2008

PERFORMANCE AND PHYSIOLOGY OF YEARLING STEERS GRAZING TOXIC TALL FESCUE AS INFLUENCED BY CONCENTRATE FEEDING AND STEROIDAL IMPLANTS

Jessica Meagan Carter
University of Kentucky

ABSTRACT OF THESIS

PERFORMANCE AND PHYSIOLOGY OF YEARLING STEERS GRAZING TOXIC TALL FESCUE AS INFLUENCED BY CONCENTRATE FEEDING AND STEROIDAL IMPLANTS

Fescue toxicosis can produce negative effects on animal weight gain and physiology. Sixty-four steers were grazed on endophyte-infected (E+) KY-31 tall fescue for 77 days in 2007 and sixty steers grazed for 86 days in 2008 to evaluate interactions with implantation of steroidal implants and concentrate feeding on performance and physiology of yearling steers. Steers were stratified by body weight for assignment to six, 3.0-ha toxic tall fescue pastures. The main plot treatment of with or without pelleted soybean hulls (SBH) were randomly assigned to pastures. Pelleted SBH were group-fed to provide daily consumptions of 2.3 kg/steer/d (as fed). Sub-plot treatments of with or without ear implantation with steroid hormone (200 mg progesterone – 20 mg estradiol) were assigned to groups of five or six steers within each pasture. Average daily gain in the experiment showed an additive effect of feeding SBH and implanting ($P<0.05$). Rectal temperatures were highest in cattle being fed SBH ($P<0.05$) with no implantation. There is a trend for a higher frequency of sleek hair coats with feeding SBH ($P<0.10$). The results of this experiment indicate that feeding SBH and implementing steroidal implantation can increase steer weight gain. In addition, providing SBH can increase the shedding of rough hair coats of fescue cattle.

KEYWORDS: Beef Cattle, Fescue Toxicosis, Hair Coat, Feed Supplementation, Steroidal Implant

Jessica Meagan Carter

December 3, 2008

PERFORMANCE AND PHYSIOLOGY OF YEARLING STEERS GRAZING TOXIC TALL FESCUE AS INFLUENCED BY CONCENTRATE FEEDING AND STEROIDAL IMPLANTS

By

Jessica Meagan Carter

Co-Director of Thesis

Co-Director of Thesis

Director of Graduate Studies

RULES FOR THE USE OF THESES

Unpublished theses submitted for the Master's degree and deposited in the University of Kentucky Library are as a rule open for inspection, but are to be used only with due regard to the rights of the authors. Bibliographical references may be noted, but quotations or summaries of parts may be published only with the permission of the author, and with the usual scholarly acknowledgments.

Extensive copying or publication of the thesis in whole or in part also requires the consent of the Dean of the Graduate School of the University of Kentucky.

A library that borrows this thesis for use by its patrons is expected to secure the signature of each user.

Name	Date

THESIS

Jessica Meagan Carter

The Graduate School

University of Kentucky

2008

PERFORMANCE AND PHYSIOLOGY OF YEARLING STEERS GRAZING TOXIC TALL FESCUE AS INFLUENCED BY CONCENTRATE FEEDING AND STEROIDAL IMPLANTS

THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in the
College of Agriculture
at the University of Kentucky

By

Jessica Meagan Carter

Lexington, Kentucky

Co-Directors: Dr. Glen E. Aiken, Adjunct Associate Professor of Crop Science
and Dr. C. T. Dougherty, Professor of Crop Science

Lexington, Kentucky

2008

ACKNOWLEDGMENTS

The assembly of the following thesis was obtainable from the direction and supervision of several individuals. First, I would like to thank my advisor, Dr. Glen Aiken, for allowing me the opportunity to pursue my Master's Degree under his leadership. I greatly appreciate the continual support and guidance he has provided me throughout my work on my Master's Degree. I offer many thanks to the co-director of my thesis, Dr. Chuck Dougherty, for his support as the Plant and Soil Sciences Director of Graduate Studies and for his accommodating assistance along the way. I am also grateful to Dr. Ray Smith for serving on my graduate committee. I am extremely thankful to Tracy Hamilton for the valuable advice and technical support provided throughout this experiment. I thank the United States Department of Agriculture Forage Animal Production Research Unit (USDA-FAPRU) for contributing with funding and the S & B Cattle Company for their collaboration efforts by providing steers for my research. I acknowledge the University of Kentucky Animal Research Center crew for assisting in the project and for allowing use of their facilities. I would like to express gratitude to Jennifer Johnson, my fellow graduate student, for helpful advice and assisting in collection of data. Additionally, I would like to thank Dr. Lowell Bush and his lab technicians for analyzing tiller samples for ergovaline concentrations.

Also, I am incredibly thankful for my parents, Gerald and Betty, and for their continuous support, encouragement, and never ending love throughout my college career. It was my parents that set the example and helped create my passion for agriculture. Furthermore, I am tremendously grateful to my wonderful family and friends that provided their never-ending love and support.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FILES

Name: Jessica Carter Final Thesis

Type: .PDF

Size: 478 KB

Chapter One: Introduction

Tall fescue (*Lolium arundinaceum* L.) is a cool-season perennial grass that is the predominant grass utilized for forage in the transition zone, an area extending from the temperate northeast, and from the subtropical southeast and west to the Great Plains. It is estimated that tall fescue inhabits 14 million hectares (Hemken et al., 1984), with 90 to 95% of its plants infected by a fungal endophyte (*Neotyphodium coenophialum*) (Bacon and Siegel, 1988; Shelby and Dalrymple, 1987). This widespread forage is economically valuable because of its advantageous agronomic characteristics. Tall fescue is easy to establish, heat and drought tolerant, extremely vigorous with long extended growing seasons, resistance to insect feeding, and provides erosion control.

Despite its productivity and persistence, endophyte-infected fescue is toxic to grazing livestock. Research in the late 1970s identified an endophytic fungus as the cause of what is commonly termed "fescue toxicosis". Symptoms of this malady include lowered weight gains, decreased reproductive performance, depressed serum prolactin concentrations, "rough hair coats" (retention of winter hair coats through the summer months), and reductions in grazing time and feed intakes (Schmidt and Osborn, 1993; Strickland et al., 1993; Thompson and Stuedemann, 1993). Furthermore, vasoconstriction reduces blood flow to the skin, which impedes dissipation of body heat (Oliver, 2005). Consequently, cattle exhibiting symptoms of toxicosis have elevated respiration rates and body temperatures. Animals exposed to ergot alkaloids produced by the endophyte have increased susceptibility to heat stress because magnification of these symptoms occurs during hot summer months. Hoveland (1993) estimated that tall fescue toxicosis costs the beef industry $600 million annually as a result of lowered conception rates and declines in body weight gains, but this annual cost is closer to 1 billion dollars with current cattle prices.

Fiorito et al. (1991) reported that lambs consuming endophyte-infected tall fescue hay in the diet had depressed total tract digestibilities of dry matter, neutral detergent fiber, and acid detergent fiber. The reports in cattle of reproductive toxicity have been demonstrated through reduced conception rates (Bond et al., 1988; Danilson et al., 1986). Foal mortality has been an evident manifestation of fescue toxicosis in equines (Monroe et al., 1988; Taylor et al., 1985; Earle et al., 1990). Furthermore, monogastric animals, such as equines, appear to be more sensitive during the last trimester of pregnancy to exposure to infected tall fescue than the ruminant.

Although performance of animals grazing endophyte-infected fescue has been disappointing, the fungus and grass relationship reflects a symbiotic relationship with ecological significance. Alkaloids synthesized by the plant-fungus association suppresses herbivory of livestock and insects, and imparts tolerances to moisture and heat stress; whereas the grass host provides protection and nutrients to the endophyte.

Research has shown (Aiken et al., 2001; Aiken et al., 2006; Bransby et al., 1994) satisfactory average daily gains (ADG) can be achieved with cattle grazing endophyte-infected tall fescue by implementing steroidal implants. Coffey et al. (1992) reported implanting stocker cattle grazing endophyte-infected tall fescue increased weight gain. Likewise, Rumsey et al. (1991) reported steers allocated to an implant treatment in a feedlot displayed increased dry matter intakes, body weight gains, and improved feed conversion.

In addition, feeding concentrate/by-product feeds can generate positive gain responses from cattle grazing toxic tall fescue. Aiken et al. (2008) reported feeding SBH to steers can achieve profitable weight gains while grazing endophyte-infected tall fescue. An 81% increase in ADG was determined with steers being fed 2.3 kg/d (as fed) of broiler litter-ground corn mix while grazing tall fescue pastures (Aiken et al., 1998).

An experiment was conducted to determine if feeding pelleted soybean hulls combined with steroidal implantation will have additive effects on weight gain and moderate the toxicosis of yearling steers grazing endophyte-infected tall fescue.

Chapter Two: Literature Review

Tall fescue was introduced into the United States from Europe in the early 1800's, but not extensively utilized until the 1940s and 1950s. A remarkable discovery was made in 1931 on a farm in Menifee County, KY, owned by William Suiter. Dr. E. N. Fergus, an agronomist at the University of Kentucky, visited the farm to identify a persistent and productive grass on a steep hillside that eventually led to the foundation of a popular forage cultivar released commercially in 1943, 'Kentucky 31.' Kentucky 31 is an admirable cultivar of tall fescue that is hardy and provides abundant forage growth.

Tall fescue is a cool-season perennial grass that is widely adapted to the southeastern United States and occupies a region termed the "Fescue Belt." This region extends between the temperate northeast and subtropical southeast and west to the Great Plains. It is an excellent and versatile forage species that has become extremely favorable to producers because of its ease of establishment, tolerance of heat, drought, and insects, as well as providing erosion control. It offers many advantages including: wide adaptation, persistence under a wide range of management regimes, good forage yield, a long-growing season, and excellent seed production (Ball, 1984).

Through adaptation tall fescue has advantageous agronomic qualities that promote sustainability, yet suppress animal productivity. These characteristics are attributed to alkaloids produced by a fungal endophyte (*Neotyphodium coenophialum*) that inhabits the tissue components in most plants of Kentucky 31 tall fescue. Cultivars of endophyte-free tall fescues that were commercially released in the 1980s lacked persistence (Ball et al., 2002). Endophytic fungi and their grass hosts typically are ecologically significant and have a mutualistic symbiotic relationship (Bacon, 1994). The fungi and grass coevolved into dependent entities and developed a mutualic association (Bacon, 1994; White, 1988; Bacon and Hill, 1995). Mutualism describes the advantages that the fungal endophyte confers on the grass in tolerance to environmental stress and herbivory, whereas, in return, the grass delivers survival, reproduction, protection and nutrients to the endophyte.

Fescue Toxicosis

Unfortunately, this persistent and productive grass causes a toxicosis in cattle that was estimated by Hoveland (1993) to annually cost the beef industry approximately $600 million due to lowered conception rates and depressed body weight gains; however, the economic losses in today's market are likely closer to one billion dollars. *Neotyphodium coenophialum* produces alkaloid metabolites that are toxic to grazing animals (Stuedemann and Hoveland, 1988; Hoveland, 1993; Porter and Thompson, 1992; Schmidt and Osborn, 1993; Watson et al., 2004) and its symptoms are collectively termed "fescue toxicosis." Fescue toxicosis, also referred to as "summer slump," is characterized by unthrifty appearance and inadequate performance of animals grazing tall fescue. The summer slump syndrome is characterized by lower weight gains, impaired reproductive performance, decreased milk production, retention of rough (winter) hair coats into warmer months, low prolactin concentrations, and restricted blood flow to peripheral tissues (Schmidt and Osborn, 1993; Strickland et al., 1993; Thompson and Stuedemann 1993). Other symptoms of this malady include decreased feed intake, labored respiration, elevated body temperatures, and excessive salivation (Schmidt and

Osborn, 1993; Thompson and Stuedemann, 1993). It should be emphasized that the fungus is an endophyte that does not directly affect either the growth or appearance of the grass and cannot be detected without laboratory analysis (Ball, 1984).

Tall fescue benefits from the endophyte/grass association in part by a number of alkaloids produced by the fungus or by the plant, in response to the fungus (Thompson et al., 1999). However, these alkaloids suppress consumption of tall fescue by both mammals and insects (Porter, 1994). Strickland et al. (1993) reported that consumption of tall fescue herbage reduces growth because of diminished feed intake and decreased digestibility of feed. Strahan et al. (1987) observed decreased dry matter intakes in ruminants fed toxic tall fescue diets in comparison to ruminants fed endophyte-free tall fescue diets. Similarly, Stuedemann et al. (1989) observed lower forage intake of steers offered endophyte-infected - as compared to endophyte-free tall fescue. Goetsch et al. (1987) conducted an experiment that also supported the conjecture of a reduction of dry matter intake of cattle consuming endophyte-infected diets. Decreased animal performance associated with consumption of toxic tall fescue has been attributed to a reduction in voluntary intake because cattle spend less time grazing (Bond et al., 1984).

