EFFECTS OF SUPPLEMENTAL PROTEIN ON PERFORMANCE OF STOCKER CATTLE GRAZING WHEAT PASTURE

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Story in Brief

A three-year study using 256 fall-weaned steers or heifers (483 lb average weight) was conducted to evaluate the effects of supplemental protein on performance of stocker cattle grazing wheat pasture. Cattle grazed wheat pasture and received no supplement or were fed 2 lb/day of either a corn-based energy supplement that contained (dry matter basis) about 8.4% crude protein or protein supplements that contained 18 to 25% meat meal (or meat and bone meal in year 3) or 22 to 33% cottonseed meal. All supplements provided 130 to 150 mg monensin/head. Supplements containing more than 16.6% (as-fed) meat meal or meat and bone meal were not fully consumed by the cattle. Irrespective of type of supplement, supplementation increased weight gains of the cattle about .22 lb/day. The meat meal, meat and bone meal or cottonseed meal supplements did not increase gains as compared with the energy supplement.

(Key Words: Wheat Pasture, Protein, Supplementation, Cattle.)

Introduction

Wheat forage commonly contains 20 to 30% crude protein on a dry matter basis. However, large amounts of soluble nitrogen (N) and soluble nonprotein N (NPN) are present in the crude protein fraction. Because of the rapid rate of degradation of wheat forage N in the rumen and loss of ammonia-N that is not incorporated into microbial protein, performance of rapidly growing cattle on wheat pasture may be limited by inadequate amounts of protein reaching the small intestine. The objective of this study

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was to determine the effect of feeding additional supplemental protein of low ruminal degradability on weight gains of stocker cattle grazing wheat pasture.

Materials and Methods

Eighty heifers in year 1 (1985-86), 96 steers in year 2 (1986-87) and 80 steers in year 3 (1987-88) were used. The trial in year 1 was conducted in cooperation with Panhandle State University (Goodwell, Oklahoma), and the trials in years 2 and 3 were conducted at the Forage and Livestock Research Laboratory (USDA/ARS, El Reno, Oklahoma). Description of the cattle, their mean initial weights and lengths of the trials are summarized in Table 1. Mean initial weight was 483 lb and the trials were approximately 111 days in length. In years 1 and 2 the heifers and steers were randomly allotted by weight within breed groups to four treatments in a randomized complete block design with two replications. Cattle of Treatment 1 received no supplement (other than free-choice access to a commercial mineral mixture[6]) while those of Treatments 2, 3 and 4 were fed daily 2 lb of a corn-based energy supplement or supplements that provided additional protein from meat meal (meat and bone meal in year 3) or cottonseed meal. In year 3, because of constraints on available wheat pasture only three treatments (i.e., 3 supplement groups) were assigned to replication 1 while five treatments (i.e., 2 nonsupplemented and 3 supplement groups) were assigned to replication 2 in an incomplete block design. Because of a shortage of wheat pasture in year 2, 1 replication was deleted due to large differences in forage availability among treatments. Therefore, data of 5 replications were included in this report.

In year 1 initial stocking density on wheat pasture was approximately 2.1 acres/heifer. Replication 1 consisted of a volunteer wheat pasture that was fertilized with 50 lb N/acre in late October. Replication 2 consisted of an irrigated wheat pasture that was planted late and was not ready for grazing at the onset of the experiment. Consequently, all cattle were placed by treatment on the volunteer wheat pasture until the irrigated wheat pasture was ready. In years 2 and 3, initial stocking densities were 1.85 and 2.6 acres/steer, respectively, with the wheat pasture being fertilized with approximately 80 lb N/acre.

Because of snow and ice cover, heifers in replications 1 and 2 in year 1 were removed from pasture and placed in drylot for 8 and 18 days,

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[6]Wheat Gainer Mineral No. 2. Farmland Industries. Guaranteed Analysis: Ca 15-17%, P 4.0%, Mg 10.0% and salt 19-21%.

Table 1. Number and description of cattle and length of trials of each year.

