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Disrupted hair follicle activity in cattle grazing endophyte-infected tall fescue in the summer insulates core body temperatures[1]

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ABSTRACT

Two experiments were conducted to characterize and evaluate rough hair coats of cattle grazing endophyte (Neotyphodium coenophialum)-infected tall fescue (Lolium arundinaceum) during the summer and their effect on body temperature. In Exp. 1, hair was clipped in bleached areas over the rumps of 5 steers grazing endophyte-infected fescue in the summer to determine percentages in 5 length intervals for hair emerged during decreasing day lengths (fall and winter) and those emerged during increasing day lengths (spring and summer). In Exp. 2, rectal temperature data from 7 grazing experiments were compiled to compare linear relationships between rectal temperature and both ambient temperature and temperature-humidity indices, and between cattle with rough, transitional (i.e., some hair shedding), and sleek hair coats. Frequency distributions of hair length intervals in Exp. 1 differed ($P < 0.001$), with 31.3% of short-day emerged hairs and 19.5% of long-day emerged hairs having lengths >20 mm; however, 80% of the hairs were emerged during long day lengths rather than short day lengths. For Exp. 2, linear increases in rectal temperatures as mean ambient temperature and temperature-humidity indices increased were greater for cattle with rough and transitional hair coats than for cattle with sleek hair coats. From these experiments, it was concluded that rough hair coats on cattle grazing endophyte-infected tall fescue are composed predominately of hair emerged during long-day lengths in the late spring and summer. Growing to excessive hair lengths, these rough hair coats insulate elevated core body temperature to intensify hyperthermia triggered by ergot alkaloid-induced vasoconstriction.

Key words: beef cattle, fescue toxicosis, hair coats, heat stress, tall fescue

INTRODUCTION

An endophytic fungus (*Neotyphodium coenophialum*) infects most plants of tall fescue (*Lolium arundinaceum*), which is one of the most widely grown forage grasses in the United States (Jackson et al., 1984). Ergot alkaloids produced by the endophyte cause constriction of vascular blood flow to peripheral tissues, which reduces the ability of an animal to dissipate body heat (Oliver, 2005). Consequently, cattle undergoing fescue toxicosis are vulnerable to severe heat stress at times of high ambient temperature and humidity (Hemken et al., 1981; Spiers et al., 2005). Classic signs of toxicosis associated with heat stress are rough hair coats during the summer, high respiration rates and salivation, and an excessive amount of time standing in the shade or ponds. Prolactin concentrations also have been consistently low in cattle exhibiting signs of toxicosis (Strickland et al., 1993).

Rough hair coats have been assumed to be from a lack of shedding

[1] Mention of trade names or commercial products in the article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA.
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of winter hair coats, but this has not been fully elucidated. The rough hair coats during the summer have been viewed as a symptom of toxicosis with no major implications on health or well being, but rough hair coats could insulate core body heat to exacerbate heat stress (McClanahan et al., 2008). Clipping rough hair coats of both European and tropical breeds of cattle facilitates greater body heat loss (Turner, 1962; Pathmasingham and Abdul, 1981). McClanahan clipped 30 to 40% of the rough hair coat coverage over steers grazing endophyte-infected fescue and reported that clipped steers had lower rectal temperatures than those with unclipped hair coats when daily mean ambient temperature was above 25°C. It was further observed that hair grew to excessive lengths during the summer, which suggests that rough hair coats during the summer could be composed of some hair that is generated during the summer. An experiment was conducted to determine whether rough hair coats of fescue cattle during the summer were composed primarily of hairs retained from the winter hair coat, or whether there also were hairs that emerged during long-day lengths and exhibited excessive growth. A second experiment was conducted to determine whether rough hair coats have an insulation effect on core body temperature, which could potentially exacerbate toxicosis-related heat stress.

