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THE EFFECT OF TREE SHADE AND BREED ON HEAT STRESS INDICATORS IN DORMER AND SOUTH AFRICAN MEAT MERINO EWES AND LAMBS

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SUMMARY

The provision of natural tree shade on the respiration rate (RR) and rectal temperature (RT) of ewes and lambs was studied during the perinatal period. Pregnant Dormer and South African Meat Merino (SAMM) ewes were randomly allocated to 18 paddocks, 9 with access to tree shade (SH) and 9 without access to shade (NS) prior to lambing in March-April 2023. The RR and RT were recorded in the afternoon from pregnant ewes randomly selected from the SH and NS paddocks on three occasions with an expected high ambient temperature. Newborn lambs were recorded for RR and RT at noon within 24 hours of birth. Micro-climate data were obtained from loggers in the paddocks. Minimum temperature for SH paddocks was higher than in the NS paddocks, the opposite being true for maxima. Ewes and lambs in SH paddocks had a lower RR and RT compared to the animals in NS paddocks, the impact accentuated at a higher THI in lambs. Dormer ewes breathed faster than their SAMM contemporaries, but this breed effect was reversed in lambs (both $P < 0.05$). Ewe traits were repeatable, with values of 0.32 for RT and 0.16 for RR. Albeit in a small study, with heat stress not observed on some days, it seems that tree shade may improve animal welfare by reducing detrimental impacts of high THI on hot days during autumn lambing. Selective breeding for heat tolerance may also be contemplated in the current flock, if supported by further research.

INTRODUCTION

There is accordance among scientists that the global climate will become more unstable in future (Blignaut *et al*. 2009), including more frequent and severe droughts and an increase in global temperatures. Heat stress can impact on ovine production and reproduction (Van Wettere *et al*. 2021) particularly compromising more vulnerable groups, such as neonatal lambs (Cloete *et al*. 2021).

Against this background we studied the provision of tree shade to two typical South African (SA) sheep breeds, the SA Meat Merino (SAMM) and the Dormer during an autumn lambing season. We hypothesised that access to tree shade would mitigate the impact of heat as suggested by the literature (De *et al*. 2020; Pent *et al*. 2021). Since both breeds originate from ovine germplasm from temperate regions, we did not expect marked differences between breeds for their reaction to heat. We could also derive repeatability estimates for heat stress indicator traits in ewes.

MATERIALS AND METHODS

Experimental site and animals. The study took place under Mediterranean conditions on the Elsenburg Research Farm near Stellenbosch, in the Western Cape of SA, and used the foundation flocks of both breeds (Dormer: Muller *et al*. 2020; SAMM: Muller *et al*. 2023). The Dormer is the primary terminal sire breed in SA and the SAMM is the main dual-purpose breed (meat and wool). The breeds were maintained in the same flock, except when mated in single-sire groups during spring 2022 to lamb in autumn 2023. The site receives 625 mm of rain p.a., 78% expected from April to September, and is characterised by cool and wet winters (minima around 5˚C) and hot, dry summers (maxima around 30˚C). Grazing consisted of irrigated kikuyu, irrigated and dryland lucerne, and dryland oat fodder crops.

Recordings. Microclimate data for relative humidity and ambient temperature were obtained from Tinytag® data loggers placed in the paddocks, while a nearby official weather station supplied macroclimatic data. Weather station data were used to calculate the daily temperature-humidity index (THI) throughout the lambing period. Recently shorn pregnant ewes of both breeds (166 in total) were randomly allocated within breed to 9 irrigated kikuyu lambing paddocks with access to tree shade (SH) or 9 paddocks without shade (NS), 14 days before lambing in March. Five or 6 Dormer and 3 or 4 SAMM ewes were allocated to each paddock. For a subsample of ewes, the respiration rate (RR, by counting side movements for 30s) and rectal temperature (RT, using a clinical thermometer) were recorded at noon 3 times on days when the maximum temperature was expected to be >30 ˚C. Upon lambing, birth weights (BW) of 216 lambs were recorded within 24 h of birth (Muller *et al*. 2020; 2023), and RR and RT were recorded simultaneously during routine lambing rounds from around 12:00. At tail-docking, on an average (SD) age of 11.4 (2.6) days, a sample of neck wool was clipped from individual ewes and analysed for cortisol concentration (CC), as an indicator of heat stress (Nejad *et al.* 2014).

Statistical analysis. Ewe RR and RT were subjected to linear mixed model analyses involving the fixed effects of breed (Dormer vs. SAMM), shade treatment (SH vs. NS) and ewe age (2 to 6 years). There was no attempt to model ambient climate, as recording was reserved for hot days. The random effect of animal was added to the model to account for the repeated sampling of ewes. A fixed model involving the same fixed effects was employed for CC. Likewise, a fixed, linear model was used to analyse lamb data, fitting the effects of breed, shade treatment, sex (ram or ewe), age of dam (2 to 6 years) and birth type (single or multiple). Lamb data were recorded under a variety of climate conditions, allowing fixed linear and random spline effects of the weather station THI to be fitted and interacted with shade treatment. All analyses proceeded in ASReml V4.2 (Gilmour *et al.* 2021). The random between-ewe variance was used to estimate repeatability of RT and RR in ewes.