Year	No.	Description of Cattle			Length of trials	
		Sex	Mean initial wt, lb	Breed	Dates	Days
1 1985-86	80	Heifers	477	Hereford x Angus x Limousin and 1/8 or 1/4 Brahman crossbred	12/8 to 3/20	103
2 1986-87	96	Steers	513	Hereford x Angus x Limousin and 1/8 or 1/4 Brahman crossbred	11/14 to 3/19	125
3 1987-88	80	Steers	458	Hereford, Angus or Hereford x Angus	12/10 to 3/25	106

respectively. During this time they received their respective supplements, limited amounts of sorghum silage and haygrazer hay. In years 2 and 3, old world bluestem hay was fed on pasture during periods of snow and(or) ice cover. Hay was fed (i.e., approximately 6.1 lb/day) for 6 and 21 days in years 2 and 3, respectively.

Composition of the supplements is shown in Tables 2, 3 and 4. Supplements consisted of a corn-based energy supplement that contained (DM basis) about 8.4% crude protein (CP) or 16 to 20% CP supplements that contained 18 to 25% meat meal[7] (or meat and bone meal[8] in year 3) or 22 to 33% cottonseed meal[9]. The supplements were isocaloric and

Table 2. Ingredient composition and nutrient content of supplements (% of DM, Year 1).

Supplement	Corn	Meat meal[a]	Cottonseed meal[b]
Ingredient			
Corn	79.0	67.1	62.8
Meat meal		17.7(16.6)[c]	
Cottonseed meal			21.8(21.5)[c]
Cottonseed hulls	9.0	9.1	4.0
Molasses	4.4	4.4	4.4
Limestone	2.0		2.1
Dicalcium phosphate	3.5		2.9
Magnesium oxide	.6	.3	.45
Salt	1.2	1.2	1.2
Trace mineral salt	.30	.30	.30
Rumensin 60 Premix[d]	.11	.11	.11
Nutrient content			
NE_G (Mcal/cwt)	56	56	56
Crude protein			
Calculated	8.1	16.3	16.3
Actual	8.3	16.1	15.4
Calcium			
Calculated	1.57	1.56	1.51
Actual	1.28	1.25	1.32
Phosphorus			
Calculated	.94	.96	1.03
Actual	1.14	1.07	1.00
Magnesium			
Calculated	.48	.49	.50
Actual	.38	.36	.39

[a]Obtained from IBP, Inc. Slaughter Plant. West Point, NE.
[b]Method of processing unknown.
[c]Values in parentheses represent % as-fed.
[d]Added to supply 65 mg monensin/lb (as-fed) of supplement.

[7]Obtained from IBP, Inc. West Point, NE Slaughter Plant.
[8]Obtained from Cargill Nutrena Feed division, McPherson, KS.
[9]Unknown origin in year 1. Obtained from Traders Oil Mill (mechanical process) in years 2 and 3, Fort Worth, TX.

Table 3. Ingredient composition and nutrient content of supplements (% of DM, Year 2).

Supplement	Corn	Meat meal[a]	Cottonseed meal[b]
Ingredient			
Corn	79.3	62.2	51.1
Meat meal		25.4(23.9)[c]	
Cottonseed meal			32.6(32.0)[c]
Cottonseed hulls	3.8	3.8	.4
Diamond V yeast culture	3.0	3.0	3.0
Molasses	4.2	4.2	4.2
Limestone	2.71		3.48
Dicalcium phosphate	5.2		3.6
Magnesium oxide	.68	.23	.42
Salt	.70	.70	.70
Trace mineral salt	.30	.30	.30
Rumensin 60 Premix[d]	.14	.14	.14
Nutrient content			
NE_G (Mcal/cwt)	57	57	55
Crude protein			
Calculated	8.4	20.2	20.2
Actual	8.6	21.5	19.9
Calcium			
Calculated	2.20	2.20	2.20
Actual	2.25	2.25	2.05
Phosphorus			
Calculated	1.25	1.25	1.25
Actual	1.43	1.08	1.35
Magnesium			
Calculated	.55	.55	.58
Actual	.56	.40	.58

[a]Obtained from IBP, Inc. Slaughter Plant. West Point, NE.
[b]Produced by Mechanical Process; Traders Oil Mill, Fort Worth, TX.
[c]Values in parentheses represent % as-fed.
[d]Added to supply 75 mg monensin/lb (as-fed) of supplement.