Ergovaline, the predominant ergopeptine alkaloid (Porter et al., 1981; Yates et al., 1985), is present at biologically active concentrations in endophyte-infested (E+) tall fescue to impose animal health and economic consequences (Garner, 1993). Ergovaline induces a strong vasoconstrictive response (Klotz et al., 2006; Abney et al., 1993; Oliver, 2005) that reduces the ability to dissipate body temperature and increases vulnerability to severe heat stress with high air temperature and relative humidity. Further, it can deprive tissues of proper blood flow and nutrition. This highly toxic ergot alkaloid is responsible for limiting grazing time of cattle during summer months. Aldrich-Markham et al. (2003) documented the ergovaline concentrations needed in threshold levels of cattle to demonstrate clinical signs of heat stress as 400 to 750 µg kg^{-1}. However, Crawford et al. (1990) demonstrated that cattle consuming tall fescue hay with only 190 µg kg^{-1} ergovaline expressed clinical signs of fescue toxicosis. Bond et al. (1984) reported decreased animal performance most evident when animals are subject to heat stress under grazing management of endophyte-infected tall fescue. Animals affected by fescue toxicosis typically seek shade and water during times of high ambient temperatures and typically they graze more during cooler night hours. It appears the onset of hot weather and high humidity magnifies the adverse symptoms of fescue toxicosis (Hemken et al., 1981; Schmidt et al., 1986). Aside from animals responding to fescue toxicosis by standing in shade or ponds, symptoms of cattle suffering from toxicity include heavy panting and excessive salivation apparently in an attempt to alleviate heat stress and decrease body temperature.

Rough hair coats retained during summer months further compound heat stress by insulating the skin. Berman (2005) suggested hair coat length influences threshold temperatures that induce heat stress challenges. Heat stress can be detrimental to animal performance and essential economic traits (Browning et al., 1998). From a literature review, Oliver (2005) surmised that animals exposed to ergot alkaloids do not handle heat stress well due to the negative responses of peripheral vasoconstriction, reduced blood flow in skin, and decreased water vaporization from skin. Spiers et al. (2005) identified markers of animal responses to heat stress under fescue toxicosis conditions. These results clearly indicate that the combination of heat stress and E+ treatment can dramatically reduce overall average daily gain (ADG) and profitability (Browning et al., 1998).

Many studies conducted with cattle and sheep consuming an E+ diet have reported hyperthermia above those of the endophyte-free control (Hemken et al., 1981; Hoveland et al., 1983; Bond et al., 1984; Strahan et al., 1987; Gadberry et al., 2003). Al-Haidary et al. (2001) reported hyperthermia in cattle developed due to decreased peripheral heat loss when consuming endophyte-infected diets under heat stress environments. Animals suffering from severe “fescue foot” may experience lameness or sloughing of hooves, or the loss of the tips of tails or ears. This disorder is generally witnessed more frequently in cold weather when vasoconstriction from the alkaloids causes hypothermia in the peripheral tissues.

Weather patterns, ambient temperature, forage composition, and animal management regimes are major components in animal productivity. The infection level of fescue pastures is considered a highly damaging factor in affecting animal performance, as well. An estimated 90-95% of tall fescue pastures in the United States have the potential for fescue toxicity of livestock (Bacon and Siegel, 1988). Average daily gain has been reported to decrease approximately 0.05 kg (0.1 lb) for each 10% increase in infection rate (Bond et al., 1984). Solutions to resolve the toxicity quandary with tall fescue remain uncertain due to endophyte-free grasses being vulnerable and highly susceptible to disease and insect infestations, and over-grazing. Endophyte-free fescue is devoid of intrusive endophytes that are responsible for causing adverse effects in grazing animals. Researchers have developed endophyte-free cultivars that are nontoxic to livestock, however, plant persistence and vigor is sacrificed (Hill et al., 1991). As a result, widespread popularity of this fescue type has yet to extend amongst producers. Nonetheless, Bond (1984) observed that cattle prefer endophyte-free fescue over clover or endophyte-infected fescue. When results of studies with endophyte-infected and endophyte-free are merged, a strong linear relationship between endophyte level in tall fescue stands and reduction in steer ADG during spring and summer has been detected (Stuedemann et al., 1985).

Prolactin

The anterior pituitary is responsible for production and secretion of prolactin. Prolactin has been known primarily as the essential hormone for mammary gland development and lactation; however, it has recently been linked to other physiological processes (Krag and Schams, 1974). Although there has not been a direct link between low prolactin concentrations and fescue toxicosis (Strickland et al., 1993), it has been used as an indicative marker (Sleper and West, 1996; Elsasser and Bolt, 1987) of dysfunction of the endocrine system related to circulating ergopeptines (Hurley et al., 1981; Aiken et al., 2006). Strickland et al. (1993) stated ergopeptines have shown to suppress prolactin secretion.

Cattle exhibiting symptoms of fescue toxicosis typically have suppressed serum prolactin concentrations (Chestnut et al., 1992; Aiken et al., 2008). Decreased prolactin secretion levels indicate that some degree of fescue toxicity is evident and that ergot alkaloids are being consumed. Gadberry et al. (2003) suggests that ergovaline produces some symptoms of fescue toxicosis, such as decreased serum prolactin secretions, and that it works in cohort with other ergot alkaloids. Carlson et al. (1985) used a rat model to demonstrate that 1 *p*g of ergovaline hindered prolactin release, indicating that this is a minute amount to induce tall fescue toxicity. Several researchers have consistently shown negative effects of endophyte-infected tall fescue on prolactin concentrations in cattle. Boling et al. (1989) even reported decreased serum prolactin in steers being fed E+; thus, indicating that steers, which have low endogenous serum prolactin experience toxicosis. Similarly, ergovaline infused in cattle resulted in depressed prolactin and increased rectal temperatures (Garner et al., 1993). Suppression of prolactin concentrations in rodent models correspond to the effects in ruminants fed toxic tall fescue (Alridch, 1991; Aldrich et al., 1993; Peters et al., 1992).

Ergovaline is the primary ergopeptine and is a known dopamine agonist (Jones et al., 2003). Ergovaline accounts for 84-97% of the total ergopeptine alkaloid content (Garner et al., 1993). Strickland et al. (1992, 1994) reported that the toxic endophyte produces ergopeptines, which disrupt dopamine-signaling pathways, contributing to symptoms of fescue toxicosis. It appears that ergovaline accumulates in leaf sheaths rather than leaf blades. Rottinghaus et al. (1991) reported the ranking order of ergovaline concentrations in tall fescue tissues from highest to lowest is: seed heads>stems and sheaths>leaf blades. Klotz et al. (2007) reported ergovaline to be a potent vasoconstrictor and proposed that ergot alkaloids are tightly bound to biogenic amide receptors could result in their accumulation in tissues, ultimately leading to susceptibility to fescue toxicosis. Dopamine agonist ergot alkaloids are considered the cause of gut motility retardation in ruminant digestive systems (Jones et al., 2003). Therefore, domperidone treatment, as Jones et al. (2003) suggested, could be a factor in reducing weight gains of cattle grazing endophyte-infected tall fescue and subsequently decrease economic losses in the beef industry.

Retention of Rough Hair Coat

Cattle grazing toxic tall fescue retain their rough hair coats into the summer. The exact cause is not known, however, it is hypothesized the cause is nutrient deficiencies due to vasoconstriction, peripheral ischemia, and/or biochemical alterations in hair follicles (Oliver, 2005). Scott et al. (1995) reported hormonal changes can affect hair coat color and quality parallel to hair coat responses in cattle grazing toxic tall fescue. Aiken et al. (2006) demonstrated the distribution of hair coat ratings between rough, transitional, and sleek did not vary among implanted and non-implanted steers grazing endophyte-infected tall fescue, suggesting that steroid hormones did not institute shedding of winter hair coats. Aiken et al. (2008) characterized hair coat scores at the conclusion of a tall fescue grazing experiment as 93.0% rough, 2.8% transitional, and 4.2% sleek, across with and without soybean hull (SBH) feeding treatments. In another grazing experiment, Aiken et al. (1998) reported that approximately 70% of the steers being fed a broiler litter-corn mixture on endophyte-infested tall fescue had rough or transitional hair coat ratings, whereas nearly 85% of the steers on the pasture-only treatment of non-infested tall fescue displayed rough hair coats. Feeding concentrates may improve weight gains of cattle but not necessarily diminishing symptoms of fescue toxicosis.

Cattle consuming endophyte-infected diets experience dysfunctional hair growth and shedding mechanisms (McClanahan et al., 2008). Disrupted seasonal trends in hair coat phases restrict ability to dissipate heat, ensuing vulnerability and generating poor animal performance. Porter and Thompson (1992) concluded that seasonal decreases in prolactin concentrations in the autumn months trigger growth of the winter hair coat. In addition, their experiment suggested increases in prolactin secretions are associated with shedding and development of the summer hair coat. Therefore, the low concentrations of the hormone present in cattle suffering from fescue toxicosis may be inadequate to promote shedding and the presence of rough (winter) hair coats of cattle during warm summer months. McClanahan et al. (2008) reported steers grazing toxic tall fescue retained their winter hair coats and the summer hair coat appeared to have uncontrolled growth. Prolactin concentrations in cattle are seasonal (Krag and Schunan, 1973), with concentrations being highest in June and July. Increases in prolactin concentrations in the late spring could activate the shedding of rough hair coats while high concentrations of the hormone in the summer could inhibit growth of the summer hair coat (Porter and Thompson, 1992; Schmidt and Osborn, 1993; Strickland et al., 1993).

Dietary Dilution of Ergot Alkaloids

One method to alleviate the severity of fescue toxicosis is to dilute the endophyte by renovating pastures with legumes (Ball, 1984). Fribourg et al. (1991) reported that having the presence of clover in low-endophyte stands increased steer ADG by supplying additional nitrogen (N) for enhanced spring forage growth, as well as energy and proteins for animal consumption. The chronic signs of fescue toxicosis were reduced when 10 to 25% clover was included in the E+ stand. Coffey et al. (1990) reported stocker calf performances were considerably enhanced with integrating legumes into fescue pastures.

Another alternative to reducing the effects of endophyte-infected tall fescue include diluting ergot alkaloids through concentrate feeding (Aiken and Piper, 1999). Renovating clovers or supplementing concentrate feedstuff in diets of animals consuming tall fescue ergot alkaloids can help reduce the undesirable effects on animal performance and physiology (Ball, 1984). The provision of feed supplements may be utilized if nutrient needs of grazing animals are inadequate to meet production goals sustainable from pasture grazing alone. Further, concentrates also can maintain performance needs under low herbage masses (Aiken and Piper, 1999).

Parish et al. (2003) reported cattle exposed to ergot alkaloids in toxic tall fescue respond with decreased feed intake. This observation could be related to important nutrient factors. Strickland et al. (1993) stated that an explanation for reductions in feed intake of cattle grazing toxic tall fescue is unclear, but digestibility effects may be a contributing factor. A study performed by Fiorito et al. (1991) demonstrated that digestibility was depressed when endophyte-infected tall fescue was in the diet of sheep. Additionally, a reduction in nutrient availability was illustrated, signifying that decreased digestibility and decreased feed intake contribute to the decline in weight gain. Average daily gain of steers grazing endophyte-infected tall fescue has been recorded at a low rate of 0.21 to 0.62 kg/d (Paterson et al., 1995). Reduction of blood flow to the digestive tract is another indication of decreased weight gains by restricting nutrient uptake potential of the tract and, consequently, diminishing available nutrients for animal growth. In addition, cattle consuming endophyte-infected tall fescue simply spend less time grazing, resulting in reduced intake.

It is speculated the use of supplements can provide alternatives to minimize effects of fescue toxicosis among animals grazing endophyte-infected tall fescue. Fescue toxicosis can be alleviated or reduced in severity of feeder calves grazing tall fescue if toxins in diet are diluted by feeding hay or concentrate feeds (Aiken et al., 1998; Ball, 1984). Various research experiments have determined that diluting fescue with moderate quality feed material is beneficial in counteracting fungal endophyte effects.

