REPRODUCTIVE PERFORMANCE IN CROSSES OF ANGUS, SANTA GERTRUDIS AND GELBVIEH BEEF CATTLE 1

J. E. Gotti2,3, L. L. Benyshek4 and T. E. Kiser4
University of Georgia4, Athens 30602

ABSTRACT

Angus (A), Santa Gertrudis (S), and Gelbvieh (G) sires were mated to A and S dams to produce five mating types (A X A, S X S, S X A, A X S and G X A) in each of four calf crops. The study involved 501 matings. Overall means for the traits measured (calves born/cows exposed; Julian birthdate, calving ease, percentage of live calves at 24 h, birth weight, survival to weaning and gestation length) were 74.2%, 48.8 d, 96.4%, 97.6%, 33.2 kg, 95.4% and 283.8 d, respectively. Angus dams had a 14 percentage point (P<.05) advantage over S dams for percentage of calves born/cows exposed. The effect of heterosis in crosses of A and S for percentage of calves born/cows exposed was negative (-11.1%) and approached significance. The percentage of calves born/cows exposed were 84.4, 70.4, 76.1 and 62.3 for the A X A, S X S, S X A and A X S mating types, respectively. Matings involving A sires and dams produced calves significantly earlier in the calving season than did matings involving S sires and dams. Matings involving S sires and dams produced calves with significantly longer gestation periods than matings of A sires and dams. Calving ease score and survival to weaning were not affected by breed of sire, breed of dam, age of dam, sex of calf, or the interaction of breed of sire x breed of dam. Percentage of live calves at 24 h indicated that straightbred S calves were significantly less viable at birth than the other four mating types. Angus dams had a significant advantage over S dams for percentage alive 24 h after birth. Straightbred A calves were significantly smaller at birth (30.1 kg) than the other mating types. Straightbred S calves were heaviest at birth (37.2 kg) and different (P<.05) from the other mating types. The three crossbred classes did not differ (S X A, 33.5 kg; A X S, 35.1 kg and G X A, 34.0 kg), and were intermediate to the two straightbred classes in the birth weight. Heterosis for birth weight in crosses of A and S was not significant.

(Key Words: Cross Breeding, Cattle, Reproduction, Santa Gertrudis, Performance.)

Introduction

Cundiff (1970) reviewed the results from crossing British breeds and the results of crossbreeding Charolais and Brahman with the British breeds of cattle. He reported a 1% calf crop weaned advantage for the F1 Brahman-British calves; however, the effect of heterosis on fertility of the crossbred Brahman-British cow was quite large (12.1 to 18.8% for calf crop weaned). Reynolds et al. (1980) reported heterosis of 14% for survival rate at birth of F1 Angus-Brahman. Peacock et al. (1977) indicated that calf survival rates at birth were similar for straightbreds and crossbreds in a study involving Angus, Brahman and Charolais; they observed negative heterosis (nonsignificant) for weaning percentage. The effects of heterosis on reproduction in Brahman crosses appears to be variable. There is little information in the literature concerning the performance of crosses between Brahman derivatives and British breeds, particularly with respect to reproduction. Neville et al. (1984) reported that reproductive performance was lower when Santa Gertrudis sires were compared with Angus and Polled Hereford sires in a rotational crossbreeding study. The literature appears to be lacking in information comparing Brahman derivative x British crossbreds with European x British crosses.

The objectives of this study were to evaluate the reproductive performance of straightbred Angus (A) and Santa Gertrudis (S), the reciprocal crosses of A and S, and Gelbvieh (G) x A crosses in the Southeastern region of the country.

1This study was partially funded by the Georgia Agr. Exp. Sta. and it is part of a Hatch Project, H608.
2This paper represents part of a dissertation submitted by the senior author to the Univ. of Georgia Graduate School in partial fulfillment of the requirements for the Ph.D. degree in Anim. Sci.
3Present address: Dept. of Agriculture, Stephen F. Austin State Univ., Nacogdoches, TX 75962.
4Anim. and Dairy Sci. Dept.
Received September 6, 1983.
Accepted June 21, 1985.
Materials and Methods

This study was conducted at the University of Georgia Agriculture Experiment Station, Athens, from 1976 to 1981. The average rainfall for the area is 128 cm with a mean temperature of 16.3°C. The cow herds were maintained on fescue (Festuca elatior) during the fall, winter and spring. Bermudagrass (Cynodon dactylon) was used for summer pasture. The cows were supplemented during the winter with rye (Secale cereale) and ryegrass (Lolium spp) pasture along with bermudagrass hay (IFN1-00-716) and corn (IFN4-02-935).