contained, with the exception of year 3, similar amounts of calcium, phosphorus and magnesium. In year 3 the calcium and phosphorus contents of the energy and cottonseed meal supplements were slightly decreased (as compared with the meat and bone meal supplement) in order to decrease the amounts of dicalcium phosphate and calcium carbonate in the supplements because of concerns of high mineral content of the supplements on palatability and intake. Monensin was included in the supplements to supply 130 to 150 mg/head/day. In years 2 and 3, respectively, Diamond V Yeast Culture or ground alfalfa hay was included in all the supplements at a level of 3 to 4% in an attempt to improve the palatability of the meat meal or meat and bone meal supplements.

Animals were group fed supplements daily, with samples being taken weekly and composited across weeks within months for analyses. In years 2

Table 4. Ingredient composition and nutrient content of supplements (% of DM, Year 3).

Supplement	Corn	Meat and bone meal[a]	Cottonseed meal[b]
Ingredient			
Corn	77.8	61.4	53.1
Meat meal		24.6(23.2)[c]	
Cottonseed meal			31.4(30.8)[c]
Cottonseed hulls	6.0	4.9	.4
Alfalfa hay, ground	4.0	4.0	4.0
Molasses	4.2	4.2	4.2
Limestone	2.74		3.51
Dicalcium phosphate	3.95		2.37
Magnesium oxide	.43		.18
Salt	.45	.45	.45
Trace mineral salt	.30	.30	.30
Rumensin 60 Premix[d]	.13	.13	.13
Nutrient content			
NE_G (Mcal/cwt)	56	56	56
Crude protein			
Calculated	8.6	20.2	20.2
Actual	8.5	16.7	18.0
Calcium			
Calculated	2.00	2.71	2.00
Actual	1.68	2.51	2.02
Phosphorus			
Calculated	1.00	1.52	1.00
Actual	1.50	1.70	1.28
Magnesium			
Calculated	.39	.39	.39
Actual	.48	.43	.55

[a]Obtained from Cargill Nutrena Feed Division, McPherson, KS.
[b]Produced by Mechanical Process; Traders Oil Mill, Fort Worth, TX.
[c]Values in parentheses represent % as-fed.
[d]Added to supply 75 mg monensin/lb (as-fed) of supplement.

and 3, supplement refusals were weighed, sampled and dried and discarded weekly to provide estimates of daily DM consumption.

In years 2 and 3, hand clipped wheat forage samples were obtained to characterize forage composition at selected times to coincide with major changes in climatic growing condition for wheat. Hand clipped forage samples were frozen immediately after clipping by suspension over liquid N, and subsequently lyophilized. Lyophilized wheat forage samples were ground through a 2 mm mesh screen in a Wiley mill and analyzed for total N by the Kjeldahl procedure. Soluble N was determined following a 1 hour incubation at 39°C in a shaking water bath using the mineral mixture (2% v/v; pH 6.5) of the "Ohio" buffer in vitro fermentation media (Johnson, 1969). Non-protein nitrogen (NPN) was determined using 25 ml of the filtrate of the soluble N procedure by sodium tungstate precipitation with 5 ml of 1.07 N

H_2SO_4 and 5 ml of 11.2% sodium tungstate. Samples were also analyzed for soluble carbohydrates by the procedure of Balwani (1965) and in vitro organic matter disappearance (IVOMD) using a modification of the Tilley and Terry (1963) procedure.

Data were analyzed by least squares analysis of variance. Orthogonal contrasts were conducted to test for the following effects: 1) control vs supplementation, 2) energy vs protein supplementation and 3) meat meal vs cottonseed meal supplementation.

Results and Discussion

Chemical composition of the wheat forage in years 2 and 3 is shown in Tables 5 and 6, respectively. Crude protein content and IVOMD averaged 23% of DM and 80.2%, respectively. Thirty-one to 43% of total forage N was present as soluble N, and NPN accounted for 13 to 29% of total N. Total soluble carbohydrate content of the forage ranged from about 15 to 35% of DM. Beever et al. (1976) observed a significant negative relationship ($r = -.98$, $P < .001$) between the amount of N flowing to the small intestine of sheep and solubility of perennial ryegrass N.

