FREQUENCY OF COTTONSEED CAKE SUPPLEMENTATION FOR YEARLING HEIFERS ON BLUE GRAMA RANGE

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Summary

Yearling replacement heifers were used in a two-year study at the Fort Stanton Experimental Ranch near Capitan, New Mexico, USA to compare frequency (once versus three times weekly) of feeding a cottonseed cake supplement. The study involved periods of 130 days (January 4 through May 14) in 1985, and 146 days (December 4 through April 29) in 1986. In each year, supplemental periods were just before the breeding season (natural breeding in multiple-sire groups) that lasted for 75 days during first year and 60 days during second year. During the first year, all (83) heifers (Angus × Hereford) were supplemented at a level equivalent to .45 kg/head daily and during second year, all (69) heifers (Angus × Hereford, Hereford) were fed at a level equivalent to .68 kg/head daily. In the first year, heifers were sorted by initial weight into two replications, i.e., those weighing under 223 kg were placed in replicate 1 and those weighing over 223 kg were placed in replicate 2. During the second year, heifers were sorted by breed into two replications, i.e., Angus × Hereford heifers were placed in replicate 1 and Hereford heifers in replicate 2. Each year, half of the heifers in each replication were supplemented once weekly and the other half three time weekly.

Weight gains of heifers were similar for the two treatments over both years of study. During the first year, weight gains for heifers supplemented once or thrice weekly (.23 vs .21 kg daily, respectively) did not differ ($p > .05$) and the same trend for the second year (.15 vs .16 kg daily, respectively) was observed. Similarly, breeding performance was consistent with weight gains and no difference ($p > .05$) between treatments was observed either year. Lower conception rates during the second year of study (92 vs 72% for years 1 and 2, respectively) were due mainly to involvement of Hereford heifers that had an average weight of 232 kg at the start of breeding season and conception rate of 54% (averaged across both supplemental treatments).

Based on the combined results of both trials, frequency of supplementation did not affect growth rate of yearling heifers nor did it influence their subsequent conception rate.

(**Key Words**: Supplementation, Frequency, Heifers, Blue Grama, Weight Gain, Breeding Performance)

Introduction

Rainfall in the southeastern United States is high and soils are heavily leached, making the yearlong supplementation of grazing cattle necessary for sustained livestock productivity. In the western United States, however, major nutritional deficiencies only occur during drought and winter forage dormancy. In most developing countries forage quantity as well as quality are limiting factors for profitable livestock production. Ranges might have adequate forage supplies to meet the minimum requirements of animals but this does not imply all demands for profitable animal production are satisfied from forage. Animals must receive adequate levels of energy, protein, minerals and vitamins to give the best possible economic returns. Therefore, supplements are often fed to correct nutrient deficiencies in the diets of range livestock. Supplemental nutrients differ in their importance only as requirements are supplied by range or not. Energy is required for all body functions, i.e., growth, maintenance, lactation, reproduction and fattening and large amounts can be stored in the body as fat. However, grain supplements often result in lower forage intake and digestibility. Feeding grain supplements is appealing, however, because they are generally less expensive than protein rich feed

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stuffs (Adams, 1986). Protein rank second to energy in amount required and is a vital nutrient for growth, reproduction and lactation. There is no provision for storing surplus protein in the body and animals without adequate protein survive at the expense of their body tissue (Knox, 1967).

Protein supplements are effective in improving energy balance by increasing intake and digestibility of range forages (Adams, 1986). Non-protein nitrogen (urea and biuret) and high protein natural feeds (alfalfa hay, cottonseed meal and soybean meal) are the two basic types of protein supplements generally provided to range livestock (Holechek and Herbel, 1986). Non-protein nitrogen (NPN) sources are cheaper than natural feed proteins and sizable amounts of the total protein requirements can be met from NPN sources. A readily available energy source must be fed with NPN to obtain effective utilization and avoid ammonia toxicity. Therefore, NPN sources are widely used with feedlot animals consuming high grain diets but sparingly used with animals grazing dormant range forages. Among protein supplements, cottonseed meal is perhaps the most widely used plant supplement and can be fed in fairly small amounts because crude protein level is quite high (40-45%).

Because of the labor cost, frequency of protein supplementation is of considerable concern to ranchers and stockmen who feed protein supplements to beef cattle in winter. There are diverse opinions about relative merits of daily, every-other-day, every-third-day and even weekly feeding of cottonseed meal. Limited experimental work has been done on length of feeding interval. Yet, high wintering costs and low winter gains seriously affect economic production of range livestock. Development of management systems to lower wintering costs in the western United States also promises to benefit range forage production. Ranchers could afford to graze their ranges less during the physiologically critical summer months if production efficiency could be increased during winter. The purpose of the present study was to compare winter gains and breeding performance of yearling heifers fed a protein supplement at different intervals.