The mating design of the experiment, the number of sires used of each breed, the number of matings and the number of calves born are given in table 1. The A and S females used in the study came from two herds that were maintained at the station for several years before 1976. The ages of the dams for both breeds ranged from 2 through 14 yr, with the majority (63%) being mature females. No replacement females were introduced during the study. The two groups of females were representative of cows maintained in Southeastern cattle operations in that they were well-adapted to the region’s climatic conditions. The project began with approximately 100 A and 50 S females.

Cows in both breeds were culled after being nonpregnant 2 yr consecutively, or because of physical unsoundness (e.g., feet and leg problems). No cows were culled on the basis of productivity (e.g., weaning weight of calves).

A 75-d breeding season starting on April 1, was used each year, the first 42 d being an artificial insemination (AI) breeding period followed by a 33-d natural service breeding period. Females were randomized with respect to mating type groups with the restriction that each cow was given the opportunity to contribute to each mating type at least once, but no more than twice, during the duration of the project. This resulted in each of the A and S cows being mated to A and S sires to produce straightbred and crossbred calves. Approximately 85% of the A cows had an opportunity to contribute to the G × A mating type. All G-sired calves were produced by AI except in 1 yr when a G sire was available for natural service clean-up after the AI period. After the AI breeding season, the A cows assigned to the G breeding group were reassigned to the A or S sire group for natural service clean-up by those breeds of bulls, except in the 1 yr when a G sire was available for natural service.

Reproductive performance was evaluated using the following criteria: percentage calves born/cows exposed (1 = calved, 0 = no calf); calving ease (1 = no assistance, 0 = assistance required); percentage live 24 h after parturition (1 = alive, 0 = dead); percentage born alive that survived to weaning (1 = alive, 0 = dead); Julian birthdate (d); birth weight (kg) and gestation length (d). A simple calving ease score of 1 and 0 was used because only a small amount of calving difficulty was observed in the study. The analysis of gestation length utilized only the calves for which exact breeding dates were known and represented 62% of the total calves born.

The data were analyzed using the methods of SAS (1979). The statistical model used to evaluate percentage calves born/cow exposed included the fixed effects of year, breed of sire, and Table 1. Design, Number of Matings and Number of Calves Born

<table>
<thead>
<tr>
<th>Breed of dam</th>
<th>Breed of sire</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Angus (26)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Santa Gertrudis (23)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gelbvieh (14)</td>
<td></td>
</tr>
<tr>
<td>Angus</td>
<td>132b</td>
<td>199</td>
</tr>
<tr>
<td>(113)</td>
<td>(92)</td>
<td>(70)</td>
</tr>
<tr>
<td>Santa Gertrudis</td>
<td>80</td>
<td>78</td>
</tr>
<tr>
<td>(52)</td>
<td>(56)</td>
<td>(56)</td>
</tr>
<tr>
<td>Total</td>
<td>212</td>
<td>90</td>
</tr>
<tr>
<td>(165)</td>
<td>(148)</td>
<td>(70)</td>
</tr>
</tbody>
</table>

aNumber of sires.
bNumber of matings; number of calves born in parentheses.

GOTTI ET AL.
breed of dam, age of dam and the interaction of breed of sire x breed of dam and a random error component. A second model was used to evaluate the other traits except Julian birthdate; it included the fixed effects of year, breed of sire, breed of dam, sex of calf, age of dam and the interaction of breed of sire x breed of dam. Also included in this second model were the random components sires nested within breed of sire and error. The nested random effect of sires within breed of sire was used as the denominator of the F ratio to test sire breed effects in this second model. A third model was developed for analysis of Julian birthdate; it was similar to the second model but included the effect of breeding management (AI vs natural service). Breeding management was included in this model because variability among sires was artificially introduced for Julian birthdate by the fact that natural service sires were used 42 d later than the AI sires. Sire breed effects for Julian birthdate were tested using the mean-squares for sires within the breed of sire x breed of dam as the denominator of the F ratio. The two-way interactions including breed of dam x age of dam and the three-way interaction of breed of sire x breed of dam x sex of calf were found to be nonsignificant; hence these interactions were eliminated from the models. Percentage heterosis was computed for the crosses involving A and S. Significance for percentage heterosis was determined by the magnitude of the F ratio for the interaction of sire breed x dam breed from an analysis in which the G x A calves were deleted. In another analysis, the five mating types (A x A, S x S, A x S, S x A and G x A) were compared using the interaction subcells (three breeds of sires and two breeds of dams). All possible comparisons were made, thus the power of the test was reduced.