RESULTS AND DISCUSSION

Micro-climate. The maximum temperature and the THI at the maximum temperature were greater in NS paddocks than in SH paddocks (P<0.01; Table 1). This trend was reversed for minimum temperatures (P<0.01). Previous studies also reported that trees moderated the micro-climate of the surrounding area, being cooler during the day and warmer at night (Cloete *et al*. 2021).

Table 1. Two-sample t-test results for micro-climate data obtained from Tinytag® data loggers in shade (SH) and no-shade (NS) paddocks for the period around lambing

Climate variable	SH	NS	T-value
Maximum ambient temperature (˚C)	21.9	23.6	-13.4*
THI at Maximum ambient temperature	20.7	21.9	-13.7*
Minimum ambient temperature (˚C)	13.3	12.9	3.3*
THI at Minimum ambient temperature	13.3	12.9	3.7*

* Significant (P<0.01); THI – Temperature-humidity index

Birth weight and heat stress indicators in neonatal lambs. Dormer lambs were 11% heavier at birth than their SAMM contemporaries (P<0.01), but BW was unaffected by shade treatment (P>0.05; Table 1). Cloete (1993) similarly reported a heavier BW for SAMM lambs than Dormers, although the same result was not observed in a more recent study (Cloete *et al*. 2021). Cloete (1993) related the smaller size of Dormer lambs to its role as a terminal sire breed on smaller Merino ewes. Sex, birth type and dam age effects on BW were as reported Muller *et al*. (2020; 2023). Lambs in NS paddocks had a higher RT (P<0.05) and a 19.1% higher RR (P<0.01) than those in SH paddocks. These results are consistent with literature pertaining to tree shade (Cloete *et al*. 2021; Pent *et al*.

2021; Dos Santos *et al*. 2021). The RT of Dormer lambs were slightly higher than those of SAMM lambs (P<0.05), but the RR of SAMM lambs was 11.9% higher than that of Dormer lambs. Birth type was the only other fixed effect to affect an indicator trait, with RR being 9.9% faster in singles than in multiples (respective geometric means 107.2 vs. 97.5 breaths/min).

Table 2. Least-squares means (±SE) depicting the effects of shade treatment (shade vs no-shade) and breed (Dormer vs SA Meat Merino) on birth weight and the heat stress indicators (rectal temperature and log-transformed respiration rate (geometric mean)) of lambs

Effect and level	Birth weight (kg)	Rectal temperature (˚C)	Respiration rate/min
Shade treatment	0.08	*	**
Shade	5.10±0.08	39.3±0.1	4.54±0.04 (93.7)
No-shade	5.25±0.10	39.5±0.1	4.72±0.05 (111.6)
Breed	**	*	*
Dormer	4.90±0.09	39.5±0.1	4.57±0.05 (96.6)
SA Meat Merino	5.45±0.09	39.3±0.1	4.68±0.05 (108.1)

* Significant (P<0.05); ** Significant (P<0.01)

Both RT and RR were affected by the interaction of shade treatment with linear and spline components of the THI (P<0.01; Figure 1). Both traits were independent of the shade treatment at THI <21. Treatment differences were accentuated as THI increased, to the extent that the RR of NS lambs exceeded that of SH lambs by a factor of 1.8 (respective geometric means of 238.2 vs. 132.9; P<0.01). These results conform to previous studies, indicating that the benefit of tree shade becomes appreciably smaller when heat stress is low, such as on cooler days (Cloete *et al*. 2021), during cooler seasons (Pent *et al*. 2021) or cooler times of the day (Dos Santos *et al*. 2021).

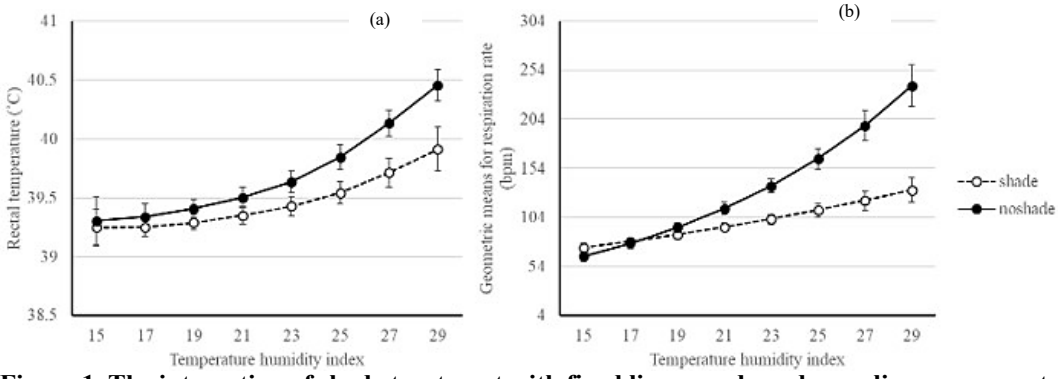

Figure 1. The interaction of shade treatment with fixed linear and random spline components of the temperature humidity index for rectal temperature (a) and respiration rate (b) of newborn lambs. Each mean is accompanied by the appropriate standard error