Aiken et al. (2006) reported ADG response of steers superior with feeding pelleted SBH at a rate of 2.3 kg/steer/d. Aiken et al. (2006) also demonstrated improved ADG can be obtained through concentrate feeding of SBH but with no differences in serum prolactin concentrations. A broiler litter and corn mixture has established significance as a prospective low-cost feedstuff for enhancing ADG of steers fed endophyte-infected tall fescue when corn costs are below $150/ton (Aiken et al., 1998; Fontenot and Webb, 1975). A study conducted with steers grazing endophyte-infected tall fescue and fed a broiler litter and ground corn supplement had similar ADG to those grazing non-infected tall fescue with no supplement (Aiken et al., 1998). Aiken and Piper (1999) concluded steer weight gains can be improved substantially if moved to an eastern gamagrass (*Tripsicum dactyloides* L.) pasture, a warm-season perennial grass, or fed a 1:1 broiler litter-corn mixture daily at a rate of at least 0.8% body weight (BW). It was reported by Goetsch (1989) that ADG doubled for calves fed infested tall fescue when ground corn was supplied at 0.75% BW. Through various research experiments, concentrate feeding has proved to substantially improve animal performance and weight gains; however, complete alleviation of fescue toxicosis symptoms remains to be elucidated.

Estrogenic Growth Promoters

Benefits of using growth-promoting implants in cattle can be obtained in various phases of beef cattle production (Perry et al., 1970). Utilizing implantation of steroidal hormones provides a complimentary management practice for maximal growth stimulation of steers grazing various forages. Notably, the use of steroidal implantation is likely profitable if forage quality and quantity are not limited (Aiken et al., 2006). Estrogenic growth promoters are being used extensively in the cattle industry for improving feed efficiency and increasing the rate of weight gain in steers. The estrogenic activity of the anabolic steroid has shown to increase growth rate and efficiency with possible endocrine effects from using implants (Brandt, 1994).

Steroidal implantation has the potential of alleviating symptoms of fescue toxicity. Bransby et al. (1994) concluded the use of steroidal implantation as an acceptable approach to improve performance of steers grazing endophyte-infected tall fescue. Aiken et al. (2006) reported a positive response to implantation with lower stocking rates implemented. This suggests implantation has a positive effect on weight gain on toxic tall fescue, if forage mass is not restricted. Furthermore, experiments that have evaluated implantation responses with exclusive forage diets have shown to demonstrate increased dry matter intakes (DMI) (Mader et al., 1994; Rumsey, 1982; Rumsey et al., 1991).

The administration of estrogenic growth promoters in stocker cattle can enhance growth potential due to their effectiveness in redirecting the partition of nutrients to protein growth rather than fat deposition. Coffey et al. (2001) reported a 14.1% increased gain in steers implanted with progesterone-estradiol during the pasture phase in comparison to non-implanted steers. Similarly, Brandt (1994) estimated that a 15.1% increase in ADG could be obtained in steers under implantation regimes over gains achieved by non-implanted steers. Implantation of steroidal hormones increased rectal temperatures of cattle grazing toxic tall fescue (Aiken et al., 2006), which can intensify heat stress. Furthermore, Aiken et al. (2006) reported implantation with steroid hormones does not initiate shedding of winter hair coats. In a study conducted by Mader et al. (1994) where sequential implant programs were implemented, heifers retained greater benefit of implantation during the preweaning phase, as opposed to steers. During the post weaning phase, increased DMI was detected in implanted cattle placed directly in the feedlot. This supports similar results found by Rumsey (1982) where implants increased post weaning DMI, reduced feed intake/unit of gain, and daily weight gain was 23% greater ($P<0.01$). Rumsey et al. (1991) reported implant treatments, under conditions of adequate nutrition, increased DMI, body weight gain, feed conversion, and empty body gains for water and protein. Rumsey and Hammond (1990) found that growth responses to hormonal repartitioning agents are dictated by the feeding regimen provided to sustain optimal growing conditions. Brazle and Coffey (1991) observed a greater response to a zeranol implant by steers grazing high-endophyte tall fescue than steers grazing low-endophyte tall fescue; thus, providing an indication that estrogenic implants may possibly counteract some negative effects related to consumption of toxic tall fescue.

Ultrasonography as a Research Tool

Ultrasonography is a diagnostic imaging technique used as a noninvasive method for visualizing soft tissues and anatomical structures. The dynamic nature of the ultrasound can facilitate the determination of lean/fat tissue accretions with acceptable accuracy and precision. It has been used for approximately 40 to 50 years as a means to evaluate live animal carcass traits. Ultrasound technology has been verified and used primarily as an indirect method to measure expected progeny differences (EPDs). Ultrasound technology is a valuable tool in estimating economically relevant composition traits of calves in grazing or feedlot practices. Aiken et al. (2002) used ultrasonography to determine the effects of corn supplementation on weight gain of steers grazing bermudagrass and steer responses to stocking rate on ryegrass mixtures. Ultrasound scans of 12th to 13th rib fat thickness and *longissimus* muscle were used to evaluate treatment effects on these measurements and to distinguish trends in these measurements over a range of ADG. It was determined that rate of growth of the *longissimus* muscle in steers increased proportionately as quantity of daily supplemental energy increased. Fat thickness showed a quadratic increase over treatments as steer ADG increased. Ultrasound technology has been utilized as a valuable indicator of body condition and composition traits of cattle (Griffin et al., 1999; Perkins et al., 1992).

Chapter Three: Materials and Methods

A grazing experiment was conducted for 77 d in 2007 and 86 d in 2008 at the University of Kentucky Animal Research Center (UK-ARC) in Woodford County. The experimental protocol was reviewed and approved by the Institutional Animal Care and Use Committee at UK (00996A2006).

Grazing and Pasture Management

Yearling steers (*Bos taurus*) used in the experiment were crossbreds of primarily Angus breeding. The grazing trial in 2007 was conducted with 64 steers from 19 April to 5 July, and in 2008 with 60 steers from 29 April to 24 July. Steers in 2007 had an initial BW of 300 ± 60 (SD) kg and those used in 2008 had an initial BW of 292 ± 57 kg. Six, 3.0-ha pastures of endophyte-infected KY-31 tall fescue were used that were on either Maury (fine, mixed, semiactive, mesic Typic Paleudalfs) or McAfee (fine, mixed, active, mesic Mollic Hapludalfs) silt loam soils. Pastures were continuously grazed with a stocking rate of 3.3 steers/ha. The steers were obtained from a local cooperator. Steers arrived at the UK-ARC 2 to 3 weeks prior to initiation of the experiment. Pastures were fertilized in April in 2007 at a rate of 67.2 kg N/ha using aqueous nitrogen. In 2008, pastures were fertilized in late March with 28 kg N/ha. An additional 56 kg of N/ha was applied in early April, generating a total of 84 kg N/ha. The pastures were mowed the first week of June each year to remove matured seed heads to minimize risk of pinkeye infections (infectious bovine keratoconjunctivitis). In addition, the pastures were mowed prior to the start of the grazing experiment in 2008.

Animal Management

Cattle were provided ad libitum access to water and minerals (Burkmann Mills, Danville, KY) throughout both experiments. The steers were treated with moxidectin dewormer (1 mL/10 kg BW pour-on) (Cydectin®, Fort Dodge Animal Health, Fort Dodge, IA) on 17 May in 2007 and 29 April in 2008 for parasitic control. Florfenicol (Nuflor® Schering-Plough Animal Health, Summitt, NJ, 40 mg/kg body weight, subcutaneous) was administered to steers exhibiting high rectal temperatures (above 40.6°C) after the temperatures were recorded, at any time during the study. Oxytetracycline injection (Liquamycin® LA-200® Pfizer Animal Health, Exton, PA, 4.5 mL/100 lbs body weight) was used to treat calves expressing pinkeye symptoms. On 17 May in 2007 the steers were given an endosulfin insecticidal (Avenger ™) fly tag for sustaining fly control. In 2008, cattle received a CyLence Ultra® fly tag with the active ingredient pyrethroid (Bayer Inc.) prior to the initiation of the grazing period.

Experimental Design and Animal Responses

Cattle were received in 2007 on 10 April and on 15 April in 2008 at the UK-ARC in Woodford County. Steers were placed in pastures on April 15 in 2007 and on 23 April in 2008 for a 6-d adjustment period to pastures and to allow activation of implants. Prior to placement on pastures, steers were dewormed, as previously described, and steers assigned an implant treatment were ear-implanted with Synovex-S (200 mg progesterone, 20 mg estradiol; Fort Dodge Animal Health, Fort Dodge, IA). Treatments were assigned using a split-plot design with 3 replications, with the main plot treatment being feeding versus non-feeding of pelleted soybean hulls (SBH) and the sub-plot feature of the design was implant versus no implant. Therefore, main plot treatments were assigned to pastures and implant treatments were assigned as groups within pastures. Steers were stratified by body weight prior to being randomly assigned to treatments. Steer numbers in 2008 were such that equal numbers of steers were placed in each pasture; however, the 64 steers used 2007 were assigned to have six implanted steers in each of two pastures of one block and six non-implanted steers in each of two pastures of another block. Pastures assigned to the feeding treatment were group-fed to provide daily consumptions of 2.3 kg/steer (as fed).

Cattle were weighed unshrunk on 19 April, 17 May, 14 June, and 5 July (termination of grazing) in 2007, and on 29 April, 27 May, 24 June, and 24 July in 2008. On the last 3 weigh days, rectal temperatures were recorded using a TM99A digital temperature instrument (Cooper-Atkins Corporation, Middlefield, CT), and blood samples were collected from the jugular vein. The blood samples were centrifuged (3,000 x g for 15 minutes) to obtain serum, which was stored frozen (0°C). Serum assayed for prolactin following procedures described by Bernard et al. (1993). On final weigh days, hair coats were rated as sleek (S), having 25 to 75% coverage by rough hair (transitional), or 75 to 100% coverage of rough hair (R3).

Ultrasound scans were taken at the termination of the grazing study using an Aloka™ SSD-500V (Tokyo, Japan) instrument with a 3.5-MHz linear array transducer (UST 6049; 170-mm window). A certified ultrasound technician scanned between the 12^{th} and 13^{th} ribs to acquire cross-sectional area of the *longissimus* muscle and rib fat thickness. Additionally, a second measurement was obtained horizontally between the pin and hook bones over the rump to determine the rump fat thickness.

Pasture Measures

A disk meter, similar to Bransby et al. (1977) with the exception that the falling plate was 45 cm in diameter and weighed 1.9 kg, was used to estimate forage mass (kg DM/ha). Disk meter height was recorded for 50 random locations within each pasture at 14-d intervals.   Calibration samples were collected on 22 June in 2007 and on 17 June in 2008 on 17 June by clipping forage below the disk meter plate to the soil surface at 5 random locations per pasture. These samples were dried at 60°C in a forced-air oven for 48 hours and weighed. Dry matter (DM) per unit of land area was subsequently regressed on disk meter height.

Tiller samples were taken at approximately 14-d intervals to determine the ergovaline concentration. The dates tiller samples were collected to detect ergovaline concentrations in 2007 include 25 April, 8 May, 22 May, 5 June, 22 June, and 7 July. In 2008, samples were collected on 30 April, 19 May, 5 June, 17 June, 30 June, and 16 July. Tiller samples were collected on 5 June in 2007 to determine endophyte infection levels. Fifty random samples of tillers from 50 individual plants were taken per pasture for infection level and fifty additional tiller samples were collected for ergovaline concentration. All tiller samples were collected by clipping individual tillers to ground level using Stanley® (New Britain, CT) retractable utility knives.

Laboratory Analyses

Tiller samples were frozen until laboratory analysis could be performed. Tiller samples were analyzed using a blot test for endophyte infection levels (Gwinn et al., 1991). Blot test kits were obtained from Agrinostics Ltd. Co. (Watkinsville, GA). Tiller samples were freeze dried and analyzed for ergovaline concentration by HPLC florescence using procedures described by Yates and Powell (1983).

Statistical Analyses

All responses were statistically analyzed using PROC MIXED of SAS (Littell et al., 1996; SAS Inst. Inc., 2002). Data was examined as a split-plot design using group within pasture as the experimental unit for animal responses and pasture as the experimental unit for pasture responses. Means separations were performed on least square means using the PDIFF option. Years were analyzed as a random effect. Animal responses were analyzed for effects of SBH feeding, ear implantation, sample date, and all interactions between the three variables. Effects of SBH feeding, sample date, and interactions were evaluated for pasture responses. Animal responses were analyzed as repeated measures using the autoregressive covariance structure. PROC FREQ option in SAS was used to evaluate differences in the distribution of hair coat ratings between years, with and without SBH feeding, with and without ear implantation, and combinations between SBH and ear implantation treatments. Chi-square tests were used to determine differences between distributions of hair coat ratings. Ergovaline and forage mass responses were analyzed using Julian date regression. Block and year were evaluated as discrete variables and Julian date was analyzed as a continuous variable to determine linear, quadratic, and cubic trends.