Table 5. Chemical composition (DM basis) of wheat forage (Year 2).

Sampling date:	Nov 14	Dec 18	Jan 15	Mar 19	SEM
IVOMD[a], %	91.6	78.5	71.5	91.4	2.40
Crude protein, %	27.7	23.2	21.5	22.4	1.09
Soluble N					
% of total N	31.0	35.2	31.3	42.6	1.96
Non-protein nitrogen					
% of total N	17.8	23.0	22.1	27.7	.96
Soluble carbohydrates, %	20.2	16.4	15.6	15.2	1.20

[a]In vitro organic matter digestibility.

Table 6. Chemical composition (DM basis) of wheat forage (Year 3).

Sampling date:	Dec 10	Jan 26	Mar 25	SEM
IVOMD[a], %	77.6	75.4	75.1	.62
Crude protein, %	24.3	19.9	22.0	.77
Soluble N				
% of total N	32.1	32.1	37.6	.97
Non-protein nitrogen				
% of total N	13.2	16.7	28.6	.93
Soluble carbohydrates, %	32.3	35.0	21.6	1.47

[a]In vitro organic matter digestibility.

Supplement consumption, mean initial and final weights and daily gains of the cattle are shown in Table 7. Mean supplement consumption of the energy, meat meal and cottonseed meal supplements were 1.76, 1.58 and 1.78 lb DM/day.

Cattle completely consumed the supplements in year 1 up until March 4 at which time consumption decreased because of increasing amounts of available forage. In years 2 and 3, the meat meal (or meal and bone meal) content of the supplements was increased from 16.6% to about 23.5% (as-fed) in order to increase the amount of protein provided by the supplements. This decreased consumption of these supplements. Mean consumption of the energy, meat meal (or meat and bone meal) and cottonseed supplements was 1.63, 1.52 and 1.65 lb DM/day (year 2) and 1.69, 1.36 and 1.78 lb DM/day (year 3).

Daily gains of the cattle were increased ($P<.03$) about .22 lb by the overall effects of supplementation. The meat meal, meat and bone meal or cottonseed meal supplements did not increase ($P>.30$) gains as compared with the corn-based energy supplement. Calculated efficiency of supplement use was 11.4, 7.2 and 6.2 lb of supplement per lb of increased gain for cattle fed the energy, meat meal or cottonseed meal supplements, respectively. Differences among supplements were not significant. The efficiency of use of the energy supplement is similar to that of 9.4 and 10.3 reported by Elder (1967) and Gulbransen (1976).

Lee (1985) reported that weight gains of calves grazing wheat pasture and fed 1.5 lb/day of a supplement containing 15% meat meal were increased .20 lb/day as compared with a control, hominy feed-based

Table 7. Performance of cattle grazing wheat pasture during the protein supplementation trials.

	Treatment				
	Control	Corn	Meat meal	Cottonseed meal	SEM
Number of cattle	52	52	52	51	
Supplement consumption[a], lb DM/head/day	---	1.76	1.58	1.78	.07
Initial weight, lb	474	476	483	479	2.5
Final weight[b], lb	667	684	697	703	8.4
Daily gain[b], lb	1.78	1.93	1.99	2.06	.07
Efficiency of supplement use[c]	---	11.4	7.2	6.2	4.5

[a]Meat meal vs cottonseed meal supplementation ($P<.10$).
[b]No supplement vs supplementation ($P<.05$).
[c]Lb of supplement per lb of increased weight gain.

supplement. Anderson et al. (1987) reported a similar gain response by stocker cattle grazing wheat pasture fed 1.5 lb/day of a supplement that contained 11.5% feather meal and 19.4% meat and bone meal. Cattle received monensin in the studies reported by both Lee (1985) and Anderson et al. (1987). Our results are not in agreement with these studies. Differences in amounts of available wheat forage, the number of days of snow and(or) ice cover and the amounts of other supplemental feeds that were fed may account for part of the discrepancy of results. In the study of Anderson et al. (1987), cattle had free-choice access to wheat hay throughout the 79 days of grazing wheat pasture and free-choice access to corn silage during 21 days of the trial when snow cover "inhibited grazing". This fairly high level of supplementation with wheat hay and corn silage would favor a response to additional supplemental protein.

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