Heat stress indicators and wool cortisol concentrations in ewes. The RT of ewes in NS paddocks was 1.3% higher (P<0.01) than in SH paddocks (Table 3). Likewise, the RR of ewes in NS paddocks exceeded that for SH paddocks by 72.8% (P<0.01). These results are consistent with those of other studies reporting the impact of tree shade in mature sheep under hot conditions (De *et al*. 2020; Pent *et al*. 2021; Dos Santos *et al*. 2021). The RT was independent of breed (P>0.10), but Dormer ewes had a 12.8% higher RR (P < 0.05). It is possible that Dormer ewes relied more on RR to maintain core temperature than their SAMM contemporaries. The backfat thickness of Dormers

exceeds the mean for SAMMs by 35% at hogget slaughter (Cloete *et al*. 2004), which could help to partly explain the breed differences. Wool CC was independent of breed but trended higher in ewes grazing NS paddocks (P=0.06). Both RT and RR were repeatable in ewes, at respectively 0.32±0.08 and 0.16±0.08. Previous short-term studies also suggested that RT was repeatable, but that RR was also affected by reranking of animals between cool and hot conditions (Steyn 2022).

Table 3. Least-squares means (±SE) depicting the effects of shade treatment (shade vs no-shade) and breed (Dormer vs SA Meat Merino) on birth weight and the heat stress indicators (rectal temperature and log-transformed respiration rate (geometric mean)) in ewes

Effect and level	Rectal temperature (˚C)	Respiration rate/min	Cortisol (pg/mg)
Shade treatment	**	**	0.06
Shade	39.1±0.1	4.54±0.04 (118.3)	2.80±0.02
No-shade	39.6±0.1	4.72±0.05 (204.2)	3.23±0.02
Breed	0.19	*	0.13
Dormer	39.4±0.1	4.57±0.05 (167.6)	2.85±0.01
SA Meat Merino	39.3±0.1	4.68±0.05 (149.3)	3.18±0.02

* Significant (P<0.05); ** Significant (P<0.01)

CONCLUSION

Tree shade ameliorated the effects of heat stress in both pregnant ewes and neonatal lambs by markedly reducing RR on hot days. Access to tree shade during autumn lambing is expected to contribute to sheep welfare under the Mediterranean conditions. Many sheep farming areas in SA have hotter summers than the Western Cape, warranting further studies in more challenging environments. RR varied between breeds, possibly in association with the smaller size of Dormer lambs and an increased fatness of Dormer ewes. Derived within-season repeatability estimates should be followed up with longer-term across-season studies, while data should be accumulated to allow preliminary heritability estimates for heat stress indicator traits.

REFERENCES

Blignaut J., Ueckermann L. and Aronson, J. (2009) *S. Afr. J. Sci.* **105**: 61.
Cloete J.J.E., Hoffman L.C., Cloete S.W.P. and Fourie, J.E. (2004) *S. Afr. J. Anim. Sci.* **34**: 44.
Cloete S.W.P. (1993) *S. Afr. J. Anim. Sci.* **23**: 38.
Cloete S.W.P., Muller A., Steyn S., Van der Merwe D.A., Nel C.L., Cloete S., Kruger A.C.M. and Brand, T.S. (2021) *J. Thermal Biol.* **99**: 103024.
De K., Sharma S., Kumawat P.K., Kumar D., Mohapatra A. and Sahoo A. (2020) *J. Vet. Behav.* **40**: 103.
Gilmour A.R., Gogel B.J., Cullis B.R., Welham S.J. and Thompson A.N. (2021) ASReml User Guide Release 4.2 Functional Specification. VSN International Ltd, Hemel Hempsted, UK.
Muller A., Brand T.S., Scholtz A.J., Kruger A.C.M. and Cloete, S.W.P. (2020) *Small Rumin. Res.* **191**: 106181.
Muller A., Brand T.S., Scholtz A.J. and Cloete, S.W.P. (2023) *Small Rumin. Res.* **228**: 107091.
Nejad J.G., Lohakare J.D., Son J.K., Kwon E.G., West J.W. and Sung K.I. (2014) *Animal* **8**: 1.
Pent G.J., Fike J.H. and Kim I. (2021) *Agrofor. Syst.* **95**: 21.
Santos M.L.P.D., Dada J.M.V., Muniz P.C., Nunes-Zotti M.L.A., Barros F.R.A.D. and Vieira F.M.C. (2021) *Small Rumin. Res.* **228**: 107091.
Steyn S. (2022) MSc (Agric) Thesis, University of Stellenbosch.
Van Wettere W.H.E.J., Kind K.L., Gatford K.L., Swinbourne A.M., Leu S.T., Hayman P.T., Kelly J.M., Weaver A.C., Kleemann D.O. and Walker S.K. (2021) *J. Anim. Sci. Biotechnol.* **12**: 1.