Chapter Four: Results and Discussion

Forage Mass

Mean forage mass was greater ($P < 0.05$) in 2007 (3,947 ± 98 kg DM/ha) than in 2008 (2,653 ± 96 kg DM/ha) (Fig. 1). Rainfall was likely a contributing factor for differences in forage growth. Rainfall during 2008 was consistently lower than the 14-average, whereas in 2007 it was greater than the average in April and July (Fig. 1). Further, there was 12 cm of rainfall 30 d prior to initiation of grazing in 2007 and only 5 cm of rainfall during the same period in 2008.

Fixed, continuous stocking resulted in linear declines in forage over time, but there was a yr by Julian date interaction ($P < 0.001$). The decline was steeper ($P < 0.001$) in 2007 than in 2008 (Figure 2). Forage mass reduction over the grazing period was approximately 45% in 2007 and 25% in 2008. Although forage declined over time, it was above 2,000 kg DM/ha at the termination of grazing in both years, which indicated that forage mass remained in amounts that would not limit animal performance (Martz et al., 1999).

Forage mass tended to be less ($P < 0.10$) with SBH feeding (3,189 ± 281 kg DM/ha) than without SBH feeding (3,351 ± 281 kg DM/ha). Sanson and Coombs (2000) reported that ADG of yearling steers increased as rate of daily corn supplementation increased up to 0.4% of body weight. However, daily corn consumption greater than 0.4% of body weight has shown to reduce *in situ* digestibility and organic matter intake of warm-season forage (Pordomingo et al., 1991). Soybean hulls, an energy supplement high in digestible fiber, can provide a positive effect on forage intake and digestibility, as compared to corn-based supplements (Ovenell et al., 1991). Richards et al. (2006) reported that supplementing with SBH at a rate of 0.6% BW per day can increase ruminal available energy without greatly altering the rumen environment. This indicates that feeding SBH at the levels fed in the present experiment increased intake of forage, but did not hinder forage mass. Based on procedures used in this grazing experiment, it is difficult to precisely measure forage mass (Aiken and Bransby, 1992). An additional explanation is that consumption of SBH diluted ergot alkaloids in the diet to decrease their negative influence on DM consumption. The increase in fescue intake would have to be slight, however, or the higher consumption could compensate for the diluted concentration of ergot alkaloids.

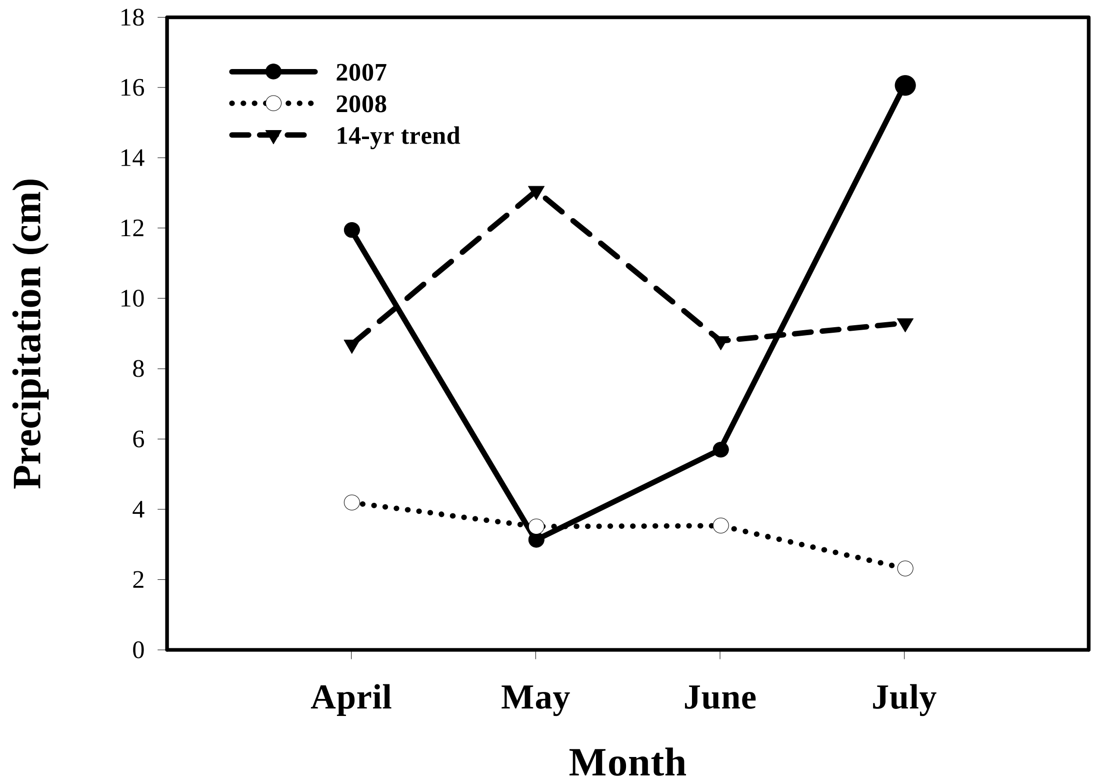

Figure 4.1 Rainfall data averaged for months of grazing in 2007 and 2008, and the 14-yr average.

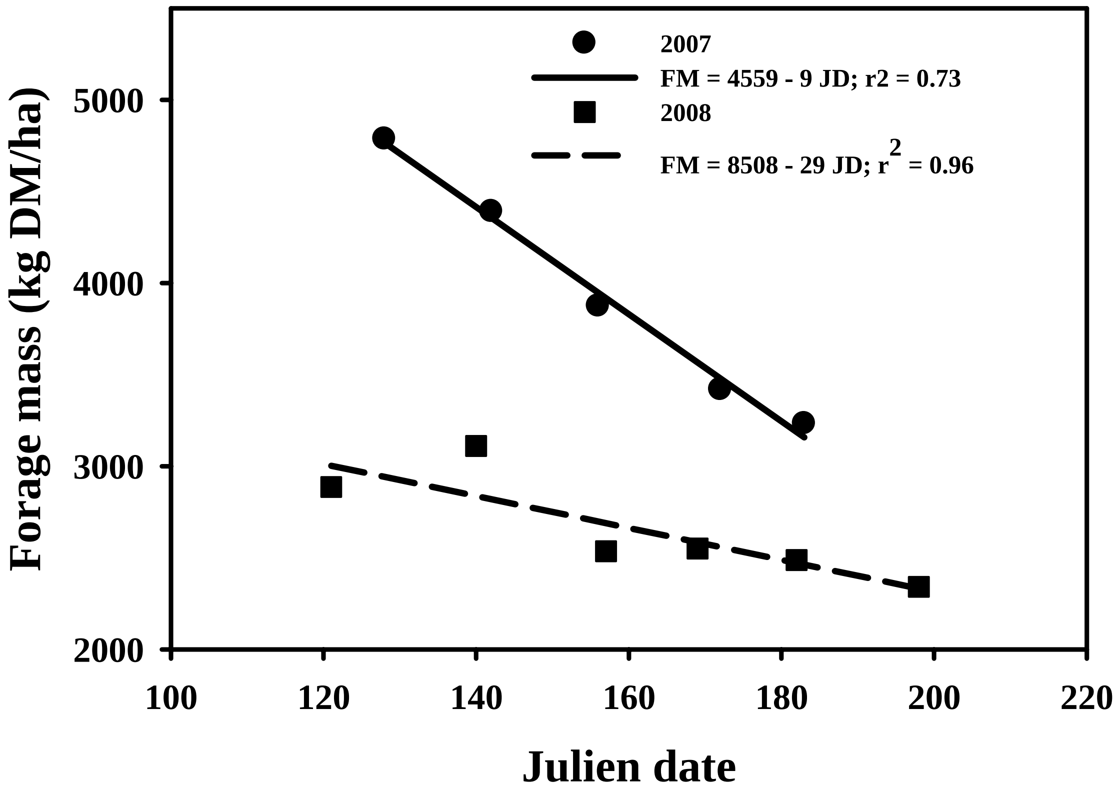

Figure 4.2 Forage mass for the 2007 and 2008 grazing season.

Endophyte Infection Levels and Ergovaline Concentrations

Pastures averaged endophyte infection levels of 80% but ranged from 64 to 84%. Endophyte infection in this range likely induced symptoms of fescue toxicosis. Toxic responses have been elucidated in fescue stands comprising 35% infection level (Fribourg et al., 1991).

Alkaloids produced by the endophyte are suggested to be the causative agent of the negative effects on animals grazing toxic tall fescue (Strickland et al., 1993; Stamm et al., 1994). Ergovaline is the ergot alkaloid in the highest concentration (Lodge-Ivey et al., 2006) and has shown to be the most potent in causing vasoconstriction (Klotz et al., 2007). Ergovaline concentrations during the grazing trial in 2007 varied from 0.3 mg/kg DM to 0.9 mg/kg DM. In 2008, the concentrations ranged from 0.4 mg/kg DM to 0.6 mg/kg DM. Aldrich-Markham et al. (2003) suggested cattle ingesting ergovaline concentrations of 400 to 750 µg/kg DM in herbage will induce symptoms of fescue toxicosis. Furthermore, Aiken et al. (unpublished data) conducted a feeding trial that demonstrated a vasoconstrictive response in heifers consuming diets with low and high concentrations of ergovaline. Heifers allocated to the diet treatment of 0.79 µg ergovaline/g DM exhibited a response within 27 hours and within 51 hours after consumption of 0.39 µg ergovaline/g DM.

Ergovaline concentrations in the fescue herbage showed curvilinear changes over the growing season in both years, with the relationship being cubic ($P < 0.05$) for both years. However, there were year by Julian date interactions ($P < 0.05$) for linear, quadratic, and cubic coefficients (Fig. 3). In 2007, ergovaline concentrations started to increase about the 115 Julian date. It is suggested that ergovaline concentrations follow the development of the fescue culm. However, a sharp decrease in ergovaline was detected soon after clipping of seed heads in the early June. Subsequently, the pasture was dominated by vegetative tillers and the gradual accumulation of ergovaline. The highest ergovaline concentrations were observed (Fig. 3) at the final sampling date (183 Julian date; 0.85 mg/kg DM). A different pattern of ergovaline concentration was observed in 2008. Pastures were mowed the start of the grazing experiment and again on approximately the 160 Julian date to eliminate seed heads. Forage mass increased consistently until day 160, as ergovaline concentration declined. This was opposite of the trend observed in 2007, but this could be attributed to low rainfall following the second mowing in 2008 (Fig. 1).

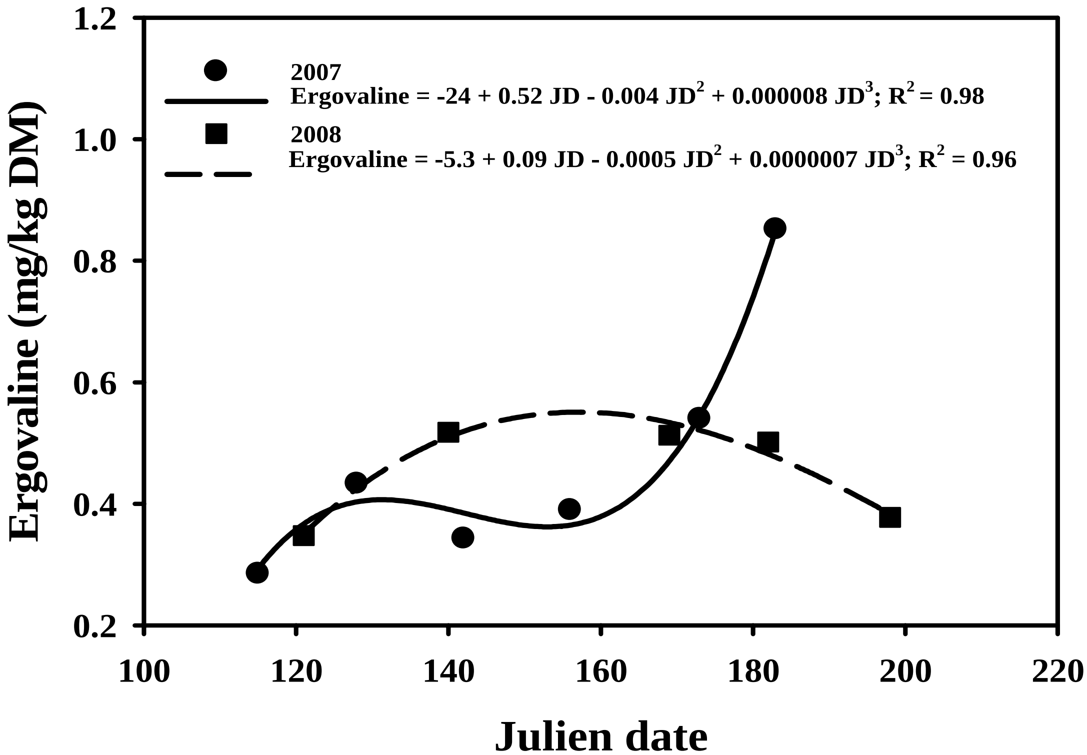

Figure 4.3 Ergovaline concentrations for 2007 and 2008 grazing season based on Julian date.

