CATTLE RESPIRATION RATES IN MODERATE AND HOT CYCLIC CONDITIONS

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Respiration rate (RR) has long served as a gross indicator of heat load in animals during hot weather, increasing when animals need to maintain homeothermy by dissipating excessive heat as more benign avenues for heat loss become inadequate. Ambient temperature (t_a) is of primary interest as it has a much greater influence on RR than humidity. The object of this study was to refine existing functional relationships between RR and t_a and apply this information to the tactical management of cattle in hot weather.

A 120 day study was undertaken at the MARC Environmental Laboratory at Clay Center, NE, using eight *Bos taurus* (Hereford x Angus x Simmental) steers growing from approximately 375 to 475 kg liveweight. The steers were housed in individual stalls in two environmentally controlled rooms (four stalls/room) and exposed to repeated cycles of thermoneutral (TNC; 18 ± 7°C) for 12 days followed by nine day exposure to hot conditions (HOT; 32 ± 7°C). Values for temperature humidity index, as described by Hahn *et al.* (1998), ranged from 52.5 to 70 for the TNC and 72.5 to 85 for HOT conditions. The cattle were fed a high concentrate diet *ad lib*. Exercise was provided weekly using a treadmill, at least 24 hours before RR observations. RR (obtained by observing each animals flank movement) were observed hourly on eight occasions for 24 hour periods (n=1536). The observations were made during the last few days of exposure to TNC (four periods) and HOT (three periods) and on one occasion on the second and third day of exposure to HOT. These observations provided the data for evaluating (i) a threshold for increased RR as a function of t_a (ii) the rate of change in RR below and above the threshold t_a, and (iii) time lags between the change t_a and the resultant RR. The data were analysed using SAS (1993).

Using data from all steers during exposure to TNC and HOT, the relationship between RR and t_a was determined (Table 1). Further analysis indicated that the temperature threshold was 21.3°C, although for individuals the threshold varied from 17 to 23°C; the rate of increase in RR below 21.3°C was 1.2 breaths/°C, but it was about 4.1 breaths/°C at temperatures above the threshold. During HOT the highest correlation coefficients were for RR lagging t_a by two hours.

Table 1. Functional relationships of respiration rate (RR) to ambient temperature (t_a) for growing *Bos taurus* steers (375 to 475 kg) in a shaded environment

Relationship	t_a range °C	r^2	Threshold [A] °C
$RR = 31.6 + 0.28t_a + 0.061t_a^2$	11<ta>39	0.72	21.3 [B]
Linear approximations:			
No Lag – RR at a specific t_a			
$RR = 32.2 + 1.23t_a$	< 21.3	0.08	-
$RR = -25.4 + 4.07t_a$	≥ 21.3	0.54	-
Two hour lag – RR two hours after a specific t_a			
$RR = 31.0 + 1.22t_a$	< 21.3	0.10	-
$RR = -32.0 + 4.32t_a$	≥ 21.3	0.64	-

[A] Ambient temperature above which RR increases markedly with increasing t_a. [B] based on the first derivative of the quadratic function

RR is easily observed in the field and may be used as the primary indicator of thermal stress. The observations suggest that healthy cattle with RR ≤ 60 breaths/minute (bpm) are not thermally stressed, while cattle with RR ≥ 120 bpm may reflect excessive heat loads and this rate should be used as a threshold for closer monitoring. As RR reaches 160 bpm or higher, consideration should be given to emergency actions for reducing excessive heat load (eg wetting the animals).

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SAS. (1993). SAS/ETS Users Guide, Version 6, Second Edition (SAS Institute Inc: Cary, NC).