Materials and Methods

This study on frequency of protein supplementation was conducted at Fort Stanton Experimental Ranch near Capitan, New Mexico, USA for a two-year period beginning January, 1985. The mean average annual precipitation at the ranch is 348 mm (table 1) with about two-thirds of the total moisture occurring during the growing season (June through September). Temperature varies from 2.2℃ to 18.6℃ with a mean of 11.0℃. Frost free days last from May 2 through October 10 and mean elevation above sea level is 2,000 M. Vegetation in the study area is dominated by blue grama (*Bouteloua gracilis* [H. B. K.] Lag.). Other grasses include side oats grama (*Bouteloua curtipendula* [Michx.] Torr.), gelleta (*Hilaria jamesii* [Torr.] Benth.), sand dropseed (*Sporobolus cryptandrus* [Torr.] Gray), mat muhly (*Muhlenbergia richardsonis* [Trin] Rydb.) and ring muhly (*Muhlenbergia torreyi* [Kunth] Hitchc.). Important forbs include carruth sagewort (*Artemisia carruthii* [Wood]), scarlet globemallow (*Sphaeralcea coccinea* [Pursh.] Rydb.) and Dakota verbena (*Verbena bipinnetifida* [Nutt.]) (Pieper et al., 1978). Soil types on the study area are described by Pieper et al. (1971).

The animals used in the study consisted of yearling heifers (Augus × Hereford and Hereford) that were purchased each year from the Roy Davidson Ranches in Quay County, New Mexico, and delivered to Fort Stanton in either late November or early December. The heifers averaged about 10 months of age at the time of delivery. Treatments studied for the two years were thrice weekly versus once weekly feeding of a protein supplement, i.e., cottonseed meal (cake) containing 41% crude protein.

Eighty-three heifers (Augus × Hereford) were used for this study during the first year (trial 1; table 2). The heifers were sorted by initial weight into two replications, i.e., those weighing under 223 kg were placed in replication 1 (rep. 1) and those weighing over 223 kg were placed in replication 2 (rep. 2). The heifers in each rep. were then allotted to the two treatments at random. The supplemental feeding period started on January 4, 1985, and ended on May 14, 1985, lasting for 130 days. The breeding season started on May 1, 1985, lasted for 75 days ending on July 15, 1985. During the second year of study (trial 2), 69 heifers (Angus × Hereford, Hereford) were used on the two treatments. Trial

TABLE 1. MONTHLY PRECIPITATION (mm) DURING 1985 AND 1986 FOR THE FORT STANTON EXPERIMENTAL RANCH NEAR CAPITAN, NEW MEXICO, AND MONTHLY AVERAGE PRECIPITATION FOR 79 YEARS BETWEEN 1895 AND 1973

Month	1985	1986	79-year average[a]
January	15.2	3.8	14.5
February	22.4	39.4	12.4
March	14.0	15.8	15.0
April	22.9	0.0	14.0
May	7.4	11.4	22.6
June	32.8	103.4	32.0
July	41.4	38.4	78.7
August	96.0	128.8	68.6
September	83.8	55.6	47.0
October	96.5	53.1	19.3
November	0.0	44.2	6.6
December	7.1	35.6	17.5
Total	439.5	529.5	348.2
Percentage of average	126.2	152.1	100.0
Growing season (mm)	254.0	326.2	226.3
Percentage of yearly total in growing season	57.8	61.6	65.0
Percentage of average growing season	112.2	144.1	100.0

[a] From U.S. Department of Commerce (1973).

TABLE 2. NUMBER AND BODY WEIGHTS OF YEARLING HEIFERS INVOLVED IN THE STUDY ON FREQUENCY OF COTTONSEED MEAL SUPPLEMENTATION DURING THE WINTER BEFORE THEIR BREEDING SEASON FOR A TWO YEAR PERIOD

	Supplementation Frequency			
	Once per week		Thrice per week	
	Rep. 1	Rep. 2	Rep. 1	Rep. 2
Trial 1[a]:				
No. of heifers	23	20	22	18
Avg. initial wt (kg)	210	242	213	240
Trial 2[b]:				
No. of heifers	14	27	10	18
Avg. initial wt (kg)	208	228	213	223

[a] In trial 1, heifers with initial weights < 223 kg were placed in replication (Rep.) 1 and those weighing > 223 kg were placed in Rep. 2.

[b] In trial 2, all Hereford heifers were placed in Rep. 1 and all Angus × Hereford heifers were placed in Rep. 2.

2 was replicated on the basis of breed, i.e., Angus × Hereford versus Hereford because sufficient animals of same breed could not be procured. The heifers were randomly allotted to the two treatments. The supplemental feeding period started on December 4, 1985, lasted for 146 days, ending on April 29, 1986. The breeding season lasted for 60 days from May 1 through June

30, 1986.

