Relationship of Milk Yield and Quality to Preweaning Gain of Calves from Angus, Brahman and Reciprocal-cross Cows on Different Forage Systems

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Story in Brief

Interactions of the regression of preweaning ADG on dam milk yield and quality with breed group and forage environment were evaluated in a two-phase study. Phase I consisted of milk yield, quality and calf gain records from 1989 to 1991 for purebred Angus and Brahman cows mated to sires of both breeds. Phase II consisted of milk yield, quality and calf gain records from 1991 to 1997 for Angus, Brahman, Angus x Brahman and Brahman x Angus mated to Polled Hereford sires. In phase I forage environments included common bermudagrass and endophyte-infected tall fescue. In phase II forage environments included common bermudagrass and endophyte-infected tall fescue (1991-1995) and a rotational system of both forages (1995-1997) in which each forage was grazed during its appropriate growing season. Milk yield was estimated monthly during lactation from spring through fall and converted to a 24-h basis. Milk fat, milk protein, and somatic cell counts were analyzed by a commercial laboratory. In Phase I, the relationships of preweaning ADG to milk yield, milk fat yield, and protein yield were higher ($P < 0.05$) in Brahman cows on bermudagrass than Angus on bermudagrass. The regression of preweaning ADG on milk yield in Phase I was higher ($P < 0.05$) for cows on tall fescue than for cows that grazed bermudagrass. In Phase II, the relationships of preweaning ADG to milk yield, milk fat yield, and milk protein yield were higher ($P < 0.01$, $P < 0.11$, $P < 0.01$, respectively) in purebred cows compared to reciprocal-cross cows. The regression of preweaning ADG on milk yield and milk protein yield was higher ($P < 0.05$) on tall fescue than bermudagrass in Phase II. These results suggest that the influence of milk yield and quality on calf growth may differ among breed types and production system, and the efficacy of improvements in milk traits may depend on the breed type and forage environment.

Introduction

The maternal ability of beef cows has been shown to be a critical component of preweaning growth in their calves (Mallinckrodt et al., 1993) and profit potential in the herd (Miller et al., 1999). Consequently, considerable emphasis has been given to improvements in maternal ability of beef cows. While nutritional environment is an obvious factor influencing milk yield, little work has been done to evaluate the influence of both breed group and forage environment on the relationship of milk yield and preweaning growth. Moreover, more work is needed to evaluate the influence of milk fat and milk protein on preweaning growth in beef calves. Thus, our objectives in this research were to evaluate the interaction of the regression of calf preweaning ADG on milk yield, milk fat, milk protein, and somatic cell counts with breed group and forage environment in Angus, Brahman, and reciprocal-cross cows and their calves managed on three different forage systems.

Experimental Procedures

Nine years of milk production and calf growth data (1989 to 1997) on approximately 310 Angus, Brahman, and reciprocal-cross cow-calf pairs managed on common bermudagrass, endophyte-infected tall fescue, or a combination of the two forages were evaluated in this study. Data from 1989 to 1991 consisted of purebred Angus and Brahman cows and their purebred and reciprocal-cross calves managed on either common bermudgrass or endophyte-infected tall fescue. Data from 1991 to 1994 were from Angus (AA), Brahman (BB), and reciprocal-cross cows (AB and BA) and their Polled Hereford-sired calves managed on either common bermudagrass or endophyte-infected tall fescue. Data from 1995 to 1997 were from AA, BB, AB, BA and their Polled Hereford-sired calves managed on either common bermudagrass, endophyte-infected tall fescue, or a combination of the two forages in which each forage was grazed during its appropriate season, usually June through October for bermudagrass and November through May for tall fescue. Milk yield was estimated monthly six times during lactation from spring through fall by method of single cow milking machine and converted to a 24-h basis ([milk weight/14] x 24; Brown et al. 1996). Average days postpartum for estimates of milk yield were 65, 94, 122, 151, 173, and 199 d from 1989 to 1991 and 60, 89, 116, 145, 172, and 199 d from 1991 to 1997. Milk fat, milk protein, and somatic cell counts were analyzed by a commercial laboratory using a Milkoscan System 4000“ (Foss North America, Eden Prairie, MN; AOAC, 1990). Details on herd and pasture management and milking procedures can be found in Brown et al. (1993,1996, 2001). Because the data in 1989 to 1991 consisted of the production of purebred and reciprocal-cross calves from Angus and Brahman sires and the data from 1991 to 1997 were the production of two- and three-breed cross calves from Polled Hereford sires, data were reported separately from 1989 to 1991 (Phase I) and from 1991 to 1997 (Phase II). In phase I there were 32 AA and 32 BB cow years for milk yield and quality on bermudagrass while cow years for milk yield and quality on fescue included 32 AA and 30 BB. Sample size for phase II is given in Table 1.

