Fodder Shrubs – an option for improving conception rates and welfare in ewes

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Abstract
Producers use a range of perennial fodder shrub species to remediate degraded and/or non-arable areas of farms in the wheatbelt of Western Australia. Fodder shrubs have been either been left ungrazed or traditionally used to fill the autumn feed gap for sheep in Western Australia. This trial aimed to evaluate the potential of fodder shrubs to reduce the potential effects of heat stress in breeding ewes and potentially reduce the negative impact of high temperatures on conception rates for summer joining flocks.

Two sites were used, a 25 year old saltbush planting and a 5 year old mixed native shrub planting. At each site, 4 temperature loggers were placed in shrubs at heights from 0.5 to 1.5 m above the ground with a control logger located on the adjacent fence. Maximum and minimum temperatures were recorded hourly across summer, autumn and winter. There was a significant difference ($p<0.001$) in maximum daily temperature between loggers at both sites with daily maximum temperatures reduced when compared to the control. Maximum temperature reduced by up to 1.5ºC in the saltbush and by up to 3ºC in the mixed species site within seasons.

Fodder shrubs have the potential to reduce heat stress on mating ewes by reducing ambient temperature during summer joining. Mixed plantings that include shrubs that have varied mature heights provide more shade than saltbush sites. Decreasing ambient temperature may result in increased ovulation rates, increased conception and lambing rates and improved lamb survival.

Keywords
Heat stress, ambient temperature.

Introduction
Reduced crop productivity/profitability, increasing risk of salinity and/or waterlogging and the challenge of climate change across the wheatbelt have led producers to reassess management options for both crop and livestock production. Producers are seeking options that have the potential to mitigate soil health issues, potentially return the land to cropping and/or provide feed for livestock particularly in autumn. The annual production cycle for both crops and pastures begins following rains at the end of a hot, dry summer (autumn break). Summer crop stubbles are no longer available and annual naturalised pastures have died – feed quality is poor and quantity is limited over summer and early autumn.

In the wheatbelt region, ewes are joined over summer between late December and early February. Sheep graze areas of harvested crop through this period in paddocks generally with few trees to provide shelter at a time when daily maximum temperatures regularly exceed 35ºC and feed quality is low; ewes grazing these areas may become heat stressed leading to reduced feed intake and loss of condition score, reduced ovulation rate and high embryo mortality (Thwaites 1971; Kleemann and Walker 2005) low lamb birthweight and decreased lamb survival (Hinch and Brien 2014). Behrendt et al.(2006) has shown that conception rate, lamb birthweight and lamb survival are highly correlated with ewe condition score. Areas planted with fodders shrubs such as saltbush (*Attriplex spp*) are able to provide some shade and some feed for ewes, potentially ensuring that target ewe condition scores are achieved and/or maintained.

Observations of sheep grazing saltbush plantings in the wheatbelt showed that sheep sought shelter from these shrubs even when ambient temperatures are around 25ºC. As part of a NRM supported on-farm trial at Jennacubbine (WA wheatbelt) the potential of fodder shrubs to reduce ambient temperature for grazing sheep was investigated. Two types of shrub plantings were evaluated, saltbush and mixed native shrubs, to determine whether fodder shrub plantings had an effect on ambient temperature.

Methods

Trial sites were located at Jennacubbine in the wheatbelt of WA (31°25'20.8"S, 116°47'34.1" E). Site 1 had been planted, in rows, with 2 saltbush species *Atriplex nummularia* (Old Man Saltbush – high growth habit) and *Atriplex amnicola* (River saltbush – low growth habit) approximately 25 years ago. Site 2 was planted approximately 5 years ago with a range of native shrubs including *Acacia* spp, and *Rhagodia* spp. - plant species with different mature heights and canopy structure. Each trial site measured 30 m x 30 m with inter-row spaces of 8-10 m. Five (5) temperature loggers (Tiny Tags - Gemini Data Loggers UK Ltd) were set up at each site. One logger (control) was located on a fence at each site, open to the elements and without any shade. Four (4) additional loggers were set up in shrubs at each site. The loggers were placed in the shrubs at heights ranging from 0.5 to 1.5 m above ground level. Maximum and minimum temperatures were recorded hourly on each logger. Data representing the period summer (2015) to end of winter (2016) are presented in this paper.

Data was downloaded from the loggers regularly throughout the period. Daily maximum and minimum temperatures were collated for each logger for the period from 8th December 2015 to 31st August 2016. Analysis of variance for logger data from each site was performed using Genstat (VSN International Ltd) for and compared maximum and minimum temperatures against the control (open air logger) within each site.

Results

Temperature range over 3 seasons

Data was analysed within each site (Tables 1, 2 and 3). Due to different physical locations, soil types and shrub species comparisons between the sites were not made.

Table 1. Maximum and minimum temperature (°C) ranges for control logger for sites 1 and 2 over summer, autumn and winter.

Site	Summer °C	#days >32°C	Autumn °C	#days >32°C	Winter °C
Maximum					
1	25.2 to 48.4	67	16.1 to 41.5	16	11.9 to 26.0
2	22.9 to 47.2	72	16.9 to 40.4	23	14.0 to 27.2
Minimum					
1	8.2 to 23.2		1.1 to 21.4		-3.0 to 11.3
2	7.9 to 23.0		1.1 to 21.0		-2.9 to 11.9

Table 2. Mean maximum temperature (°C) (standard error of mean) of temperature loggers at Site 1 (saltbush).