Animal Performance

Data were combined over years, with year being analyzed as a random effect. There was greater cumulative ADG in period 1 (i.e., first 28 d of grazing) with SBH feeding ($P < 0.05$) and steroidal implantation ($P < 0.05$), but there was no interaction between the treatments ($P = 0.41$) to show additive effects by combining the two treatments (Table 1). Average daily gain with feeding pelleted SBH was approximately 12% greater than without pelleted SBH feeding. There was an estimated 21% increase in ADG of steers with the steroidal implant treatment. Kahl et al. (1978) reported that steers on concentrate diets and implanted with the same product used in the present experiment, had 23% greater ($P < 0.001$) ADG than non-implanted steers during both the 0- to 60- and 60- to 120-day growth periods.

Feeding SBH or steroidal implantation offered similar responses ($P<0.05$) for cumulative ADG in period 2, but there was a tendency for an interaction between treatments ($P = 0.10$) on cumulative ADG. For period 3, there was an interaction ($P < 0.05$) of greater significance between steroidal implantation and SBH feeding. Cumulative ADG was greatest for steers on the combined treatments had an estimated 71% increase ($P < 0.05$) over the control treatment ($P<0.001$) and 29% greater than the SBH feeding and no implanting treatment ($P < 0.001$) and 52% greater than the implanting and no SBH feeding treatment ($P < 0.05$). Beyond Period 1, apparently there was interactivity between SBH feeding and implanting to substantially increase weight gain.

Table 4.1   Mean ADG of 3 periods for steers that grazed toxic tall fescue pasture

SBH	Implant	Period 1 [‡]	Period 2	Period 3
			- - - - kg d^{-1} - - - -	
N	N	1.22	0.96 c	0.72 d
N	Y	1.45	1.09 b	0.81 c
Y	N	1.34	1.10 b	0.95 b
Y	Y	1.66	1.38 a	1.23 a

[†] Main effects of feeding SBH ($P<0.05$) and implanting with steroid hormones ($P<0.01$) (SBH x Impl, $P>0.40$).

[abcd] Means within columns with different letters are significantly different ($P<0.05$).

Steer ADG were relatively high for the control treatment in both years for endophyte-infected tall fescue. Average daily gains for all treatment groups were greater than the range (0.21 to 0.62 kg/d) estimated by Paterson et al. (1995) for steers grazing tall fescue with infection levels greater than 61%. As previously mentioned, for each 10% increase in infection level, average daily gain decreases approximately 0.1 lb (Bond et al., 1984). In another experiment, Crawford et al. (1989) reported an approximate 0.07 kg/d depression in ADG for each 10% unit increase in endophyte-infection occurrence in spring and summer grazing of tall fescue. As previously discussed, steers used in the present experiment were received on 10 April in 2007 and 11 April in 2008 resulting in only a few weeks of preconditioning before the start of the grazing experiment. Compensatory weight gain may have occurred over the first 28 days of the study when the tall fescue was at its highest forage quality and ambient temperatures were moderately low.

Ground soybean hulls, a co-product in the milling of soybean meal and oil, is an excellent source of digestible fiber and energy and has potential for increasing daily gains of animals on pasture grazing regimes. Quicke et al. (1959) reported soybean hulls are low in lignin and have a large proportion of potentially digestible fiber. Due to the moderately-high nutritive value for ruminants, Hibberd et al. (1987) reported soybean hulls can be fed as a primary dietary ingredient for cattle and, furthermore, can be utilized in a range of rations. Fiber contents, neutral detergent fiber (NDF) and acid detergent fiber (ADF) can be used to calculate energy content, digestibility, and potential intake. Generally, as fiber content increases, the digestible energy content decreases. Neutral detergent fiber represents the total cell wall constituents including hemicellulose,

cellulose, and lignin and is closely related to potential feed intake. Acid detergent fiber is comprised of cellulose and lignin – two elements in forage that are highly indigestible. Acid detergent fiber can be used to predict digestibility and energy. The crude protein (CP) content can be generated by measuring the nitrogen (N) concentration and multiplying that by 6.25. Richards et al. (2006) reported the nutrient composition of SBH for % NDF, % ADF, and % N were 67.8, 47.5, and 1.9, respectively.

Growth promoters are extensively used in the cattle industry to improve animal performance through maximizing rate of gain and feed conversion (Rumsey et al., 1991). Various research studies have demonstrated that estrogenic growth stimulators promote growth and lean tissue deposition at several growth development phases (Mader et al., 1994; Rumsey, 1982; Coffey et al., 1992). Steroidal implants divert absorbed nutrients from fat to protein but only under conditions of adequate nutrition.

Cost of Weight Gain

Without implantation, SBH feeding can provide cost-effective increases in weight gain if SBH are purchased at very low bulk rates (Table 2). At 2.3 kg pelleted SBH/steer per day, the breakeven cost for SBH was $130/ton with a high cattle price ($1.20/lb). When steroid implants are used in conjunction with SBH, the breakeven cost of SBH was $230/ton for the lowest cattle price ($0.80/lb), and more than $230/ton at higher cattle prices (Table 2). The additive effect of implanting on ADG can generate weight gain that is below the breakeven with even high SBH costs over a wide range of cattle prices.

Table 4.2 Breakeven costs of additional average daily gain to achieve net return from feeding SBH over a range of cattle selling prices

	Ear implant	
Selling price	With	Without
	Cost of SBH/ton †	
$1.76/kg ($0.80/lb)	230	90
$1.98/kg ($0.90/lb)	>230*	100
$2.20/kg ($1.00/lb)	>230	110
$2.43/kg ($1.10/lb)	>230	120
$2.65/kg ($1.20/lb)	>230	130

* Breakeven cost is greater than $230/ton

† SBH cost/English ton

Hair Coat Rating

Cattle suffering from tall fescue toxicosis may retain rough hair coats through the summer months and this may increase their susceptibility to heat stress (McClanahan et al., 2008). Hair coat ratings were similar ($P > 0.10$) between the two years and there was no main effect ($P > 0.10$) of implanting on hair coat ratings. The hair coat ratings differed ($P < 0.05$) in animals with and without SBH feeding. An estimated 18% of steers under the SBH feeding treatment had sleek hair coats and 39% of the steers had over 75% coverage of rough winter hair coats. A high percentage (approximately 61%) of steers that were not fed SBH retained their winter hair coat. This suggests that feeding SBH at the consumption rate used in the experiment had a dilution effect on the ergot alkaloid concentrations in the total diet. In a similar experiment, a high percentage of steers fed a broiler-litter corn supplement while grazing endophyte-infected tall fescue exhibited sleek or transitional hair coats (Aiken et al., 1998). A percentage of steers not fed SBH also had sleek (5%) and transitional (34%) hair coats, which can be associated with genetics (Olson et al., 2003).

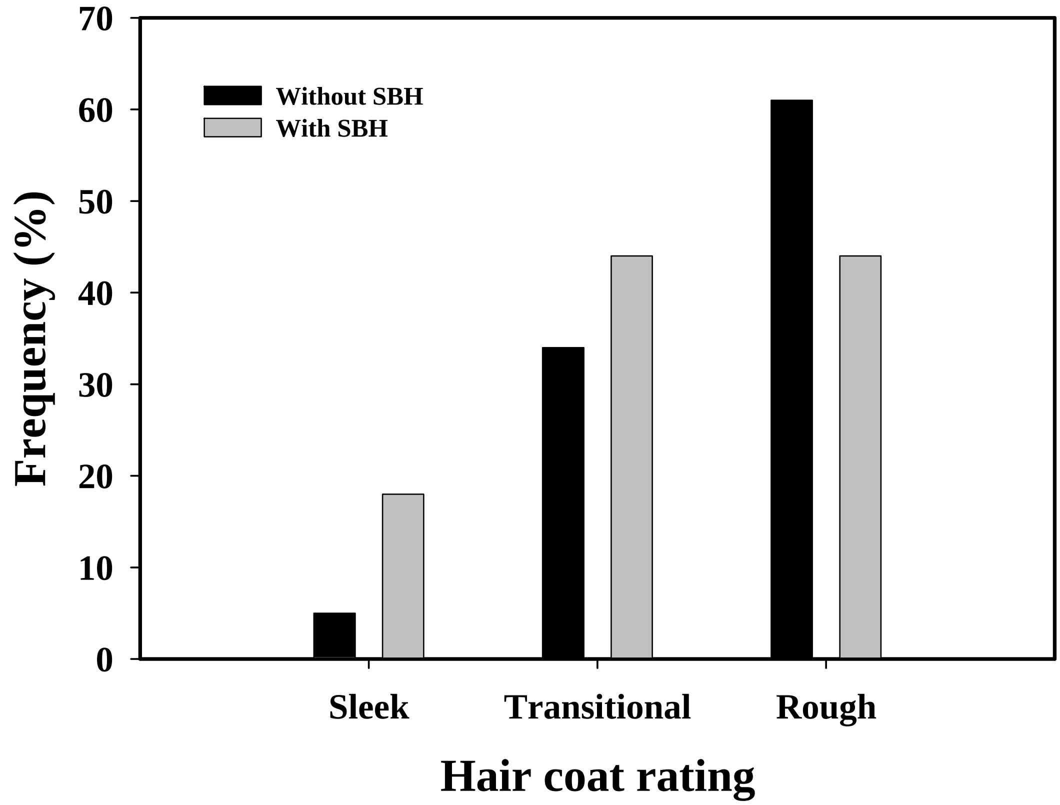

Figure 4.4 Haircoat ratings for steers with or without SBH feeding.

Rectal Temperature

There were differences ($P < 0.05$) in rectal temperature among measurement dates, with rectal temperatures being greater on measurement date 2 (39.6 ± 0.08ºC) than on measurement date 1 (39.3 ± 0.08ºC) or measurement date 3 (39.2 ± 0.08ºC). Mean ambient temperature was shown to dramatically increase by measurement date 2 in 2007 (Figure 5) and likely was an influencing factor in elevating rectal temperatures. Rectal temperature is strongly affected by ambient temperature (Cole, 1993).

Feeding SBH without implantation had the highest (39.5ºC) body temperatures ($P < 0.001$), whereas the rectal temperatures were similar ($P > 0.10$) among the other three treatments: 39.3 ± 0.08ºC for control treatment; 39.4 ± 0.08ºC for implant only treatment; 39.3 ± 0.08ºC for combined feeding + implant treatment. Feeding soybean hulls could have increased gut fill to create a higher heat increment. In contrast, Aiken et al. (2006) reported higher rectal temperatures in steers implanted with steroid hormones and grazing endophyte-infected tall fescue than those not implanted. Differences in body temperature have not been detected between different implants (McClanahan et al., 2008) or in cattle with contrasting feeding regimes (Aiken et al., 2008). However, as indicated by McClanahan et al. (2008), implants can increase sweat production, in which is associated with increased peripheral blood flow (Finch, 1986). Implantation and SBH feeding could possibly interact to improve vasculature circulation.