Data were analyzed by methods of mixed model least squares. Linear models for 1989 to 1991 included the fixed effects of year, sire breed, dam breed, sex of calf, forage, and interactions among fixed effects; random effects included sire of calf nested in sire breed and the pooled interactions of sire in sire breed with fixed effects. Linear

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models for 1991 to 1997 included the fixed effects of year, grandsire breed, granddam breed, sex of calf, age of dam, forage, and interactions among fixed effects; random effects included sire of calf and the pooled interactions of sire with fixed effects. Covariates included in separate models were 24-hr milk yield, 24-hr milk fat yield, 24-hr milk protein yield, and somatic cell count, as well as interactions of these covariates with sire breed, dam breed, forage, sire breed x dam breed, sire breed x forage, dam breed x forage, and sire breed x dam breed x forage. Contrasts among regression coefficients for different classes were done using "t" statistics.

Results and Discussion

Breed and Forage Effects for Traits Analyzed. Least-squares means and standard errors for traits analyzed are given in Tables 2 and 3 for Phase I and Phase II, respectively. In Phase I, preweaning ADG of calves was lower (P < 0.01) on tall fescue than bermudagrass. There was an interaction (P < 0.05) of breed of dam with forage for milk yield where AA cows on tall fescue were lower (P < 0.01) than AA on bermudagrass while forage differences were not evident in BB cows. In Phase I, BB cows had higher (P < 0.01) milk fat yield than AA and milk fat yield was higher (P < 0.01) on bermudagrass than tall fescue. Similar to milk yield, milk protein yield was higher (P < 0.01) in AA on bermudagrass than AA on tall fescue but similar in BB on tall fescue and bermudagrass. In Phase I, forage effects for somatic cell counts were similar in AA, but BB on tall fescue had higher counts than BB on bermudagrass (P = 0.05). In Phase II, there was an interaction (P < 0.05) of grandsire breed x granddam breed x forage for preweaning ADG. Maternal heterosis for preweaning ADG was larger on tall fescue than bermudagrass (P < 0.05) while maternal heterosis was similar in tall fescue and the rotational system. Milk yield was higher (P < 0.01) on bermudagrass than either tall fescue or the rotational system and milk yield on the rotational system was higher (P < 0.01) than tall fescue. Heterosis for milk yield was similar in all forage systems and averaged 4.84 lb (P > 0.26). Milk fat yield differed (P < 0.05) among all of the forage systems and was largest on bermudagrass, intermediate on the rotational system, and lowest on tall fescue. There was marginal evidence that heterosis for milk fat yield differed among forages (P < 0.15) with heterosis on bermudagrass larger (P < 0.10) than heterosis on tall fescue. Milk protein yield differed (P < 0.01) among the forages and was highest on bermudagrass, intermediate on the rotational system, and lowest on tall fescue. Heterosis for milk protein yield was similar among forages and averaged 16.72 lb (P > 0.37). There was little evidence of forage differences in somatic cell count but heterosis was evident with somatic cell count in crossbred cows lower (P < 0.05) than counts in purebreds.

Regression of Preweaning ADG on 24-hr Milk Yield. Estimates of the regression of preweaning ADG on 24-hr milk yield and their standard errors are given in Tables 4 (Phase I) and 5 (Phase II). In Phase I there was little evidence of an interaction of 24-hr milk yield with sire breed. There was however evidence of an interaction (P < 0.10) of the relation of preweaning ADG to milk yield with dam breed and forage. On bermudagrass, preweaning ADG increased 0.102 lb per lb milk in calves from BB cows (P < 0.01) whereas the same relationship in calves from AA cows was 0.0257 lb per lb milk (P = 0.30). On tall fescue, the relationship was similar for calves from both breeds (P = 0.63). In the Phase II data there was evidence that the regression of preweaning ADG on 24-hr milk yield was different among grandsire breed x granddam breed subclasses (P < 0.01) and among forage classes (P < 0.10). The regression averaged across pasture types was higher (P < 0.01) in calves from AA than calves from Angus x Brahman and BA cows. The regression was also higher (P < 0.05) in calves from BB than BA cows. Consequently, the relationship was generally higher for calves from purebred cows than from crossbred cows with the average slope for calves from purebreds exceeding that of calves from crossbreds by .047 lb ADG per lb milk (P < 0.01). The regression of preweaning ADG on milk yield was higher (P < 0.05) on tall fescue compared to bermudagrass in Phase II where the regression on rotation was intermediate to the other two forage systems and not significantly different from either. The data from the current study support the hypothesis of stronger relationships of milk yield to preweaning ADG in lower producing cows where purebred cows had lower milk yield than crossbreds and where cows on endophyte-infected tall fescue had lower milk yields than cows on bermudagrass. However, the relationship of milk yield to preweaning ADG in Phase I was higher for calves from BB cows than calves from AA cows on bermudagrass, even though differences in milk yield were not significant.