Yearling receiving supplement once per week were fed their total allowance for the week on Tuesdays, whereas the supplement for the other group was fed on Monday, Wednesday and Friday each year. All Animals were fed at a rate equivalent to 1 lb (.45 kg) per head per day during first year and 1.5 lb (.68 kg) per head per day during second year. Weight of each animal was recorded at the start and termination of each year feeding period to determine winter gains. Heifers were tested for pregnancy in October.

The animals grazed in separate, adjacent pastures each year. The grass was dry and dormant during most of the study period. For chemical composition and other vegetation characteristics, the readers are referred to Pieper et al. (1978). Stocking rate was moderate (about 12 ha/yearling annually) on the two pastures. The quantity of forage was very similar between pastures during the first year but during second year, i.e., 1986, more forage was available in the pasture where yearlings fed once per week grazed, hence it was stocked heavier. Each treatment group had access to a free choice salt : mineral mix (50% dicalcium phosphate; 45% salt; and 5% cottonseed meal). Complete record of the health of animals was maintained. The intensity of weather remained normal for the two years and no drought or extraordinary snowfall was experienced.

The data on weight gains were analyzed by two-sample t test for independent samples and the two replications were pooled since they did not differ ($p > .10$). Breeding performance data were analyzed by chi square test (McClave and Dietrich II, 1985).

Results and Discussion

During each of the two trials, heifers supplemented once a week in this study made essentially the same winter gains as did those supplemented thrice/week (table 3). No difference ($p > .05$) in their weight gains were observed. Heifers fed once/week had an average daily gain of .15 kg while those fed three times/week averaged .16 kg during the second year of study. These gains were lower than those made during the first year (.23 vs .21 kg) even though the heifers were supplemented at a higher level in 1986 than in 1985 (.68 vs .45 kg/head on a daily equivalent basis). Lower gains observed in trial 2 were probably the result of differences in forage quality between the two years. The study was conducted during the time when the grass was dry and dormant and most of the animals often lose weight during this period without supplementation, therefore, these weight gains of 0.15 to 0.23 kg/day with supplementation seem to be satisfactory. These results agree with those reported earlier from northeastern Oklahoma where cottonseed cake was fed to yearling steers on winter range at daily, every-third-day and weekly intervals (McIlvain and Shoop, 1962).

TABLE 3. WEIGHT GAINS OF YEARLING REPLACEMENT HEIFEERS AS INFLUENCED BY FREQUENCY OF COTTONSEED MEAL SUPPLEMENTATION DURING THE WINTER IN A TWO-YEAR STUDY[a]

	Supplementation Frequency							
	Once per week				Thrice per week			
	Total gain		Avg daily gain		Total gain		Avg daily gain	
	(kg)	SE[b]	(kg)	SE[b]	(kg)	SE[b]	(kg)	SE[b]
Trial 1 : (130 days)	30[c]	1.4	.23	.01	28[c]	1.5	.21	.01
Trial 2 : (146 days)	22[d]	1.2	.15	.01	24[d]	2.5	.16	.02

[a] Heifers in both supplementation groups were fed at a level equivalent to 0.45 kg per head daily during trial 1 and 0.68 kg per head daily during trial 2.

[b] Standard error of mean.

[cd] Values within trials with same superscript do not differ ($p > .05$).

Weight gains during trail 1 compared across initial body weight replications (i. e., less than 223 vs more than 223 kg, table 4) indicate a somewhat faster ($p < .10$) gain rate (.23 vs .20 kg per day) by the heifers in the lighter weight group. Higher gains made by the lighter heifers may have been a reflection of compensatory gains.

Results on breeding performance for the two trials are shown in table 5. Conception rates between treatment groups (i.e., supplemented once vs thrice weekly) did not differ ($p > .05$) for either year. However, conception rates during first year of study were higher (95 vs 90%) than during the second year (73 vs 82%). Differences between years resulted form low conception rates of Hereford heifers (table 6) involved in trial 2. Average weight of all Hereford heifers at the start of the breeding season was 232 kg and their conception rate was only 54% (averaged across both supplemental treatments). Based on other research (Wiltbank et al., 1969), it is probable that many of the Hereford heifers had not reached puberty by the start of the breeding season.

As compared with Hereford heifers used in trial 2, Angus × Hereford heifers were heavier at the start of the trial (249 kg), gained at a similar rate during the supplemental period but had a much higher conception rate (89%) than Hereford heifers (table 6). The reproductive performance of crossbred heifers involved in the two trials of this study was similar to that of yearling heifers used in an earlier experiment (Melton and Riggs, 1964).