Tag #	1	2	3	4	5
Summer	36.90 (0.563)	36.57 (0.552)	36.33 (0.554)	36.90 (0.575)	35.33 (0.545)
Autumn	26.55 (0.652)	26.09 (0.680)	25.62 (0.659)	27.34 (0.635)	25.39 (0.629)
Winter	17.88 (0.259)	17.27 (0.239)	16.74 (0.240)	19.26 (0.279)	16.91 (0.239)
Grand mean	26.82^{bc}	26.35^{ab}	25.93^{ab}	27.56^{c}	25.59^{a}

abc – means within a row with the same letter are not significantly different (Tukey's test $p < 0.05$)

Table 3. Mean maximum temperature (°C) (standard error of mean) of temperature loggers at Site 2 (mixed native shrubs.)

Tag #	6	7	8	9	10
Summer	35.78 (0.498)	33.29 (0.492)	33.69(0.500)	33.48 (0.492)	34.62 (0.514)
Autumn	25.36 (0.508)	21.98 (0.488)	21.99 (0.491)	22.24 (0.491)	21.99 (0.502)
Winter	19.68 (0.270)	16.25 (0.233)	16.31 (0.235)	16.50 (0.232)	16.85 (0.245)
Grand mean	27.88^{b}	24.86^{a}	25.06^{a}	25.09^{a}	25.83^{a}

ab – means within a row with the same letter are not significantly different (Tukey's test $p < 0.05$)

There was a significant difference ($p < 0.001$) for maximum temperature between loggers and between seasons within site 1 (Table 2). There was no significant difference for minimum temperature between loggers over this period but there was a significant difference ($p < 0.001$) between seasons for minimum temperature.

There was a significant difference ($p < 0.001$) for maximum temperature between loggers and between seasons within site 2 (Table 3). There was no significant difference for minimum temperature between loggers; there was a significant difference ($p < 0.001$) between seasons for minimum temperature.

Discussion

In the wheatbelt of Western Australia large areas of land have been planted with saltbush species to mitigate and reduce the effects of encroaching salinity. Managing these areas and having strategies to optimise productivity have become an issue for many producers as information on fitting these areas into the farm system is limited. Areas of saltbush are either not grazed or may be reserved as a resource to fill the 'autumn feed gap', allowing producers to concentrate on sowing crops after the autumn break. There is limited information on fitting mixed native shrub plantings into the farm system.

Shrubs are used widely to provide sheep with shelter from adverse winter conditions and reduce lamb mortality during lambing (Taylor et al. 2011) in areas where winter conditions can result in high lamb mortality. A number of studies have identified heat stress as possible cause of reduced conception rates in sheep. The number of days that ambient temperatures were $\geq$ 32ºC at joining have been positively correlated with return to service and negatively correlated with ovulation rate, fertility and embryo survival Australian sheep flocks (Kleemann and Walker 2005; Thwaites 1971). Data from these studies have indicated that the majority of losses occur as embryo deaths within 24 hours of conception. Results from studies in Victoria have shown that 10-16% more lambs are present at marking when shelter was available during joining (Austin 2009). Summer temperatures in the wheatbelt of Western Australia exceeded 32ºC over 80% of summer days (December 2015 to February 2016) and more than 20% of days during autumn (March 2016 to May 2016) (Table 1).

This study was aimed at identifying opportunities for fodder shrubs to improve sheep productivity outside the traditional autumn feed gap. Summer joining in the wheatbelt of Western Australia is characterised by high temperatures and limited feed availability and low feed quality. Although stubbles can increase ewe condition score following harvest due to presence of fallen grain, decreasing feed availability and quality over the main joining period in late summer could reduce conception rates and potentially lead to low lamb birthweight and decreased lamb survival since joining paddocks tend to be exposed and have minimum shade available for ewes and rams.

This study used temperature loggers placed in shrubs at varying heights in a well-established saltbush site (25 years old) and a new (5 years) mixed native shrub site to assess the potential for fodder shrubs to improve conception rates and animal welfare during hot summer periods. Saltbush shrubs develop woody and open growth habits when left ungrazed. Shrubs at site 1 had limited foliage at lower levels over summer and limited shelter available at sheep height as shrubs had become woody and open and had limited leaf canopy. Maximum temperatures recorded by all loggers located in saltbush were not significantly different from the control (reference) logger located on the fence although the maximum temperatures recorded by a logger less exposed and located deeper in saltbush (#5) were significantly lower than the control logger across the seasons (Table 2). Height management of saltbush plantings through grazing and trimming may increase the density of foliage; that in turn may improve the ability of these sites to reduce heat stress in ewes at joining.

Site 2 contained native shrubs including species such as *Acacia* spp, *Rhagodia* spp and *Maireana* spp. These species have a range of growth habits from low, bushy shrubs to tall, branching shade trees. The site is young and has not yet reached maturity. However, even as an immature planting, the species combination significantly reduced maximum ambient temperature in all seasons (Table 3) with the control logger having significantly higher maximum temperatures than the loggers located in the shrubs. In the mixed species site the loggers were located in *Acacia* spp at 1.5 to 2 m above the ground. As the foliage in these species becomes denser with maturity of the shrubs, the shading effect is likely to increase and the temperature differential become greater. Although temperatures were not monitored under the more dense foliage of lower growing species, it is likely that the temperature differences may be greater than those currently recorded.

Reducing ambient temperature through the provision of shade for the summer joining period has the potential to improve conception rates in ewes through improved ovulation rates and reduced embryonic mortality.

Conclusion

Fodder shrubs have the potential to have a greater role in ewe management than just the provision of feed during autumn. This study indicates that fodder shrubs could be used to reduce the potential impact of high summer temperatures on conception rates and lambing performance of ewes in the wheatbelt of Western Australia. Using fodder shrubs to reduce the impact of heat stress under high ambient temperatures will in turn improve the welfare of the flock through the provision of shade, particularly in the mixed species plantings.

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