HEAT STRESS AND WOOL GROWTH IN SHEEP

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Summary

The wool production of mature Merino ewes subjected to a standard heat stress continuously for 14 days (Experiment A), continuously for 7 days (Experiment B), and for 7 h/day for 7 days (Experiment C), has been compared with that of untreated controls.

In the four weeks following experimental treatment A, the clean scoured wool production of treated ewes was only 77.5% of that observed during the four-week pre-treatment period. The corresponding value for treatment B was 90.2%. Treatment C did not significantly depress clean scoured wool production.

Feed intakes during hot-room exposures **A** and B were significantly depressed. Simulating the feed intake observed during hot-room exposure A under normal temperature conditions indicated that the depression in clean scoured wool production induced by treatment A could be wholly accounted for by the concomitant depression in feed intake.

It is concluded that prolonged exposure to high temperatures and solar radiation under field conditions may result in depressed wool growth rates, but that short term exposures, such as might occur during 'heat waves' in more temperate regions, are unlikely to have such an effect.

I. INTRODUCTION

Many of Australia's Merino sheep graze in areas which experience prolonged periods of high ambient temperature. Others, in more temperate regions, are subject to frequent summer 'heat waves'. Although ambient temperature has been implicated in the control of non-nutritional seasonal changes in wool growth (Ferguson, Hardy and Carter 1949; Wodzicka 1960), the effects of high temperature on wool growth have not, to the author's knowledge, been examined in detail.

This paper reports the results of three experiments in which the effects of various degrees of heat stress on the wool growth of mature Merino ewes were examined, and of one designed to evaluate the role of depressed appetite in the observed response. The results of a preliminary experiment have been reported elsewhere (Thwaites 1967).

II. MATERIAL AND METHODS

(a) Experimental design

The four experiments were all of the same basic design; an experimental period (Table 1) preceded by a four-week pre-experimental period and followed by a six-week post-experimental period. During each experiment, control ewes were maintained indoors at prevailing ambient temperatures. Treated ewes were similarly housed except for the hot-room exposures imposed during the experimental periods of Experiments A, B and C.

(b) Animals

Six-year-old medium-wool Merino ewes were used in all experiments. All ewes were used in two experiments, but in all cases at least 12 weeks separated successive treatment periods.

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TABLE 1

Experimental treatments

Experiment	No. of ewes per group	Control temperature range (°C)	Experimental period (days)	Treatment
A	4	12.5-25.5	14	Continuous hot-room exposure
B	4	7.0-19.5	7	Continuous hot-room exposure
C	6	5.0-24.0	7	7 hours hot-room exposure per day
D	6	11.0-21.0	14	Simulated hot-room feed intake

(c) Management

(i) General

Under control conditions both control and treated groups in each experiment were housed separately in indoor pens with adequate natural ventilation and lighting. All ewes were weighed prior to daily feeding, at weekly intervals during each experiment.

(ii) Feeding

Beginning one month prior to Experiment A, and continuing throughout the experimental period, the ewes were communally fed, in groups, a ration of 680 g lucerne chaff and 410 g concentrates per head at 1700 h daily. After an initial equilibration period, this feeding regime maintained group mean liveweights, corrected for estimated wool growth, virtually constant. The liveweights of individual ewes ranged from 39 to 57 kg. Drinking water at ambient temperature, was available at all times.

(d) Treatments

(i) Hot-room

In the hot-room, ewes were housed in a 2.1 x 6.1 m pen on a raised, slatted floor. The room's automatic control mechanism was such that temperature and humidity fluctuated regularly with a cycle length of 15 min. Temperature fluctuated over a range of 1.7°C and relative humidity (R.H.) over a range of 4%.

Ewes in Experiments A and B were subjected to continuous hot-room exposure under conditions which averaged 39.9°C and 47% R.H. In an attempt to simulate the diurnal rhythm of heat stress encountered under field conditions, ewes in Experiment C were exposed to hot-room conditions of 41.3 °C and 46% R.H. for 7 h/day for 7 days.

(ii) Simulated hot-room feed intake

Ewes in Experiment D were maintained under control temperature conditions. During the two-week experimental period the feed intake of treated ewes was regulated daily so as to simulate the depressed feed intake exhibited by treated ewes during hot-room exposure in Experiment A.