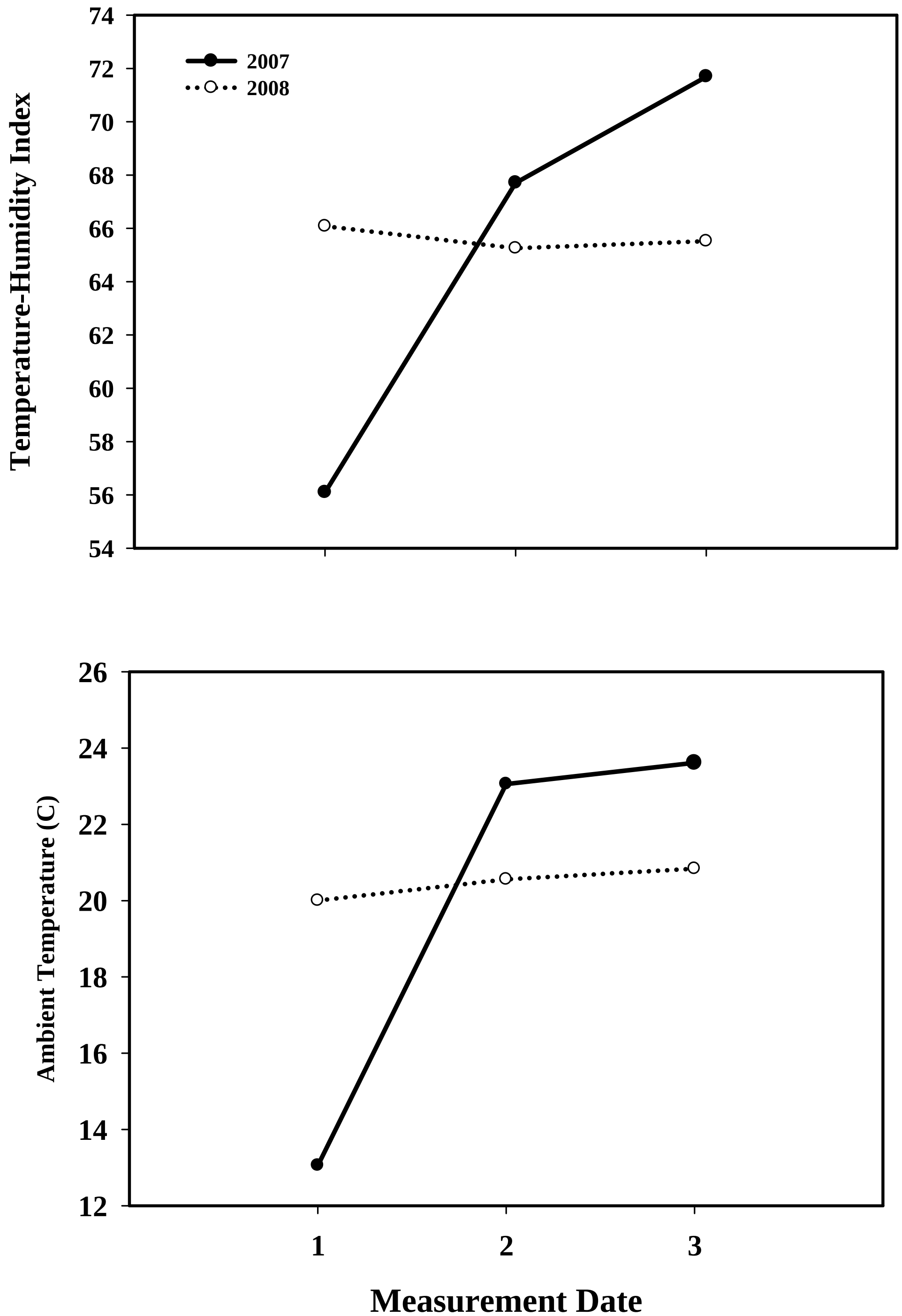

Figure 4.5 Mean ambient temperature and heat indices for periods of the day on the measurement dates steer BW and rectal temperatures were collected.

Serum Prolactin

Prolactin is consistently low in cattle stressed by fescue toxicosis and, therefore, it may serve as a marker for toxicosis even though it has not been implicated as a causal factor (Strickland et al., 1993). Blood serum was assayed for serum prolactin for 2007 and not 2008 samples. There was no implant effect (P = 0.82) on serum prolactin concentrations in 2007. Likewise, Coffey et al., (1992) reported implanting stocker cattle while grazing endophyte-infected tall fescue did not increase prolactin concentrations, but did significantly increase grazing gains. Feeding SBH in 2007 resulted in a near four-fold increase ($P<0.05$) in serum prolactin concentrations over steers without SBH feeding. Prolactin in serum from steers supplemented with SBH had least square means of 104.19 ± 13.99 ng/mL while steers not fed SBH had least square means of 28.73 ± 13.46 ng/mL. Other researchers have not reported significant differences in prolactin concentrations when feeding practices were implemented (Aiken et al., 1998). Influential factors possibly masking prolactin responses include residence time in GI tract, environmental conditions, endophyte-infection levels, previous animal history, ergovaline concentrations, plane of nutrition, and animal genetics.

Feeding pelleted soybean hulls to steers provides a high fiber diet in addition to consumption of tall fescue in grazing regimes. A plausible explanation for its activity in this experiment suggests a dilution of the ergot alkaloids. Research has shown cattle are highly sensitive to ergot alkaloids (Aiken et al., 2007; Klotz et al., 2007). There are commercial products are available that bind ergot alkaloids and prevent absorption thereby mitigating the symptoms of fescue toxicosis. Research on cattle indicated that yeast-derived cell wall preparation (YCW) increased serum prolactin increased linearly with increasing YCW supplementation (Merrill et al., 2007). The mode of action for YCW is not clear, but Akay et al., (2003) suggests it binds the toxin(s) causing fescue toxicosis. It is possible that the cell wall of SBH has similar chemical composition to YCW and also binds ergot alkaloids and reduces the severity of fescue toxicosis. However, additional research is needed to confirm if the response was attributed to a dilution effect, chemical binding activities, or a combination of the two.

Ultrasonography

There was a year effect on *longissimus* dorsi area between steers ($P < 0.05$) and with no interactions between SBH and implants (Table 3). Ultrasonography indicated that the implantation and SBH treatments alone had no significant effect on the on *longissimus* dorsi area. Feeding SBH, however, in conjunction with implants resulted in a 13.5% increase in *longissimus* area over that of the control treatment at termination of grazing (77 d in 2007; 86 d in 2008) (Table 3).

Steers with implants but without SBH had the lowest rump fat thickness ($P < 0.001$); indicating nutrients were preferentially partitioned to lean tissue deposition. The highest rump fat thickness was found in steers on the combined treatment ($P < 0.001$) of SBH feeding and steroidal implants with an estimated 45% increase over implanted only steers. This suggests that feeding SBH or the combined effect of feeding SBH with implantation encourages fat deposition. Steroidal implants increase the quantity and percentage of lean tissue, while reducing the deposition of fat (Lemieux et al., 1990). Conversely, Rumsey (1982) reported that steers implanted with the Synovex ingested more DM than non-implanted steers, resulting in increased energy retention as fat.

Rib fat thickness responded to SBH feeding ($P < 0.05$) with an estimated 18% increase in steers being fed SBH compared to those not fed SBH. Additional fat thickness of the SBH steers suggests soybean hulls promoted fat deposition through increased net energy intake. There was no effect of implantation ($P = 0.38$) on rib fat thickness.

Table 4.3 Ultrasound measurement averages for steers that grazed toxic tall fescue pastures in 2007 & 2008.

		Longissimus Area	**Rump Fat Thickness**	**Rib Fat Thickness**[‡]
SBH	Implant	- cm^2 - - - - - - - - -	cm - - - - - - - - -	cm - -
N	N	50.97 b	0.41 b	0.43 b
N	Y	50.77 b	0.33 c	0.41 b
Y	N	51.16 b	0.43 a	0.48 a
Y	Y	57.87 a	0.46 a	0.48 a

[†] 12th to 13th rib fat thickness

[abc] Means within columns with different letters are significantly different (P<0.05).

The consensus of literature is that implantation does not promote fat deposition (Lemieux et al., 1988; Lemieux et al., 1990). In opposition, Rumsey (1982) reported implanted steers tended ($P > 0.10$) to have higher quality grades, more marbling, and greater *longissimus* area in addition to higher dressing percentages than carcasses of non-implanted steers, reflecting greater intake, higher gain, and improved body condition. Although carcass traits were not measured in the present experiment, feeding SBH appeared to have a stronger influence than steroid implantation on body condition and *longissimus* area.

Chapter Five: Conclusion

Soybean hulls may be used as a low-cost feedstuff because they are readily available in the tall fescue grasslands. Soybean hulls are especially cost-effective when purchased in bulk and they are a popular alternative to high-priced energy supplements. Soybean hull feeding has exceptional potential to enhance weight gains with steers grazing endophyte-infected fescue. An additional technological approach to improve animal performance under optimal conditions of nutrition is the use of animal growth promoters. Estrogenic growth promoters are a cost-effective management practice.

Results showed positive interactions exist between SBH supplementation and estradiol + progesterone growth hormones with regard to animal growth rates. Our highest recorded weight gains were obtained from the combined treatment of SBH and steroidal ear implants, which achieved a mean ADG of 1.23 kg/d over the duration of the grazing trial (77 d in 2007; 86 d in 2008). The combination of treatments provided an estimated 71% increase ($P < 0.05$) over the control treatment ($P < 0.001$). Furthermore, there was a 32% increase ($P<0.001$) in growth rates with SBH in the absence of implants ($P < 0.001$) and a 13% higher growth rate with implanting in the absence of SBH ($P < 0.05$). Thus, combining SBH feeding with steroidal implantation provides an additive effect on animal performance.

Highest rectal temperatures were recorded in animals fed SBH without implants; possibly from higher heat increments from digestion due to increased gut fill. Evaluating body temperature responses, it is surmised that implantation with SBH feeding interact to improve blood circulation. Additionally, rough hair coat ratings were predominately observed in steers with the non-feed treatment. A near four-fold increase in serum prolactin levels were observed in steers being fed SBH versus steers without access to SBH. Ebling et al. (1991) conluded that prolactin under non-toxic situations is responsible for restricting hair growth and inducing coat shedding. However, cattle suffering from fescue toxicosis express suppressed serum prolactin levels and therefore may not have sufficient hormone concentrations to initiate shedding or inhibit growth. Feeding SBH in the present experiment to steers grazing toxic tall fescue implies it can dilute ergot alkaloids in the total diet, increase serum prolactin concentrations, and reduce vulnerability to heat stress through supporting hair coat shedding mechanisms associated with prolactin levels.

The interaction of feeding SBH and implants resulted in a substantial increase in *longissimus* cross sectional area and rump fat thickness. This response is likely attributed to additional nutrient absorption with feeding SBH and, therefore, suggests that feeding SBH or the combined effect of feeding SBH with ear implantation provided high enough digestible energy to encourage fat deposition. Rib fat thickness also increased with SBH feeding to further indicate that soybean hulls promote fat deposition through supplementary energy.

Enhanced ADG, improved vasculature circulation, greater *longissimus* areas, and increases in rump fat thickness indicates that the combined effects of feeding SBH with steroidal implantation improves animal performance and counters negative physiological effects of animals consuming endophyte-infected tall fescue. Additionally, feeding pelleted SBH may also modify negative effects of animals normally observed with intake of toxic tall fescue by increasing prolactin concentrations. Although fescue toxicosis is not completely alleviated, the severity was apparently reduced.

References

Abney, L. K., J. W. Oliver, and C. R. Reinemeyer. 1993. Vasoconstrictive effects of tall fescue alkaloids on equine vasculature. J. Equine Vet Sci. 13(6):334-340.

Aiken, G. E., and D. I. Bransby. 1992. Observer variability for disk meter measurements of forage mass. Agron. J. 84:603-605.

Aiken, G. E., D. M. Ball, E. L. Piper, and C. P. West. 1998. Performance of steers fed a broiler litter-corn mixture on endophyte-infested and non-infested tall fescue. Prof. Anim. Sci. 14:51-55.

Aiken, G. E., and E. L. Piper. 1999. Stocking rate effects on steer performance for two methods of alleviating fescue toxicosis. Prof. Anim. Sci. 15:245-252.

Aiken, G. E., E. L. Piper, and C. R. Miesner. 2001. Influence of protein supplementation and implant status on alleviating fescue toxicosis. J. Anim. Sci. 79:827-832.

Aiken, G. E., PAS, F. M. Rouquette, Jr., and R. K. Miller. 2002. Grazing treatment effects on ultrasound measures of 12^{th} to 13^{th} rib fat thickness and longissimus area. Prof. Anim. Sci. 18:368-372.

Aiken, G. E., M. L. Looper, S. F. Tabler, D. K. Brauer, J. R. Strickland, and F. N. Schrick. 2006. Influence of stocking rate and steroidal implants on growth rate of steers grazing toxic tall fescue and subsequent physiological responses. J. Anim. Sci. 84:1626-1632.

Aiken, G. E., B. H. Kirch, J. R. Strickland, L. P. Bush, M. L. Looper, and F. N. Schrick. 2007. Hemodynamic responses of the caudal artery to toxic tall fescue in beef heifers. J. Anim. Sci. 85:2337-2345.

Aiken, G. E., L. K. McClanahan, and F. N. Schrick. 2008. Steer responses to feeding soybean hulls on toxic tall fescue pasture. Prof. Anim. Sci. 24(5):399-403.

Aiken, G. E., J. R. Strickland, M. L. Looper, L. P. Bush, and F.N. Schrick. Hemodynamics are altered in the caudal artery of beef heifers fed different ergot alkaloid concentrations. Unpublished data.

Akay, V., K. A. Dawson, D. G. Ely, and D. K. Aaron. 2003. Evaluation of a carbohydrate-based adsorbent for controlling intoxication associated with endophyte-infected pasture grasses. Biotechnology in the feed industry, 2003 proceedings (19^{th} annual). Pages 267-274. T. P. Lyons and K. A. Jacques, ed. Alltech Nottingham Univ. Press, Nottingham, UK.

