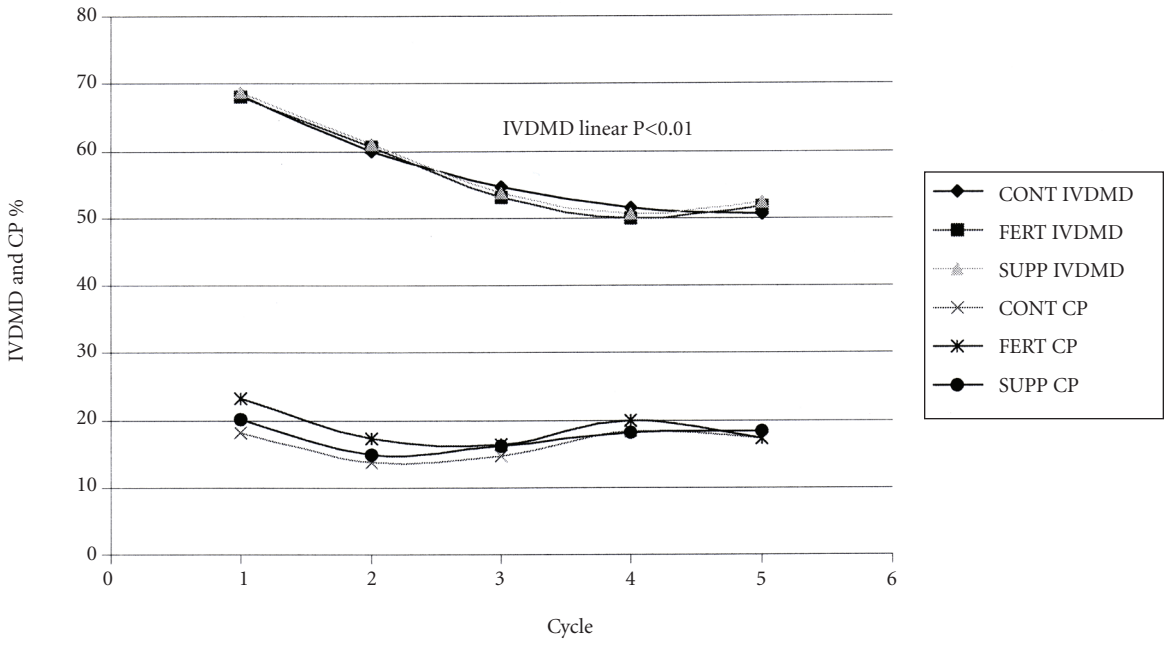

Figure 1. *In vitro* **dry matter digestibility and CP content of smooth bromegrass over time for grazing management and supplementation strategies of steers.**

N for volatilization or surface water runoff greater in the FERT livestock system.

The effects of DDGS supplementation and fertilization on forage disappearance are shown in Table 1. Steers supplemented with DDGS had numerically less forage disappearance with a replacement rate of 0.43 lb of forage per lb of DDGS. *In vitro* dry matter digestibility of diets (Figure 1) of the smooth bromegrass was not different ($P>0.05$) among treatments. However, there was a significant linear ($P<0.01$) decrease in IVDMD over time.

Dried distillers grains significantly increased steer performance when grazing smooth bromegrass pastures. Additionally, N retention and N use efficiency were greater for SUPP steers compared to FERT. Dried distillers grains can be used as a substitute for forage and N fertilizer by improving performance, reducing cost of gains, and increasing N retention in yearling steers.

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