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FACTORS AFFECTING PUBERTY ATTAINMENT IN PUREBRED AND CROSSBRED HEIFERS

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SUMMARY

This paper reports breed differences for puberty attainment in Angus and Hereford sired heifers from the first cohort of a larger trial. Pre-joining, there were no statistically significant differences between the breeds in age, weight, height, fat and net weight although crossbreed heifers were 17 kg heavier (5%), 0.2 mm fatter (5%), 15 mm taller (1%) with 8 kg more net weight than purebreds. A greater number of crossbred heifers had reached puberty prior to joining (21%; P=0.062). Age and fat depth were significant for attainment of puberty, but height and weight were not.

INTRODUCTION

The reproductive performance of female breeding stock is one of the largest economic drivers in Southern Australian beef production systems (Wathes *et al.* 2014). The aim was to utilise a crossbreeding system to optimise fertility traits, by utilising heterosis and breed effects. These mechanisms effectively increase performance traits and adaptability of genetic resources to the climate, environment and nutritional availability (Gregory and Cundiff 1980).

Genetic selection in temperate beef genotypes has primarily focused on the selection and improvement of feedlot production traits using BREEDPLAN estimated breeding values (EBVs) for, weight at endpoint, and more recently meat quality and yield (Hebart *et al.* 2016). Strong selection pressure on improving feedlot performance and carcass quality traits have been accompanied by a negative trend in fertility in some herds (Wathes *et al.* 2014).

Heifer conception rates are primarily determined by the age at which puberty is attained (Day 2015). The optimum age to reach puberty is by 13 months for joining at 15 months and calving at 24 months (Patterson *et al.* 1992). Age at puberty varies largely within and between breeds, and is dictated by the environment (Chenoweth 1994), plane of nutrition and the genetics of both sire and dam (Patterson *et al.* 1992). Body weight is the key determinate to attain puberty (Wathes *et al.* 2014), literature recommends *Bos taurus* breeds reach 60% of mature cow weight (MCW), 30-45 days prior to joining to ensure conception rates >85% (Ahmadzadeh *et al.* 2011). A recent study by Jones *et al.* (2016) reports that both fat and weight are important for a successful conception and heavier heifers can succeed with lower levels of fat.

The aim of this paper was to assess the factors that affect puberty attainment in a cohort of Angus and Hereford sired beef heifers from Angus dams. It was hypothesised that crossbred heifers will achieve a minimum proportion of mature cow weight earlier, and reach puberty at a younger age than the purebreds.

MATERIALS AND METHODS

Animals and heifer management. The 208 heifers for this study came from Angus dams joined to either 11 Hereford or four Angus sires using artificial insemination, resulting in 135 Hereford and 72 Angus sired heifers in the first cohort of the "Black Baldy" trial. The heifers were located at, Musselroe Bay in the north east of Tasmania. The Angus dams came from two management

groups that differed in age of dam (maiden-2 year old or mature-3 year old), insemination dates, paddock location and sire line.
Heifer calves were born late June to early August 2015. Calves were weaned from both management groups in March 2016 and joined as one cohort and grown out to joining together under the same management.

Ovarian assessment was performed to define portion pubertal, by transrectal real-time ultrasonography at three time points when heifers averaged 300, 387 and 448 days of age, heifers that had reached puberty were excluded from subsequent ovarian measurements. Scanning involved detection of a corpus luteum (CL) or formation of a corpus albican (CA) on either the left or right ovary, confirming that the animal had ovulated (Monteiro *et al.* 2013).

At each ovarian measurement all heifers were weighed on a scale placed under a crush, height was recorded by measuring the distance from the hip to the top of the crush, this number was subtracted from the height from the top to the base of the crush, P8 fat depth was obtained using ultrasonography.

Body condition score is related to body weight and fat coverage, both which can be used to assess reproductive performance (Jones *et al.* 2016). This trial did not record body condition thus generated a new trait to define heifer condition, where weight was regressed on height at each measurement and the residuals were interpreted as net weight. Heifers with a positive net weight were considered to have a better or greater condition than expected for a given height, and therefore were expected to reach puberty at an earlier age.

Statistical analysis. All data was analysed using GenStat 15th Edition Sp2 (VSN Int 2016) statistical programme. Two primary models were fitted:

1. To determine whether there was a significant difference between the breeds in the attainment of puberty and other traits (age, weight, height, P8 fat depth and net weight), a general (generalised for puberty) linear mixed model was fitted to the data. The fixed effects included management group and breed, the interaction between these effects were also tested. A random effect of sire nested within breed was also included.
2. To determine what traits were significantly influencing the attainment of puberty, a generalised linear mixed model was fitted to the data with the fixed covariates of age, weight, height and P8 fat depth. Age by weight, height and P8 fat interaction terms were also included but were not significant ($P>0.05$) and so were not included in the final model.

RESULTS AND DISCUSSION

There were no statistically significant differences between the breeds in age, weight, height, P8 fat and net weight (model 1), although crossbred heifers were 15 mm taller (1%), 0.2 mm fatter (5%), 17 kg heavier (5%) with 8 kg more net weight. An additional 21% of crossbreed heifers had reached puberty at the final scan, prior to joining, this included heifers that were pubertal at scan point one and two (Table 1, Figure 1). Management group effects were large for all traits (not presented).