Regression of Preweaning ADG on 24-hr Milk Fat Yield. Estimates of the regression of preweaning ADG on 24-hr milk fat yield and their standard errors are given in Tables 6 (Phase I) and 7 (Phase II). There was an interaction of the regression of preweaning ADG on milk fat yield with dam breed and forage type (P < 0.05). The relationship was higher (P < 0.05) in calves from BB cows than calves from Angus cows on bermudagrass (2.03 vs 0.278 lb/lb respectively), while the relationship in calves from the two breeds was similar on tall fescue (P = 0.59). In Phase II, the regression of preweaning ADG on milk fat yield, averaged over pasture types, was higher (P < 0.05) in calves from Angus than from AB, BA, and BB cows. The relationship in calves from AB was larger (P < 0.10) than the relationship in calves from BA. Additionally, the average regression of preweaning ADG on milk fat yield tended to be higher (P = 0.11) for calves from purebreds than from crossbreds. While the relationship between preweaning ADG and milk fat yield, averaged across breed types, was not significantly different among forages, the relationship for calves on tall fescue was numerically greater than bermudagrass or the rotational system.

Regression of Preweaning ADG on 24-hr Milk Protein Yield. Estimates of the regression of preweaning ADG on 24-hr milk protein yield and their standard errors are given in Tables 8 (Phase I) and 9 (Phase II). The regression of preweaning ADG on milk protein yield differed (P < 0.10) among dam breed x forage subclasses in Phase I. On bermudagrass, preweaning ADG increased 3.02 lb per lb increase in milk protein in calves from BB cows (P < 0.01), but only 0.82 lb per lb increase in milk protein in calves from Angus cows (P > 0.23). In Phase II, there was an interaction (P < 0.01) of milk protein yield with grandsire breed x granddam breed and an interaction with forage (P < 0.10). The regression of preweaning ADG on milk protein yield, averaged across forage types, was higher (P < 0.01) in calves from Angus than from AB and BA (P < 0.01), while the relationship was higher (P < 0.10) in calves from BB than from BA. Similar to the other two traits, the relationship was higher (P < 0.01) in the average of calves from purebreds compared to the average of calves from crossbreds. The regression of preweaning ADG on milk protein yield was higher (P < 0.05) in tall fescue than bermudagrass.

Regression of Preweaning ADG on Somatic Cell Counts. There was little evidence of a relationship of somatic cell counts to preweaning ADG in these data (data not shown). Estimates calculated were -2.2 x 10-5 (P = 0.88) and –8.8 x 10-5 (P = 0.28) lb per 1000 somatic cells increase in Phase I and Phase II, respectively. Simpson et al. (1995) reported no difference in weaning weights in calves from high somatic cell count cows and low somatic cell count cows. Brown et al. (1998) reported negative relationships between somatic cell count and weaning weight, but the results were not statistically significant.

Implications

Phenotypic improvements in yield of milk fat, and yield of milk protein are associated with improvements in preweaning ADG in beef cattle. However, the magnitude of the association appears to be less in breed groups or environments that support higher milk production. Consequently, further improvements in breeds and(or) environments where milk production is at relatively high levels may be less efficacious than improvements in breeds and(or) environments at lower levels of milk production. However, it is possible that improvements in productivity may be possible, even at higher levels of milk production, in certain genotypes and environments. Consequently, matching animal genotype to environment remains a consideration.

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Table 1. Cow-years for milk yield and quality estimates for forage, sire breed,and dam breed subclasses 1991-1997, Phase II

	Breed type[a]			
Forage	AA	AB	BA	BB
Bermuda	41	37	42	38
Fescue	41	37	39	35
Rotational	12	12	12	12

[a] A = Angus, B = Brahman; sire breed listed first.