Al-Haidary, A., D. E. Spiers, G. E. Rottinghaus, G. B. Garner, and M. R. Ellersieck. 2001. Thermoregulatory ability of beef heifers following intake of endophyte-infected tall fescue during controlled heat challenge. J. Anim. Sci. 79:1780-1788.

Aldrich, C. G. 1991. Feed intake, diet utilization and thermal balance of ruminants as affected by endophyte infected tall fescue. M.S. Thesis. Univ. of Missouri, Columbia.

Aldrich, C. G., J. A. Paterson, J. L. Tate, and M. S. Kerley. 1993. The effects of endophyte-infected tall fescue consumption on diet utilization and thermal regulation in cattle. J. Anim. Sci. 71:164-170.

Aldrich-Markham, S., G. Pirelli, and A. M. Craig. 2003. Endophyte toxins in grass seed fields and straw; effects on livestock. Publication EM 8598. Report of Oregon State Univ. Ext. Serv., Corvallis, OR.

Bacon, C. W., and M. R. Siegel. 1988. Endophyte parasitism of tall fescue. J. Prod. Agric. 1:45-55.

Bacon, C. W. 1994. Toxic endophyte-infected tall fescue and range grasses: historic perspectives. J. Anim. Sci. 73:861-870.

Bacon, C. W. and N. S. Hill. 1995. Symptomless grass endophytes: Products of coevolutionary symbiosis and their role in the ecological adaptation of infected grasses. In: S. C. Redlin (Ed.) Systematics, ecology and evolution of endophytic fungi in grasses and woody plants. American phytopathological society, St. Paul, MN.

Ball, D. M. 1984. An overview of fescue toxicity research. Auburn Vet. 39:66.

Ball, D. M., C. S. Hoveland, and G. D. Lacefield. 2002. Fescue toxicity. Pages 198–205 in Southern Forages: Modern Concepts for Forage Crop Management. 3rd ed. Graphic Communications Corp., Lawrenceville, GA.

Berman, A. 2005. Estimates of heat stress relief needs for Holstein dairy cows. J. Anim. Sci. 83:1377-1384.

Bernard, J. K., A. B. Chestnut, B. H. Erickson, and F. M. Kelly. 1993. Effects of prepartum consumption of endophyte-infected tall fescue on serum prolactin and subsequent milk production. J. Dairy Sci. 76:1928-1933.

Boling, J. A., L. D. Bunting, G. M. Davenport, J. L. Van der Veen, K. M. Meekins, N. W. Bradley, and R. E. Kohls. 1989. Physiological responses of cattle consuming tall fescue to environmental temperature and supplemental phenothiazine[1]. J. Anim. Sci. 67:2377-2385.

Bond, J., J. J. Powell, D. J. Undersander, P. W. Moe, H. F. Tyrell, and R. R. Oltjen. 1984. Forage composition and growth and physiological characteristics of cattle grazing several varieties of tall fescue during summer conditions. J. Anim. Sci. 59:584-593.

Bond, J., G. P. Lynch, D. J. Bolt, H. W. Hawk, G. Jackson, Jr., R. J. Wall. 1988. Reproductive performance and lamb weight gains for ewes grazing fungus-infected tall fescue. Nutr. Rep. Int. 37:1099-1115.

Brandt, R. T., Jr., R. L. Preston, R. H. Pritchard, and A. H. Trenkle. 1994. Metabolizable protein needs of steers implanted with trenbolone acetate and estradiol. J. Anim. Sci. 72:353

Bransby, D. I., A. G. Matthews, and G. F. Krause. 1977. Disk meter for rapid estimation of herbage yield in grazing trials. Agron. J. 69:393-396.

Bransby, D., D. Kee, S. Sladden, J. Eason, and J. Owen. 1994. Fighting fescue toxicity. Highlights Agric. Res. Alabama Agric. Exp. Stn. 41:3-4.

Brazle, F. K., and K. P. Coffey. 1991. Effect of zeranol on performance of steers grazing high and low endophyte tall fescue pastures. Prof. Anim. Scientist. 7(3):39.

Browning, Jr., R., M. L. Leite-Browning, H. M. Smith, and T. Wakefield, Jr. 1998. Effect of ergotamine and ergonovine on plasma concentrations of thyroid hormones and cortisol in cattle. J. Anim. Sci. 76:1644-1650.

Chestnut, A. B., P. D. Anderson, M. A. Cochran, H. A. Fribourg, and K. D. Gwinn. 1992. Effects of hydrated sodium calcium aluminosilicate on fescue toxicosis and mineral absorption. J. Anim. Sci. 70:2838-2846.

Coffey, K. P., L. W. Lomas, and J. L. Moyer. 1990. Grazing and subsequent feedlot performance by steers that grazed different types of fescue pasture. J. Prod. Agric. 3:415-420.

Coffey, K. P., J. L. Moyer, L. W. Lomas, J. E. Smith, D. C. La Rue, and F. K. Brazle. 1992. Implant and copper oxide needles for steers grazing *Acremonium coenophiliam*-infected tall fescue pastures: effects on grazing and subsequent feedlot performance and serum constituents. J. Anim. Sci. 70:3203-3214.

Coffey, K. P., W. K. Coblentz, J. B. Jumphry, E. L. Piper, C. F. Rosenkrans, Jr., D. S. Hubbell, III, K. F. Harrison, T. M. Denard, F. W. Pohlman, D. H. Hellwig, L. B. Daniels, and L. J. McBeth. 2001. Growth performance and serum prolactin concentrations of stocker steers implanted with trenbolone acetate while grazing endophyte-infected fescue in the spring. Prof. Anim. Sci. 17:166-173.

Cole, N. A. 1993. Nutritional management of stressed and morbid calves. Pages 178-179 in Current Veterinary Therapy: Food Animal Practice. 3rd ed. J. L. Howard, ed. W. B. Saunders Co., Philadelphia, PA.

Crawford, Jr., R. J., J. R. Forwood, R. L. Belyea, and G. B. Garner. 1989. Relationship between level of endophyte infection and cattle gains on tall fescue. J. Prod. Agric. 2:147-151.

Crawford, Jr., R. J., G. B., Garner, D. H. Wallace, and S. J. Gross. 1990. Effects of continuous invermectin administration on performance of steers affected by fescue toxicosis. J. Animl Sci. 68:561.

Danilson, D. A., S. P. Schmidt, C. C. King, L. A. Smith, and W. B. Webster. 1986. Fescue toxicity and reproduction in beef heifers. J. Anim. Sci. 63(Suppl 1):296 (Abstract).

Earle, W. E., D. L. Cross, L. W. Hudson, L. M. Redmond, and S. W. Kennedy. 1990. Effect of energy supplementation on gravid mares grazing endophyte-infected fescue. Eq. Vet. Sci. 10:126-130.

Ebling, F. J. G., P. A. Hale, and V. A. Randall. 1991. Hormones and hair growth. In: L. A. Goldsmith (ed.) Physiol., Biochem., and Molecular Biol. of the Skin. 2nd ed. pp. 660-696. Oxford University Press, New York, NY.

Elsasser, T. H., and D. J. Bolt. 1987. Dopaminergic-like activity in toxic fescue alters prolactin but not growth hormone or thyroid stimulating hormone in ewes. Domest. Anim. Endocrinol. 4:2259.

Finch, V. A. 1986. Body temperature in beef cattle: its control and relevance to production in the tropics. J. Anim. Sci. 62:531-542.

Fiorito, I. M., L. D. Bunting, G. M. Davenport, et al. 1991. Metabolic and endocrine responses of lambs fed Acremonium coenophialum-infected or noninfected tall fescue hay at equivalent nutrient intake. J. Anim. Sci. 69:2108-2114.

Fontenot, J. P., and K. E. Webb, Jr. 1975. Health aspects of recycling animal wastes by feeding. J. Anim. Sci. 40:1267.

Fribourg, H. A., A. B. Chestnut, R. W. Thompson, J. B. McLaren, R. J. Carlisle, K. D. Gwinn, M. C. Smith, and M. C. Dixon. 1991a. Steer performance in fescue-clover pastures with different levels of endophyte infestation. Agron. J. 83:777-781.

Gadberry, M. S., T. M. Denard, D. E. Spiers and E. L. Piper. 2003. Effects of feeding ergovaline on lamb performance in a heat stress environment. J. Anim. Sci. 81:1538-1545.

Garner, G. B., G. E. Rottinghaus, C. N. Cornell, and H. Testereci. 1993. Chemistry of compounds associated with endophyte/grass interaction: Ergovaline- and ergopeptine-related alkaloids. Pages 65-80 in Int. Symp. *Acremonium/*Grass Interactions. Elsevier Science Publishers, Amsterdam, The Netherlands.

Goetsch, A. L., A. L. Jones, S. R. Stokes, K. W. Beers, and E. L. Piper. 1987. Intake, digestion, passage rate and serum prolactin in growing dairy steers fed endophyte-infected fescue with noninfected fescue, clover or wheat straw. J. Anim. Sci. 64:1759-1768.

Goetsch, A. L. 1989. Effects of supplementation on feed intake, digestion, and performance by cattle consuming endophyte-infected tall fescue. In Proc. Ark. Fescue Toxicosis Conf. C. P. West (Ed.). p. 17. Ark. Exp. Stn. Spec. Rep. 140.

Griffin, D. B., J. W. Savell, R. P. Recio, R. P. Garrett, and H. R. Cross. 1999. Predicting carcass composition of beef cattle using ultrasound technology. J. Anim. Sci. 77:889-892.

Gwinn, K. D., M. H. Collins-Shepard and B. B. Reddick. 1991. Tissue print-immunoblot, and accurate method for the detection of Acremonium coenaphialum in tall fescue. The Am. Phytophathological Soc. 81:747-48.

Hibberd, C. A., F. T.McCollum, and R. R. Scott. 1987. Soybean hulls for growing beef cattle. Anim. Sci. Res. Rep., Oklahoma Agric. Exp. Sta. pp 248–251.

Hill, N. S., D. P. Belesky, and W. C. Stringer. 1991. Competitiveness of tall fescue as influenced by Acremonium coenophialum. Crop Sci. 31:185-190.

Hemken, R. W., J. A. Boling, L. S. Bull, R. H. Hatton, R. C. Buckner, and L. P. Bush. 1981. Interaction of environmental temperature and anti-quality factors on the severity of fescue toxicosis. J. Anim. Sci. 52:710-714.

Hemken, R. W., J. A. Jackson, Jr., and J. A. Boling. 1984. Toxic factors in tall fescue. J. Anim. Sci. 58:1011-1016.

Hoveland, C. S., S. P. Schmidt, C. C. King, Jr., J. W. Odom, E. M. Clark, J. A. McGuire, L. A. Smith, H. W. Grimes, and J. L. Holliman. 1983. Steer performance and association of *Acremonium coenophialum* fungal endophyte on tall fescue pasture. Agron. J. 75:821-824.

Hoveland, C. S. 1993. Importance and economic significance of the *Acremonium* endophytes to performance of animals and grass plant. Agric., Ecosystems, & Environ. 44:3-12.

Hurley, W. L., Convey, E. M., Leung, K., Edgerton, L. A. and R. W. Hemken. 1981. Bovine prolactin, TSH, T4, T3 concentrations as affected by tall fescue summer toxicosis and temperature. J. Anim. Sci. 51:374-379.

Jones, K. L., S. S. King, D. E. Griswold, D. Cazac, and D. Cross. 2003. Domperidone can ameliorate deleterious reproductive effects and reduced weight gain associated with fescue toxicosis in heifers. J. Anim. Sci. 81:2568-2574.

Kahl, S., J. Bitman, and T. S. Rumsey. 1978. Effect of synovex-s on growth rate and lasma thyroid hormone concentrations in beef cattle. J. Anim. Sci. 46:232-237.

Krag, H., and D. Schams. 1974. Prolactin release in cattle. J. Reprod. Fertil. 39:463.

Klotz, J. L., L. P. Bush, D. L. Smith, W. D. Shafer, L. L. Smith, A. C. Vevoda, A. M. Craig, B. C. Arrington, and J. R. Strickland. 2006. Assessment of vasoconstrictive potential of D-lysergic acid using an isolated bovine lateral saphenous vein bioassay[1]. J. Anim. Sci. 84:3167-3175.

Klotz, J. L., L. P. Bush, D. L. Smith, W. D. Shafer, L. L. Smith, B. C. Arrington, and J. R. Strickland. 2007. Ergovaline-induced vasoconstriction in an isolated bovine lateral saphenous vein bioassay. J. Anim. Sci. 85:2330.

Lemieux, P. G., F. M. Byers, and G. T. Schelling. 1988. Anabolic effects on rate of protein and fat deposition and energy retention in cattle fed forage and grain diets. J. Anim. Sci. 66:1824-1836.