Results and Discussion

Least-squares means for the effects of breed of sire, breed of dam, sex of calf and breed of sire x breed of dam are given in table 2 for each of the traits studied.

Percentage Calves Born/Cows Exposed, Gestation Length and Julian Birthdate. Gelbvieh x Angus matings were not included in the analysis of percentage calves born/cows exposed or Julian birthdate. The G x A matings were predominantly through AI. The lack of natural service clean-up resulted in these characteristics being biased for the G x A crosses.

The overall pregnancy rate based on calves born/cows exposed for the study was 74.2%, with an average Julian birth day of 48.8 d; the average gestation length was 283.8 d. Age of dam did not significantly affect any of these three traits, nor did sex of calf affect Julian birth date or gestation length.

Reproductive rate expressed as calves born/cows exposed was not significantly affected by breed of sire; however, there was a significant difference (9.5 d) for average calving date between the two breeds of sires, with A-sired calves being born earlier. Turner et al. (1968) and Peacock et al. (1977) found that Brahman sires had a significantly higher pregnancy rate than A sires; however, Crockett et al. (1973) reported that A bulls sired a higher percentage calf crop than Brahman bulls. Brown et al. (1975) reported a 10-d increase in calving date for S sires compared with A sires. Reynolds et al. (1980) reported that calves sired by A bulls bred to Brangus and Africander-Angus dams were born 22 d earlier than calves sired by Brahman bulls bred to the same types of dams. Reynolds et al. (1979) found a significant 9-d longer gestation period and a lower pregnancy rate per service for Brahman sires compared with A sires, when both breeds were bred to the same types of cows. There was a significant difference in gestation length for S- and G-sired calves vs A-sired calves in the current study (285.5, 286.2 and 283.5 d, respectively); thus the 2-d difference between the S and A sires for gestation length accounted for part of the difference in Julian birthdate between the two sire breeds.

Angus dams had a significant advantage (14 percentage points for calves born/cows exposed) in reproductive rate over the S dams. These results are in agreement with research in Florida by Crockett et al. (1973), where a 15% advantage in birth rate for A cows compared with Brahman cows was found. Turner et al. (1968) found a calving percentage advantage of over 5% for Brahman cows compared with A or Hereford cows in a Louisiana study.

In this study, A cows calved 8.7 d earlier than S cows. Long and Gregory (1974) reported that A dams calved 5 d earlier than Hereford dams. Reynolds et al. (1980) reported that A straightbred calves were born 33 d earlier than Brahman straightbred calves. There was also a
<table>
<thead>
<tr>
<th>Mating Type</th>
<th>Calves born/ cow exposed, %</th>
<th>Julian birthdate, d</th>
<th>Gestation length, d</th>
<th>Calving ease, %</th>
<th>% live after birth</th>
<th>Birth weight, kg</th>
<th>% survival to weaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>A x A</td>
<td>84.4 ± 3.8d</td>
<td>35.1 ± 2.2d</td>
<td>281.8 ± 0.6d</td>
<td>93.3 ± 4.0d</td>
<td>99.1 ± 2.4d</td>
<td>30.1 ± 0.09d</td>
<td>94.9 ± 3.0d</td>
</tr>
<tr>
<td>S x S</td>
<td>70.4 ± 4.8ef</td>
<td>50.4 ± 2.9e</td>
<td>288.2 ± 0.9e</td>
<td>97.9 ± 5.0d</td>
<td>90.9 ± 3.3e</td>
<td>37.3 ± .95e</td>
<td>90.6 ± 4.0d</td>
</tr>
<tr>
<td>S x A</td>
<td>76.1 ± 3.9df</td>
<td>43.9 ± 2.3f</td>
<td>283.1 ± 0.6df</td>
<td>96.6 ± 5.0d</td>
<td>98.9 ± 2.7d</td>
<td>33.5 ± .83f</td>
<td>92.0 ± 3.3d</td>
</tr>
<tr>
<td>A x S</td>
<td>62.3 ± 4.7e</td>
<td>45.8 ± 2.8ef</td>
<td>285.0 ± 0.8f</td>
<td>98.0 ± 5.0d</td>
<td>98.1 ± 3.1d</td>
<td>35.1 ± 1.00e</td>
<td>89.2 ± 3.9d</td>
</tr>
<tr>
<td>G x A&lt;sup&gt;b&lt;/sup&gt;</td>
<td>284.2 ± 0.6f</td>
<td>96.3 ± 3.0d</td>
<td>98.3 ± 3.3d</td>
<td>34.0 ± .95f</td>
<td>94.4 ± 4.1d</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A sires      | 73.4 ± 3.0d                 | 39.2 ± 1.8d        | 283.5 ± 0.5d        | 95.1 ± 4.3d    | 98.6 ± 2.3d      | 32.5 ± 0.86d    | 92.4 ± 2.8d       |