Table 2. Least-squares means and standard errors for breed of dam x forage subclasses for calf growth and milk traits, Phase I

Breed[a]	Forage	Preweaning ADG[b]	24-hr Milk Yield[c]	24-hr milk fat[c]	24-hr milk protein[c]	Somatic Cells[d]
AA	Bermuda	2.02 ± 0.04	14.63 ± 0.75	0.48 ± 0.02	0.46 ± 0.02	165 ± 52
	Tall Fescue	1.85 ± 0.04	10.61 ± 0.75	0.33 ± 0.02	0.35 ± 0.02	108 ± 52
BB	Bermuda	1.98 ± 0.04	13.49 ± 0.75	0.55 ± 0.02	0.46 ± 0.02	158 ± 51
	Tall Fescue	1.85 ± 0.04	12.58 ± 0.75	0.46 ± 0.04	0.42 ± 0.02	304 ± 51
Approximate $LSD_{0.10}$		0.05	0.79	0.03	0.03	120

[a] A=Angus, B=Brahman; sire breed listed first.
[b] lb per day.
[c] lb per 24-hr.
[d] x 10^3 cells.
Approximate LSD is for comparison within or between breed group x forage subclass means for the given forage subclass.

Table 3. Least-squares means and standard errors for breed of grandsire x breed of granddam x forage subclasses for calf growth and milk traits, Phase II

Breed[a]	Forage	Preweaning ADG[b]	24-hr Milk Yield[c]	24-hr milk fat[c]	24-hr milk protein[c]	Somatic Cells[d]
AA	Bermuda	1.94 ± 0.04	15.33 ± 0.64	0.55 ± 0.02	0.48 ± 0.02	210 ± 52
	Tall Fescue	1.39 ± 0.04	9.00 ± 0.64	0.29 ± 0.02	0.29 ± 0.02	311 ± 52
	Rotation	1.63 ± 0.09	12.10 ± 1.23	0.44 ± 0.07	0.40 ± 0.04	278 ± 101
AB	Bermuda	2.33 ± 0.04	20.61 ± 0.66	0.81 ± 0.02	0.68 ± 0.02	205 ± 54
	Tall Fescue	2.00 ± 0.04	14.56 ± 0.665	0.48 ± 0.02	0.48 ± 0.02	159 ± 54
	Rotation	2.22 ± 0.09	18.63 ± 1.23	0.68 ± 0.07	0.62 ± 0.04	178 ± 101
BA	Bermuda	2.39 ± 0.04	21.98 ± 0.62	0.81 ± 0.02	0.75 ± 0.02	130 ± 51
	Tall Fescue	2.07 ± 0.04	15.00 ± 0.64	0.53 ± 0.02	0.53 ± 0.02	109 ± 52
	Rotation	2.24 ± 0.09	20.17 ±1.25	0.79 ± 0.07	1.17 ± 0.04	121 ± 102
BB	Bermuda	2.31 ± 0.04	17.03 ± 0.64	0.70 ± 0.02	0.59 ± 0.02	199 ± 52
	Tall Fescue	1.91 ± 0.04	12.82 ± 0.66	0.51 ± 0.02	0.44 ± 0.02	185 ± 54
	Rotation	2.11 ± 0.09	15.46 ± 1.23	0.66 ± 0.07	0.53 ± 0.04	259 ± 101
Approx. $LSD_{0.10}$	Bermuda vs Tall Fescue	0.05	0.68	0.03	0.02	122
Approx. $LSD_{0.10}$	Bermuda vs Rotation Fescue vs Rotation	0.07	1.04	0.05	0.03	188

[a] A=Angus, B=Brahman, sire breed listed first.
[b] lb per day.
[c] lb per 24-hr.
[d] x 103 cells.
Approximate LSD is for comparison within or between breed group x forage subclass means for the given forage subclass.

Table 4. Regression coefficients and standard errors for preweaningADG (lb) on average milk yield (lb) for Angus and Brahman cows on commonbermudagrass or endophyte-infected tall fescue, Phase I

	Breed[a]	
Forage	AA	BB
Bermuda	0.0257 ± 0.0249^{b}	0.0932 ± 0.0253^{c}
Tall fescue	0.0884 ± 0.0299^{b}	0.0693 ± 0.0246^{b}

[a] A = Angus, B = Brahman; sire breed listed first.
[bc] Mean coefficients in the same row without a common superscript differ ($P < 0.05$).