Lemieux, P. G., F. M. Byers, and G. T. Schelling. 1990. Relationship of anabolic status and phase and rate of growth to priorities for protein and fat deposition in steers. J. Anim. Sci. 68:1702-1710.

Littell, R. C., G. A. Milliken, W. W. Stroup, and R. D. Wolfinger. 1996. SAS System for Mixed Models. SAS Inst. Inc., Cary, NC.

Lodge-Ivey, S. L., K. Walker, T. Fleischmann, J. E. True, and A. M. Craig. 2006. Detection of lysergic acid in ruminal fluid, urine, and in endophyte-infected tall fescue using high-performance liquid chromatography. J. Vet. Diagn. Invest. 18:369-374.

Mader, T. L., J. M. Dahlquist, M. H. Sindt, R. A. Stock, and T. J. Klopfenstein. 1994. Effect of sequential implanting with Synovex on steer and heifer performance. J. Anim. Sci. 72:1095-1100.

Martz, F. A., V. G. Tate, and J. R. Gerrish. 1999. Meeting nutritional needs of livestock from pasture. In Missouri Grazing Manual. J. R. Gerrish and C. A. Roberts (Eds.). M157:37.

McClanahan, L. K., G. E. Aiken, and C. T. Dougherty. 2008. Hair coat and steroidal implant effects on steers grazing endophyte-infected tall fescue during the summer. 24:269-276.

Merrill, M. L., D. W. Bohnert, D. L. Harmon, A. M. Craig, and F. N. Schrick. 2007. The abililty of a yeast-derived cell wall preparation to minimize toxic effects of high ergot-alkaloid tall fescue straw in beef cattle. J. Anim. Sci. 85:2596-2605.

Monroe, J. L., D. L. Cross, L. W. Hudson, D. M. Hendricks, S. W. Kennedy, and W. C. Bridges, Jr. 1988. Effect of selenium and endophyte-contaminated fescue on performance and reproduction in mares. Eq. Vet. Sci. 8:148-153.

Oliver, J. W. 2005. Pathophysiologic response to endophyte toxins. In Neotyphodium in Cool-Season Grasses. p. 291-304. C. A. Roberts, C. P. West, and D. E. Spiers (Eds.). Blackwell Publishing, Aimes, IA.

Olson, T. A., C. Lucena, C. C. Chase Jr., and A. C. Hammond. 2003. Evidence of a major gene influencing hair length and heat tolerance in *Bos taurus* cattle. J. Anim. Sci. 81:80–90.

Ovenell, K. H., K. S. Lusby, G. W. Horn, and R. W. McNew. 1991. Effects of lactational status on forage intake, digestibility, and particulate passage rate of beef cows supplemented with soybean meal, wheat middlings, and corn and soybean meal. J. Anim. Sci. 69:2617-2623.

Parish, J. A., M. A. McCann, R. H. Watson, N. N. Paiva, C. S. Hoveland, A. H. Parks, B. L. Upchurch, N. S. Hill, and J. H. Bouton. 2003. Use of non-ergot alkaloid-producing endophytes for alleviating tall fescue toxicosis in stocker cattle. J. Anim. Sci. 81:2856-2868.

Paterson, J., C. Forcherio, B. Larson, M. Samford, and M. Kerley. 1995. The effects of fescue toxicosis on beef cattle productivity. J. Anim. Sci. 73:889.

Perkins, T. L., R. D. Green, and K. E. Hamlin. 1992. Evaluation of ultrasound estimates of carcass fat thickness and longissimus muscle area in beef cattle. J. Anim. Sci. 70:1002-1010.

Perry, T. C., M. Stob, D. A. Huber, and D. C. Paterson. 1970. Effect of subcutaneous implantation of resorcyclic acid lactone on performance of growing and finishing beef cattle. J. Anim. Sci. 31:789.

Peters, C. W., K. N. Grigsby, C. G. Aldrich, J. A. Paterson, R. J. Lipsey, M. S. Kerley, and G. B. Garner. 1992. Performance, forage utilization, and ergovaline consumption by beef cows grazing endophyte fungus-infected tall fescue, endophyte fungus-free tall fescue, or orchardgrass pastures. J. Anim. Sci. 70:1550.

Pordomingo, A. J., J. D. Wallace, A. S. Freeman, and M. L. Galyean. 1991. Supplemental corn grain for steers grazing native rangeland during summer. J. Anim. Sci. 69:1678-1687.

Porter, J. K., C. W. Bacon, J. D. Robbins, and D. Betowski. 1981. Ergot alkaloid identification in Clavicipitaceae systemic fungi of pasture grasses. J. Agric. Food Chem., 29:653-658.

Porter, J. K. and F. N. Thompson, Jr. 1992. Effects of fescue toxicosis on reproduction in livestock. J. Anim. Sci. 70:1594-1603.

Porter, J. K. 1994. Chemical constituents of grass endophytes. In: C. W. Bacon and J. F. White (Ed). Biotechnology of Endophytic Fungi of Grasses. pp 103-123. CRC Press, Boca Raton, FL.

Quicke, G. V., O. G. Bentley, H. W. Scott, R. R. Johnson, and A. L. Moxon. 1959. Digestibility of soybean hulls and flakes and the in vitro digestibility of the cellulose in various milling by-products. J. Dairy Sci. 42:185–186.

Richards, C. J., R. B. Pugh, and J. C. Waller. 2006. Influence of soybean hull supplementation on rumen fermentation and digestibility in steers consuming freshly clipped, endophyte-infected tall fescue. J. Anim. Sci. 84:678-685.

Rottinghaus, G. E., G. B. Garner, C. N. Cornell, and J. L. Ellis. 1991. HPLC method for quantitating ergovaline in endophyte-infested tall fescue: Season variation of ergovaline levels of stems with leaf sheaths, leaf blades, and seed heads. J. Agric. Food Chem. 39:112.

Rumsey, T. S. 1982. Effect of Snyovex-S implants and kiln dust on tissue gain by feedlot beef steers. J. Anim. Sci. 54:1030.

Rumsey, T. S. and A. C. Hammond. 1990. Effects of intake level on metabolic response to estrogenic growth promoters in beef steers. J. Anim. Sci. 68:4310-4318.

Rumsey, T. S., A. C. Hammond, and J. P. McMurtry. 1991. Response to reimplanting beef steers with estradiol benzoate and progesterone: performance, implant absorption pattern, and thyroxine status. J. Anim. Sci. 70:995-1001.

Sanson, D. W., and D. Coombs. 2000. Energy supplementation for yearling cattle grazing ryegrass and ryegrass/rye mixtures. 2000 Rosepine Res. Rep. Vol. 11. Louisiana Agric. Exp. Stn., Baton, Rouge.

SAS Institute Inc. 2002. The SAS System for Windows Version 8.0. SAS Inst., Cary, NC.

Schmidt, S. P., D. A. Danielson, J. L. Holliman, H. W. Grimes, and W. B. Webster. 1986. Fescue fungus suppresses growth and reproduction in replacement beef heifers. Alabama Agric. Exp. Sta. Highlights Agric. Res. 33(4):15.

Schmidt, S. P. and T. G. Osborn. 1993. Effects of endophyte-infected tall fescue on animal performance. Agric., Ecosystems, and Environ. 44:233-262.

Scott, D. W., W. H. Miller, Jr., and C. Griffin. 1995. Pigmentary abnormalties. In: Muller and Kirk's Small Animal Dermatology(5th ed.). pp806-823. W. B. Saunders Co. Philadelphia, PA.

Shelby, R. A. and L. W. Dalrymple. 1987. Incidence and distribution of the tall fescue endophyte in the United States. Plant Dis. 71:783-786.

Sleper, D. A., and C. P. West. 1996. Tall fescue. Pages 471-502 in Cool-Season Forage Grasses. L. E. Moser, D. R. Buxton, and M. D. Casler, ed. Agron. Monogr. No. 34. ASA, CDDA, and SSSA, Madison, WI.

Spiers, D. E., P. A. Eichen, and G. E. Rottinghaus. 2005. A model of fescue toxicosis: Responses of rats to intake of endophyte-infected tall fescue. J. Anim. Sci. 83: 1423-1434.

Stamm, M. M., T. DelCurto, M. R. Horney, S. D. Brandyberry, and R. K. Barton. 1994. Influence of alkaloid concentration of tall fescue straw on the nutrition, physiology, and subsequent performance of beef steers. J. Anim. Sci. 72:1068-1075.

Strahan, S. R., R. W. Hemken, J. A. Jackson, R. C. Buckner, L. P. Bush, and M. R. Siegel. 1987. Performance of lactating dairy cows fed tall fescue forage. J. Dairy Sci. 70:1228-1234.

Strickland, J. R., D. L. Cross, T. C. Jenkins, R. J. Petroski, R. G. Powell. 1992. The effect of alkaloids and seed extracts of endophyte-infected fescue on prolactin secretion in an in vitro rat pituitary perfusion system. J. Anim. Sci. 70:2779-2786.

Strickland, J. R., J. W. Oliver, and D. L. Cross. 1993. Fescue toxicosis and its impact on animal agriculture. Vet. Hum. Toxicol. 35:454-464.

Strickland, J. R., D. L. Cross, G. P. Birrenkott, L. W. Grimes. 1994. Effect of ergovaline, loline, and dopamine antagonists on rat pituitary cell prolactin release in vitro. Am J. Vet. Res. 55:716-721.

Stuedemann, J. A., S. R. Wilkinson, D. P. Belesky, C. S. Hoveland, O. J. Devine, D. L. Breedlove, H. Ciordia, and F. N. Thompson. 1985. Effect of cultivar, level of fungal endophyte (*Acremonium coenophialum*) and nitrogen fertilization of tall fescue (*Festuca arundinacea*) on steer performance. In: Proc. 15th Int. Grassl. Congr. p 1171. Natl. Grassl. Res. Inst., Nishi-nasuno, Tochigiken 329-27.

Stuedemann, J. A., and C. S. Hoveland. 1988. Fescue endophyte: History and impact on agriculture. J. Prod. Agric. 1:39.

Stuedemann, J. A., D. L. Breedlove, K. R. Pond, D. P. Belesky, L. P. Tate, Jr., F. N. Thompson, and S. R. Wilkinson. 1989. Effect of endophyte (*Acremonium coenophialum*) infection of tall fescue and paddock exchange on intake and performance of grazing steers. Pages 1243-1244 in Proc. XVI Int. Grasslands Congress, Nice, France.

Taylor, M. C., W. F. Loch, and M. Ellersieck. 1985. Toxicity in pregnant pony mares grazing Kentucky-31 fescue pastures. Nutr. Rep. Int. 31:787-795.

Thompson, F. N. and J. A. Stuedemann. 1993. Pathophysiology of fescue toxicosis. Agric., Ecosystems, and Environ. 44:263-281.

Thompson, F. N., J. A. Stuedemann, and N. S. Hill. 1999. Anti-quality factors associated with alkaloids in eastern temperate pasture grasses. In: Anti-Quality Factors in Rangeland and Pastureland Forages. Joint mtg. of American Forage and Grassland Council and The Society for Range Management, Omaha, NE.

Watson, R. H., M. A. McCann, J. A. Parish, C. S. Hoveland, F. N. Thompson, and J. H. Bouton. 2004. Productivity of cow-calf pairs grazing tall fescue pastures infected with either the wild-type endophyte or a nonergot alkaloid-producing endophyte strain, AR542. J. Anim. Sci. 82:3388-3393.

White, J. F., Jr., and T. L. Bultman. 1988. Endophyte-host associations in forage grasses. XI. A proposal concerning origin and evolution. Mycologia 80:442.

Yates, S. G. and R. G. Powell. 1983. Analysis of ergopeptine alkaloids in endophyte-infected tall fescue. J. Agric. Food Chem. 36:337-340.

Yates, S. G., R. D. Plattner, and G. B. Garner. 1985. Detection of ergopeptine alkaloids in endophyte-infected, toxic Ky-31 tall fescue by mass spectrometry/mass spectrometry. J. Agric. Food Chem. 33:719.

Vita

The author, Jessica Meagan Carter, was born on February 25, 1985 in Danville, Kentucky to Gerald and Betty Carter. She was raised in Franklin, Kentucky on the family farm raising stocker calves, row crops, and hay. Riding horses and competing in horse shows was her passion since the age of 9 and continued after high school graduation. She graduated from Franklin-Simpson High School in 2003 and later pursued a college degree starting in August 2003 at Murray State University. She competed in intercollegiate rodeos and was a member of the equestrian team. She graduated from Murray State University in December 2006 with a Bachelor of Science degree in Animal Science with a Food Animal Emphasis. Immediately following graduation, she enrolled at the University of Kentucky in January 2007 to pursue a Master of Science degree in Crop Science where she worked as a graduate research assistant for Dr. Glen Aiken and Dr. Chuck Dougherty.