S sires      | 73.2 ± 3.1d                 | 48.7 ± 1.8e        | 285.5 ± 0.5e        | 98.1 ± 4.8d    | 94.9 ± 2.5d      | 35.5 ± .73e     | 90.9 ± 3.1d       |

G sires<sup>b</sup> | 286.2 ± 0.6e | 98.3 ± 3.8d | 98.3 ± 3.3d | 36.2 ± 1.00e | 92.7 ± 4.3d |

A dams       | 80.3 ± 2.7d                 | 39.6 ± 1.6d        | 283.0 ± 0.3d        | 94.7 ± 3.1d    | 98.8 ± 2.3d      | 32.2 ± 0.41d    | 93.6 ± 2.9d       |

S dams       | 66.3 ± 3.4e                 | 48.3 ± 2.1e        | 287.0 ± 0.8e        | 99.2 ± 3.9d    | 94.3 ± 2.5e      | 36.5 ± .41e     | 90.2 ± 3.2d       |

Bulls        | 44.3 ± 1.8d                 | 284.7 ± 0.4d       | 97.3 ± 3.4d         | 96.6 ± 2.5d    | 35.7 ± .76d      | 93.7 ± 2.6d     | 90.1 ± 2.7d       |

Heifers      | 43.6 ± 1.8d                 | 285.4 ± 0.4d       | 96.6 ± 3.4d         | 98.0 ± 2.5d    | 33.0 ± .73e      | 90.1 ± 2.7d     | 90.1 ± 2.7d       |

Heterosis<sup>c</sup> | −8.2 (−11.1%)<sup>†</sup> | 2.1 (2.5%) NS<sup>g</sup> | −8 (−3%) NS | 1.7 (1.8%) NS | 3.1 (3.2%) NS | .59 (1.7%) NS | −2.0 (−2.2%) NS |

<sup>a</sup>A = Angus, S = Santa Gertrudis, G = Gelbvieh; sire breed listed first.
<sup>b</sup>The Gelbvieh x Angus mating types were not analyzed for calves born/cows exposed and Julian birthdate because most of the matings were AI.
<sup>c</sup>Heterosis = 1/2[(SA + AS) − (AA + SS)].
<sup>d</sup>e,f Values that do not have a common superscript differ (P<.05).
<sup>g</sup>NS = nonsignificant.
<sup>†</sup>P<.10.
significant 4-d difference in gestation length between the two breeds of dams, with A dams having a shorter gestation length.

The breed of sire x breed of dam interaction approached significance for percentage calves born/cows exposed for the crosses involving A and S. The pregnancy rate for crossbred matings was 8.2 percentage points below the average of the straightbred matings for percentage calves born/cows exposed. Negative heterosis for pregnancy rate was reported by Peacock et al. (1977) for crosses among A, Charolais and Brahman breeds of cattle; however, the magnitude was larger in the current study. The pregnancy rate for crossbred matings was 8.2 percentage points below the average of the straightbred matings for percentage calves born/cows exposed. Negative heterosis for pregnancy rate was reported by Peacock et al. (1977) for crosses among A, Charolais and Brahman breeds of cattle; however, the magnitude was larger in the current study. The straightbred A matings resulted in the highest pregnancy rate, although not significantly different from the S x A mating. Straightbred A matings also resulted in significantly earlier calving dates than the other mating types. Angus x S matings had the lowest pregnancy rate, although not significantly different from the straightbred S. Crossbred calves (A x S, S x A) were born an average of 2.1 d later than straightbred calves (A, S).