Feeding heifers once weekly rather than three

TABLE 4. WEIGHT GAINS OF YEARLING REPLACEMENT HEIFERS AS INFLUENCED BY INITIAL BODY WEIGHT AND BREED IN A TWO-YEAR STUDY ON FREQUENCY OF COTTONSEED MEAL SUPPLEMENTATION DURING THE WINTER

Trial and replication	Weight Gain Performance			
	Total gain		Avg daily gain	
	(kg)	SE[a]	(kg)	SE[a]
Trial 1 (130 days):				
Rep. 1 (wt < 223 kg)	30.5[b]	1.2	.23[b]	.01
Rep. 2 (wt > 223 kg)	26.8[c]	1.7	.20[c]	.01
Trial 2 (146 days):				
Rep. 1 (A × H)[d]	23.6[e]	1.5	.16[e]	.01
Rep. 2 (H)[d]	21.8[e]	2.0	.15[e]	.01

[a] Standard error of mean.
[b] Values within trial 1 followed by different superscript are different ($p < .10$).
[d] A × H = Angus × Hereford heifers and
H = straightbred Hereford heifers.
[e] Values within trial 2 followed by same superscript are not different ($p > .10$).

TABLE 5. BREEDING PERFORMANCE OF YEARLING REPLACEMENT HEIFERS AS INFLUENCED BY FREQUENCY OF COTTONSEED MEAL SUPPLEMENTATION IN THE WINTER BEFORE THEIR BREEDING SEASON

	Supplementation Frequency			
	Once per week		Thrice per week	
	No. pregnant/ no. exposed	Pregnancy rate (%)	No. pregnant/ no. exposed	Pregnancy rate (%)
Trial 1:	41/43	95[a]	36/40	90[a]
Trial 2:	30/41	73[b]	23/28	82[b]

[ab] Values with same superscript in the same row do not differ ($p > .05$).

TABLE 6. BREEDING PERFORMANCE OF YEARLING REPLACEMENT HEIFERS AS INFLUENCED BY INITIAL BODY WEIGHT AND BREED IN A TWO-YEAR COTTONSEED MEAL SUPPLEMENTATION STUDY

Trial and replication	Breeding Performance	
	Number pregant/ number exposed	Pregnancy rate (%)
Trial 1 (130 days):		
Rep. 1 (wt < 223 kg)	42/45	93[a]
Rep. 2 (wt > 223 kg)	35/38	92[a]
Trial 2 (146 days):		
Rep. 1 (A × H)[b]	40/45	89[c]
Rep. 2 (H)[b]	13/24	54[d]

[a] Values within trial 1 followed by the same superscript do not differ ($p > .05$).
[b] A × H = Angus × Hereford heifers and
H = straightbred Hereford heifers.
[cd] Values within trial 2 followed by unlike superscripts differ significantly ($p < .05$).

times weekly reduced transportation and labor costs involved in supplementation by about 60% without changing performance in these trials. It can be concluded that feeding once weekly is as satisfactory as feeding three times weekly.

Literature Cited

Adams, D. C. 1986. Getting the most out of grain supplements. Rangelands 8:27.

Holechek, J. L. and C. H. Herbel 1986. Supplementing range livestock. Rangelands 8:29.

Knox, J. H. 1967. Supplemental feeding of range cattle. New Mexico State Univ., Coll. Agr. Home Econom. Memoir Series No. 1.

McClave, J. T. and F. H. Dietrich II 1985. Statistics (3rd Ed.). Dellen Publishing Co., San Francisco, California.

McIlvain, E. H. and M. C. Shoop. 1962. Daily versus every-third-day versus weekly feeding of cottonseed cake to beef steers on winter range. J. Range Manage. 15:143.

Melton, A. A. and J. K. Riggs. 1964. Frequency of feeding protein supplement to range cattle. Tex. Agr. Sta. Bull. B-1025.

Pieper, R. D., J. R. Montoya and V. L. Groce. 1971. Site characteristics on pinyon-juniper and blue grama ranges in southcentral New Mexico. New Mexico State Univ. Agr. Exp. Sta. Bull. 573.

Pieper, R. D., A. B. Nelson, G. S. Smith, E. E. Parker, E. J. A. Boggino and C. F. Hatch. 1978. Chemical composition and digestibility of important range grass species in southcentral New Mexico. New Mexico State Univ. Agr. Exp. Sta. Bull 662.

U.S. Department of Commerce. 1973. National Oceanic and Atmospheric Administration, Environmental Data Service. Climatology of the U.S. No. 81. Asheville.

Wiltbank, J. N., C. W. Kasson and J. E. Ingalls. 1969. Puberty in crossbred and staightbred beef heifers on two levels of feed. J. Anim. Sci. 29: 602.