(e) Heat stress indices

As an indication of the degree of stress imposed on treated ewes by the various hot-room exposures, rectal temperatures (clinical thermometer inserted 10 cm for 1 min) and respiratory rates (mean of two 30 sec flank-movement counts) were recorded at intervals during each experimental period.

(f) Wool growth indices

(i) Clean scoured wool production

Tattooed patches on the right midside of all ewes were clipped at weekly intervals during each experiment. The wool harvested in this manner was scoured by passing it through a series of detergent and washing soda solutions (Thwaites 1967).

(ii) Fibre diameter

Measurements of fibre diameter were made on 100 randomly selected fibres from each scoured sample, with the aid of a Reichert 'Lanameter' projection microscope.

(iii) Fibre length

The lengths of 50 randomly selected fibres from each scoured sample were measured with a projection microscope (x80) and cartometer.

III. RESULTS AND DISCUSSION

Rectal temperatures and respiratory rates under control conditions did not vary significantly between experiments, and averaged 38.71 ± 0.08°C (S.E.) and 54.11 ± 4.61 respirations/min respectively. Hot-room exposure led to a highly significant increase in both parameters. The increases in Experiments A and B were similar, levels of 40.35 ± 0.11°C and 192.62 ± 3.71 respirations/min being attained. During Experiment C rectal temperatures and respiratory rates rose from control levels at the beginning of each daily exposure to an average of 40.16 ± 0.09°C and 238.08 ± 2.79 respirations/min after 7 h.

Figure 1 illustrates the changes in the wool growth indices which were observed during the four experiments. In Experiment A clean scoured wool production in treated ewes was significantly depressed ($P < 0.01$) by hot-room treatment. The response was a delayed one; wool growth began to decline during the second week of treatment, reached its lowest level (approx. 65% of pre-treatment levels) in the second week after treatment, and thereafter increased until pre-treatment levels were regained in the fifth week after hot-room exposure. This response was very similar to that observed during a preliminary experiment (Thwaites 1967).

The 7-day hot-room exposure employed in Experiment B elicited a similar response, although in this case the depression in wool growth was of lesser magnitude and duration (lowest level approx. 80% of pre-treatment levels), and was significant at $P < 0.05$ only. Wool growth was not significantly affected by treatment in Experiment C.

Fibre lengths did not vary significantly during any of the experiments (see Figure 1). Changes in fibre diameter, on the other hand, when present, paralleled those in clean scoured wool production. That the responses in wool growth arose primarily from changes in fibre diameter is substantiated by the fact that the