Table 5. Regression coefficients and standard errors for preweaning ADG (lb) on average daily milk yield (lb) for Angus, Brahman, and reciprocal-cross cows on common bermudagrass, endophyte-infected tall fescue or a combination of the two forages, Phase II

	Breed type[a]				
Forage	AA	AB	BA	BB	Average
Bermuda	0.0871 ± 0.016	0.0743 ± 0.017	0.0440 ± 0.017	0.0675 ± 0.016	0.0682 ± 0.008^{b}
Tall fescue	0.1401 ± 0.200	0.0600 ± 0.015	0.0642 ± 0.017	0.1175 ± 0.022	0.0979 ± 0.010^{c}
Rotation	0.1142 ± 0.026	0.0530 ± 0.024	0.0425 ± 0.023	0.1082 ± 0.039	0.0794 ± 0.016^{bc}
Average	0.1137 ± 0.012^{b}	0.0658 ± 0.012^{cd}	0.0502 ± 0.012^{c}	0.0977 ± 0.017^{bd}	

[a] A=Angus, B=Brahman; sire breed listed first.
[bcd] Mean coefficients in the same row or column without a common superscript differ ($P < 0.05$).

Table 6. Regression coefficients and standard errors for preweaning ADG (lb)on average daily milk fat (lb) for Angus and Brahman cows on commonbermudagrass or endophyte-infected tall fescue, Phase I

	Breed[a]	
Forage	AA	BB
Bermuda	0.2785 ± 0.4937[b]	2.0396 ± 0.5106[c]
Tall fescue	1.7087 ± 0.5683[c]	1.2811 ± 0.5518[c]

[a] A=Angus, B=Brahman, sire breed listed first.
[bc] Mean coefficients in the same row without a common superscript differ (P < 0.05). Mean coefficients in the same column without a common superscript differ (P <0.10).

Table 7. Regression coefficients and standard errors for preweaning ADG (lb) on average daily milk fat (lb) for Angus, Brahman, and reciprocal-cross cows on common bermudagrass, endophyte-infected tall fescue or a combination of the two forages, Phase II

	Breed type[a]				
Forage	AA	AB	BA	BB	Average
Bermuda	2.009 ± 0.4580	1.3891 ± 0.3443	0.8815 ± 0.4259	1.3138 ± 0.3813	1.3985 ± 0.2072
Tall fescue	2.7014 ± 0.4930	1.4639 ± 0.3843	0.6888 ± 0.3601	1.5479 ± 0.4574	1.6005 ± 0.2317
Rotation	1.8900 ± 0.6043	1.2786 ± 0.6699	0.7623 ± 0.4675	0.3748 ± 1.3521	1.0764 ± 0.4530
Average	2.2000 ± 0.3018[b]	1.3772 ± 0.2829[c]	0.7775 ± 0.2429[d]	0.7775 ± 0.2429[cd]	

[a] A=Angus, B=Brahman; sire breed listed first.
[bcd] Mean coefficients in the same row without a common superscript differ (P < 0.10).

Table 8. Regression coefficients and standard errors for preweaning ADG (lb)on average daily milk protein (lb) for Angus and Brahman cows on commonbermudagrass or endophyte-infected tall fescue, Phase I

	Breed[a]	
Forage	AA	BB
Bermuda	0.8274 ± 0.6813[b]	3.0226 ± 0.7636[c]
Tall fescue	2.6770 ± 1.0283[c]	1.946 ± 0.7698[c]

[a] A=Angus, B=Brahman, sire breed listed first.
[bc] Mean coefficients in the same row without a common superscript differ (P < 0.05).

Table 9. Regression coefficients and standard errors for preweaning ADG (lb) on average milk protein (lb) for Angus, Brahman, and reciprocal-cross cows on common bermudagrass, endophyte-infected tall fescue or a combination of the two forages, Phase II

	Breed type[a]				
Forage	AA	AB	BA	BB	Average
Bermuda	3.0371 ± 0.5821	1.9776 ± 0.4628	0.9409 ± 0.5146	1.9723 ± 0.4666	1.9820 ± 0.2627 [b]
Tall fescue	4.2919 ± 0.6587	2.2244 ± 0.4888	1.9591 ± 0.5099	3.2560 ± 0.6184	2.9328 ± 0.3117 [c]
Rotation	3.7831± 0.8375	2.0374 ± 0.8008	1.3935 ± 0.7583	2.9346 ± 1.2956	2.5370 ± 0.5463 [bc]
Average	3.7039 ± 0.4110[b]	2.0799 ± 0.3731[cd]	1.4311± 0.3821[c]	2.7209 ± 0.5346[bd]	

[a] A=Angus, B=Brahman, sire breed listed first.
[bcd] Mean coefficients in the same row or column without a common superscript differ (P < 0.05).