MATERIALS AND METHODS

Exp. 1

Hair coat data were collected for yearling steers grazing tall fescue pastures located at the University of Kentucky Animal Research Center near Versailles, Kentucky. The experimental protocol was reviewed and accepted by the Institutional Animal Care and Use Committee at the University of Kentucky.

Five 8- to 10-mo-old steers grazing a 3.0-ha pasture of endophyte-infected pasture and with mean initial BW of 302 ± 20 kg (SD) were used to collect hair data. All steers were crossbred but were of primarily Angus breeding with black hair coats. The sole source of nutrients was pasture forage and supplemental minerals fed free-choice. Endophyte infection percentage of the pasture was tested in 2007 on June 5 by collecting single whole tillers from 25 randomly chosen plants in the pasture. Tiller samples were analyzed using the immuno-blot test (Gwinn et al., 1991).

Two separate rectangular areas (approximately 8 × 16 cm) over the rump, in a region just above the midpoint between the pin and hook bones of the pelvis, were bleached on each steer with a mixture of Basic White Extra Strength Lightener with potassium persulfate and ammonium persulfate (Clairol Inc., Stamford, CT) and 40 volume Crème Developer (Brentwood Beauty Labs Int. Inc., Dallas, TX). Between 10 and 15 min after application, the bleach was washed off with water. Bleaching was done on April 23, which was 34 d past spring equinox (March 20). Prior to the experiment steers grazed endophyte-infected tall fescue pasture, and initial grazing of endophyte-infected tall fescue began April 23.

Hair in bleached areas was clipped to the skin surface with surgical clippers (2-cm-wide blade), with the first rectangular area being clipped on June 7 (1st clipping) and the second rectangular area being clipped on July 5 (2nd clipping). Hair was clipped with a horizontal sweep of the clippers at the base of each bleached area, and hair was discarded. This provided a hair-free skin surface to initially place the clipping blade for a vertical sweep for collection of hair over a distance of approximately 4 cm. Clippers were firmly pressed against the hide to ensure that all hair was clipped at the skin's surface. Day lengths on hair clipping dates were 14:44 (June 7) and 14:43 (July 5; after summer equinox).

Each sample of clipped hair was thoroughly mixed, and 300 individual hairs were randomly chosen for measurement of length. Individual hairs were measured as being in length intervals of $L \leq 5$ mm, $5 < L \leq 10$ mm, $10 < L \leq 15$ mm, $15 < L \leq 20$ mm, or $L > 20$ mm. Bleaching status of individual hairs was visually determined to be 1) completely bleached from base to tip (no growth since bleaching), indicating the follicles were inactive at and after bleaching and therefore assumed to be retained from the winter hair coat (short-day emerged hair); 2) partially bleached (bleached at the hair tip and unbleached at the hair shaft base), indicating follicles were active and the hair was growing at the time of bleaching (assumed to be a long-day emerged hair); and 3) unbleached from base to tip, indicating the follicle was active after bleaching, with the bleached hair being shed and growth of a long-day emerged hair being initiated after bleaching occurred. Completely bleached hairs were categorized as being from winter hair coats, and partially and unbleached hairs were categorized as being from summer hair coats

Distributions of hair lengths were calculated separately for short- and long-day hairs. Differences in hair length distributions between clipping dates and differences between dates within each hair length interval were determined using chi-squared procedures of SAS (Schlotzhauer and Littell, 1997). Differences between dates in distributions of short-day and long-day emerged hairs also were analyzed using chi-squared procedures.

Exp. 2

The experiment was conducted by pooling data from 7 different grazing experiments with yearling cattle grazing endophyte-infected tall fescue (Table 1). Four experiments were conducted at the Dale Bumpers Small Farms Research Center (35°06′N, 93°55′W) in Booneville, Arkansas, and 3 were conducted at the University of Kentucky Animal Research Center (38°04′N, 84°44′W) in Woodford County. The Animal Use and Care Committee at the USDA-ARS Dale Bumpers Small Farms Research Center approved all procedures used at that Booneville, Arkansas, location,