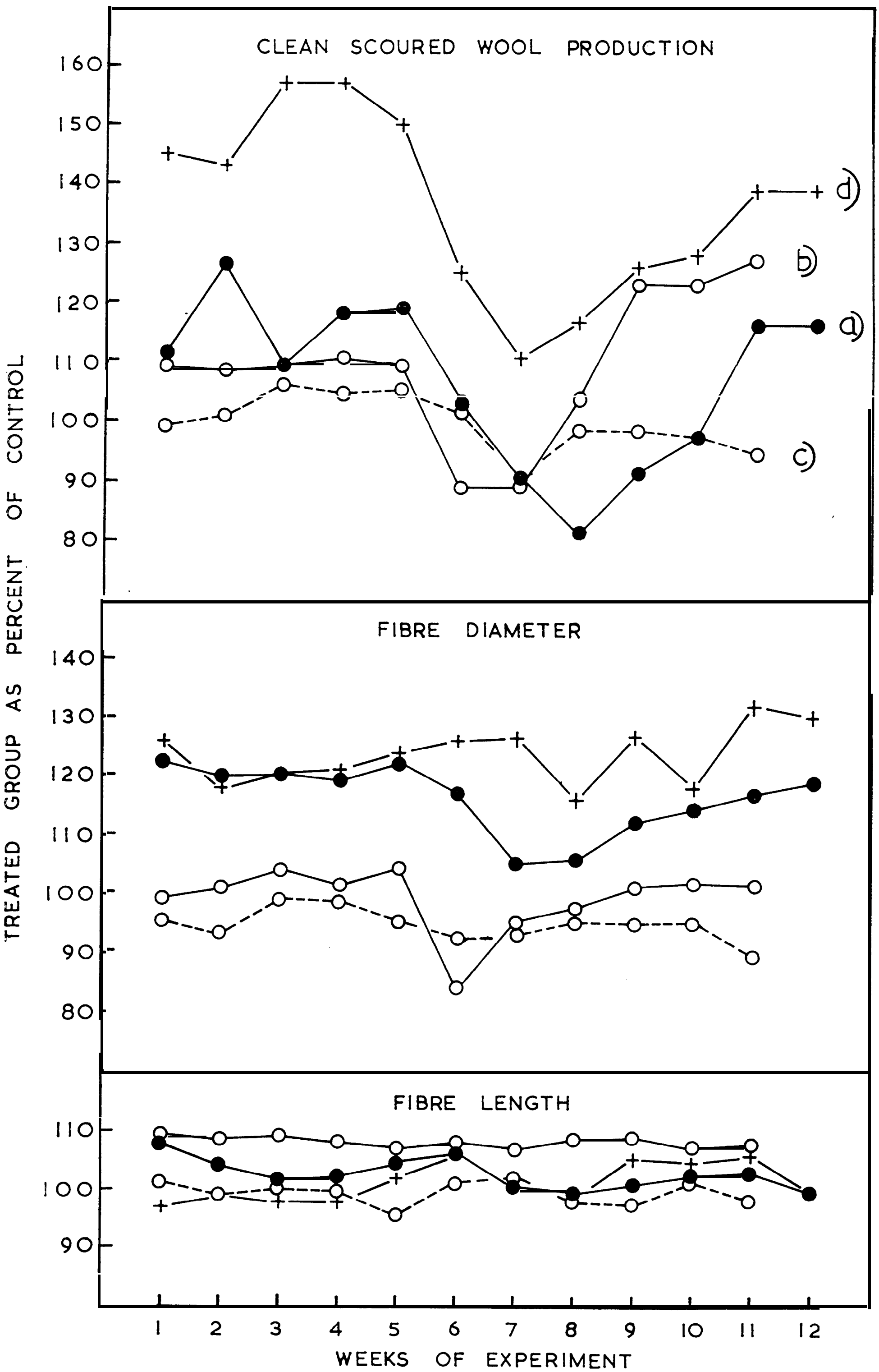

Fig. 1.—Treatment effects on indices of wool growth.

depressions in fibre diameter observed in Experiment A and B are of sufficient magnitude to account fully for the concomitant depressions in clean scoured wool production.

During the period of hot-room exposure in Experiment A, treated ewes rejected, on a caloric basis, 38 % of the ration offered them. In Experiment B, 18% of the ration was rejected. The possibility thus arises that at least some of the reduction in wool growth which followed hot-room exposures A and B might have been due to the lowered feed intake which occurred during these exposures. The results of Experiment D confirm this possibility. Simulating the feed intake of treated ewes in Experiment A under control temperature conditions gave the same reduction in wool growth. That high temperatures, *per* se, do not depress wool growth to any appreciable extent is further borne out by Experiment C, in which no appetite depression occurred and in which wool growth was unaffected by daily hot-room exposure.

'Tenderness' and 'break' in the fleece have been associated by previous authors with 'stress' situations such as those encountered during under-nutrition, disease, blowfly strike, worrying by dogs and exposure to cold, wet conditions. It is obvious from the present work that high temperature cannot be added to this list of stressors, although its indirect effects through reduced appetite, might obviously predispose to these wool faults. Lindner and Ferguson (1956) consider adrenocortical hyperfunction to be involved in stress-induced reductions in wool fibre diameter. However, morphological and histological examination of the adrenals of more than 100 ewes which were subjected to continuous heat stress such as that in Experiment A has failed to reveal any indication of adrenocortical hyperactivity (Thwaites, unpublished).

The results of these experiments clearly demonstrate that prolonged heat stress, through its depressing effect on appetite, may severely depress wool growth rates in unacclimatised sheep. Support is thus given to the suggestion (Moule 1958) that high ambient temperature may be involved in the relatively poor wool production of sheep in arid regions. Under field conditions in such areas, the deleterious effects of high temperature would be heightened by poor pasture availability and quality, and lessened by diurnal temperature variations (Experiment D) and animal acclimatisation.

The reduction in wool growth which resulted from appetite depression during heat stress is in line with recent American work (Johnson *et al* 1966) which has shown that more than half of the decline in the milk production of dairy cows in a hot environment could be ascribed to failure of appetite.

IV. ACKNOWLEDGMENTS

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