Table 1. Predicted means and standard errors (S.E.) for sire breed pubertal by scan three (pre-joining)

Heifer trait (units)	Angus	S.E.	Hereford	S.E.	P-value
Age (days)	449	3	448	2	0.540
Weight (kg)	329	7	346	4	0.075†
Height (mm)	1197	7	1212	4	0.066†
P8 fat (mm)	3.7	0.2	3.9	0.1	0.594
Net weight (kg)	-8	4	0	3	0.410
Pubertal (%)	35	7	56	4	0.062†

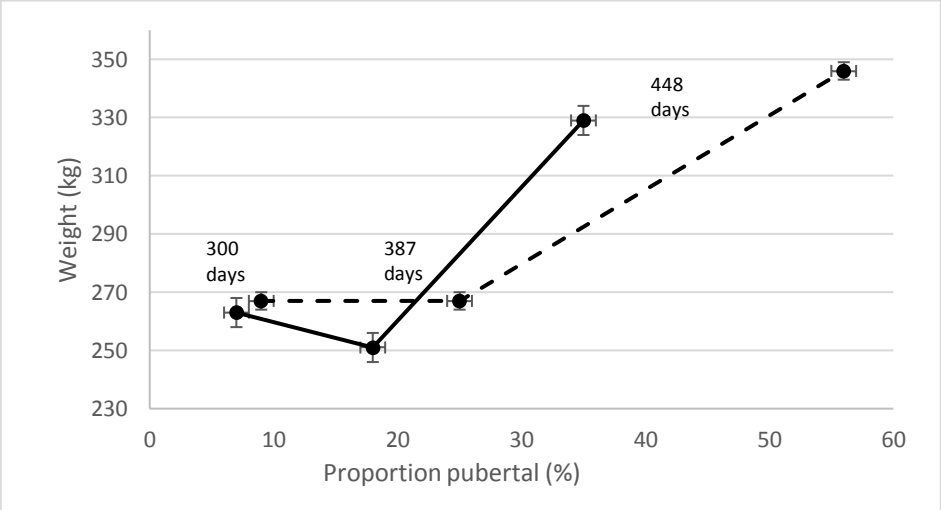

Figure 1. Breed differences in mean body weight and proportion pubertal (Model 1) at scans one, two and three (300, 387 and 448 days of age respectively). Angus heifers are represented by the solid line and Hereford cross Angus by the broken line.

Previous studies have suggested that getting heifers to a minimum proportion of MCW 30-45 days prior to joining, will increase first season conception rates (Patterson *et al*. 1992), through younger attainment of puberty. A complementarity advantage acquired through crossbreeding is heterosis, the additive genetic merit and growth inherited by the progeny from the terminal sire, which effects the age of puberty in offspring (Gregory and Cundiff, 1980). Wiltbank *et al.* (1969) demonstrated this in Angus and Hereford reciprical crosses reporting the Angus x Hereford and Hereford x Angus reached puberty earlier (29 and 55 days respectivley) than their purebred counter parts. Breed was almost significant in this trial for weight (P=0.075), this non-significant result may be due to the loss in body weight in both the Angus and Hereford x Angus between scan one and two when harsh environmental conditions were encountered. Average daily growth (ADG) was not recorded in this trial although at each measurement crossbred heifers were heavier with higher portions of cycling individuals. This concurs with recent literature reporting that ADG before 15 months can stimulate growth paths leading to early onset of puberty (Wathes *et al.*

2014). Gasser *et al.* (2006) demonstrated this, showing heifers with high ADG (1.2 kg/day) reached puberty by 271 days, compared to heifers with low ADG (0.7 kg/day) that reached puberty at 331 days weighing 282 kg and 367 kg respectively. The results from the current trial suggest that crossbreed heifers were able to cope with harsher environmental conditions, maintaining weight and condition more efficiently than their purebred counterpart, resulting in higher portions of heifers reaching puberty by the final ovarian scan prior to joining.

Age and fat depth were associated with attainment of puberty (Table 2), but weight and height were not. Two-way interactions between variables were tested and were not significant and were not retained in the final model. Acquiring a critical fat depth was more important for heifers to attain puberty than age alone. Age at puberty is strongly correlated to first season conception rates, Byerley *et al.* (1987) demonstrated the importance of age reporting that heifers that attain puberty earlier in life, and that had cycled multiple times prior to mating, had pregnancy rates of 78% in comparison to 57% in heifers that had reached puberty but where only in first oestrus at joining. A recent study by Jones *et al.* (2016) concluded that both fat and muscle were important for heifer conception. To achieve 85% conception rates under a six week joining period, Jones *et* al. (2016) predicted that Angus heifers needed to be 52% of MCW with 8 mm of rib fat or 69% of MCW with 4 mm of fat.

Table 2. Type 3 tests of significance (P-value) for traits affecting puberty at scan three

	Age	**Weight**	**Height**	**P8 fat**
Pubertal (%)	0.021*	0.428	0.457	0.015*

CONCLUSION

In conclusion, age and fat depth were important for attainment of puberty. Interestingly despite an almost significant difference in portion pubertal between breeds prior to joining there was no difference in net weight or fat depths. Although not significant crossbred heifers were heavier, taller and fatter with a higher portion pubertal at joining, this may increase first season conception rates. Lastly, the proportion of pubertal heifers at different weight and ages presented should guide future studies investigating attainment of puberty in southern Australian heifers.

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