Straightbred S had the longest (288.6 d) and straightbred A the shortest (281.8 d) gestation length. The three crossbred mating types were not significantly different in gestation length and intermediate to the two straightbred types.

These data indicate a lowered fertility rate in S cattle, which was not overcome by crossbreeding with A. In the case of S females, the pregnancy rate was actually lower (not significant) for the crossbred matings than for the straightbred S. Peacock et al. (1977) reported similar results in Brahman females.

The lower reproductive rate of the S females may have been partially due to their later calving dates and subsequent cycling during the hotter and dryer part of the breeding season when the pastures may have been providing less adequate nutrition. The latter part of the breeding season may have had more effect on the activity of the A bulls than the S bulls, which may have caused some of the difference between the reciprocal crosses of the two breeds for reproductive rate. It is generally thought that the S breed is more heat tolerant than the A breed. The S bulls appear to have settled more S females toward the end of the breeding season than did the A bulls.

In light of the generally held premise that the heterotic effects on fetal viability are significant, it might be expected that the S x A would have a pregnancy rate greater than the straightbred A. Although not significant, the S x A matings were 8.3 percentage points lower than the straightbred A in reproductive rate. This, along with the A sire advantage in Julian birthdate over the S sires, may indicate a fertility problem in the S sires. Neville et al. (1984) reported that S sires had lower reproductive rates than A and Polled Hereford sires in a rotational crossbreeding study. There may have been a difference in quality of semen used for the two breeds of sires in the current study; however, this was not detected in an examination of the semen before the breeding season.

Calving Ease. No significant differences for calving ease were found for any of the effects included in the statistical model. This was not unexpected because most of the cows in the study were mature females and had at least one calf before the project was initiated. Gregory et al. (1978) found more calving difficulty in G x A crossbred than straightbred A. The straightbred A calves had a 10% advantage in calving ease over the G x A in that study.

Percentage Live 24 h After Birth. Main effects were found to be nonsignificant for percentage live 24 h after birth, except for breed of dam. Angus dams surpassed S dams by 4.5 percentage points for percent live. Straightbred S calves showed significantly less viability at birth than the other mating types; however, significant heterosis was not found for this trait.

Birth Weight. Angus bulls sired calves that were significantly smaller than S and G bulls (32.5, 35.5 and 36.2 kg, respectively). These results are in agreement with the literature (Long and Gregory, 1974; Brown et al., 1975; Spelbring et al., 1977). Straightbred A calves were significantly smaller than the other mating types at birth, which is consistent with the literature (Long and Gregory, 1974; Brown et al., 1975; Spelbring et al., 1977). Reynolds et al. (1980) reported that straightbred A birth weights were .5 kg greater than straightbred Brahman. In the same study, straightbred Brangus were 1.9 kg heavier than straightbred A, which is considerably less than the 7.1-kg difference found between straightbred S and A in the current study. Mean birth weights for straightbred A reported by Crockett et al. (1978) and Reynolds et al. (1980) were lighter than those found in the current study. The mean birth weight found for the straightbred A (30.1 kg)
in the current study is less than the 33.4 and 31.7 kg reported by Spelbring et al. (1977) and Gregory et al. (1978), respectively.

Differences in birth weight between the three crossbred mating types (A × S, S × A and G × A) were not significant. Heterosis for crosses involving only A and S was also not significant. Reports of heterosis for birth weight are variable in the literature. Bailey and Moore (1980) did not find significant heterosis for birth weight in crosses of Hereford and Red Poll cattle. Significant heterosis for birth weight involving crosses of A and Brahman breeds was reported by Crockett et al. (1978) and Reynolds et al. (1980) (15% and 15.4%, respectively). Long and Gregory (1974) found significant heterosis (3%) for birth weight in crosses of Hereford and A.

Age of dam did not significantly affect birth weight, but there was a significant difference due to sex of calf.

Percentage Survival to Weaning. Percentage survival to weaning was not significantly affected by any of the factors included in the model. The difference between A and S dams approached statistical significance. A nonsignificant advantage for the straightbreds over the crossbred was observed because of the lower survival rate of the A × S crossbreed. Peacock et al. (1977) found significant breed of dam effects for survival to weaning, with Brahman dams having an 8.5% advantage over A dams. Reynolds et al. (1980) reported differences in survival rate for A and Brahman straightbreds, (92.9 and 73.2, respectively) and significant heterosis (14.1%) for crosses of these two breeds.

Literature Cited


