Recent Advances for Management of Fescue Toxicity in Beef Cattle Production

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The Fescue Problem

Endophyte-infected tall fescue (**E+**) is the dominant forage species in many parts of the southeastern United States. The dominant cultivar of endophyte-infected fescue is Kentucky 31 which is associated with excellent stand persistency, drought and pest resistance, high yield of moderate to high quality forage, and detrimental effects on animal performance (Hoveland, 1993). These negative effects on animal performance are known as the condition fescue toxicity; which results in: rough hair coats during summer, decreased blood flow to peripheral parts of the body, elevated body temperature, increased respiration rate, decreased milk production, reduced conception rates, reduced DMI, and poor ADG (Strickland et al., 2011). Industry-wide economic losses resulting from reduced growth and reproduction as a result of fescue toxicity were estimated to be over $3.2 billion (Kallenbach, 2015). Endophyte-infected fescue plants serve as hosts to ergot alkaloid-producing endophytes that live in the intercellular spaces in the plant. The effects of fescue toxicity are often greatest during late summer as plants accumulate greater ergot alkaloid concentrations (Belesky et al., 1988), and elevated environmental temperatures exacerbate the negative thermoregulatory effects of endophyte consumption (Hemken et al., 1981).

Pastures in what became known as the “fescue belt” were planted with E+ to stop soil erosion and take advantage of its desirable agronomic characteristics. It was only these E+ stands were established that negative effects on animal growth and performance were observed (Bacon, 1995). Beef producers are left with the challenge of managing sub-optimal animal performance when grazing cattle on E+ pastures because of the prevalence and high cost of replacing E+ pastures. Extensive research efforts have investigated how to best address the complex issue of fescue toxicity. Possible solutions are to renovate pastures with novel endophyte-infected fescue cultivars, utilize management strategies to decrease the symptoms of fescue toxicity, and select for cattle that less susceptible to fescue toxicity. A single best solution for fescue toxicity has yet to be discovered. This proceedings will outline current options for dealing with the problem of fescue toxicity.

Pasture Renovation with Novel Endophyte-Infected Fescue

Plant breeders have developed new cultivars of tall fescue that do not contain the ergot alkaloids known to cause fescue toxicity in grazing animals. Endophyte-free cultivars were developed in an attempt to completely remove the causative agent of fescue toxicity. Performance was dramatically improved when cattle grazed on endophyte-free pastures; however, endophyte-free stands had extremely low persistence and pastures reverted back to E+. Approximately 20 years ago, novel endophyte-infected fescue cultivars (**NE**) were developed to provide the positive agronomic attributes of E+ (Gunter and Beck, 2004) without negatively affecting animal performance (Parish et al., 2003). The first NE cultivar released commercially was MaxQ sold by Pennington Seed, Inc. (Madison, GA). MaxQ is the most heavily researched and widely-used NE cultivar. Improvements in growth and performance of cattle grazed on NE are because the ergot alkaloid-producing endophytes found in E+ are replaced with novel endophytes that do not produce ergot alkaloids.

Simply renovating E+ pastures with NE appears to be a straightforward solution to avoiding fescue toxicity. Yet, there are significant challenges to replacing E+ with NE in beef cattle operations. Converting E+ to NE comes at the significant costs of herbicide, seed, and fertilizer. Establishment costs of NE pastures have been estimated between $157.84 (Lacy et al., 2003) and $232.12 (Beck et al., 2008) per acre. Gunter and Beck (2004) and Beck et al. (2008) determined that renovating E+ pastures with NE takes between 3 to 7 yr to return profit to stocker operations. Additionally, renovation of a stand of E+ to NE requires 2 years before the new NE stand can be grazed. Pasture renovation requires that producers are able to graze other acreage during the renovation period. Renovation of E+ pastures is more practicable in areas with relatively flat terrain and good soils. Many areas in the “fescue belt” are located in Appalachia and have shallow, rocky soils and would be susceptible to soil erosion during pasture renovation. Understandably, there is great reluctance by many beef producers to renovate a large portion of their existing E+ pastures (Lacy et al., 2003).

An alternative to totally renovating a beef operation’s pasture acreage to NE is the strategic renovation of only the acres most suitable for reseeding. The newly established NE pastures would then be grazed strategically during times of greatest risk of fescue toxicity during the operation’s production cycle. This would mean grazing cows on NE pastures leading up to, during, and immediately after the breeding season. Young, growing cattle could be grazed on E+ pastures during the early summer and the switched to NE pastures during late summer when higher environmental temperatures would be expected to exacerbate the effects of fescue toxicity. Wilson et al. (2014) observed no differences in ADG of stocker calves that were either grazed on NE pastures during the entire summer or grazed on E+ from late spring through July 1 and grazed on NE from July 1 through late summer.

Nutritional Management to Alleviate the Symptoms of Fescue Toxicity

Because complete replacement of E+ is often not possible, nutritional strategies to alleviate the symptoms of fescue toxicity include diluting dietary ergot alkaloid concentrations, managing pastures to maintain vegetative growth, and feeding novel feedstuffs. Interseeding E+ with legumes is a practice that has been recommended to dilute ergot alkaloid intake for several decades (Kallenbach, 2015). Clover species are the primary legume used because they can easily be frost seeded by broadcasting seed on E+ pastures during early spring when freezing and thawing of the ground works the seed into the ground. Clover provides an increase in nutritive value during spring and early summer; however, are typically not present in late summer because of poor drought resistance and early grazing pressure. Another method to dilute ergot alkaloid intake is supplementation of concentrates to cattle grazing E+ pasture (Aiken and Strickland, 2013). High fiber supplements such as soybean hulls, dried distillers grains plus solubles, and corn gluten feed are preferable to high starch supplements like corn to avoid negative associative effects in the rumen. This is because high fiber supplements will not trigger a shift in rumen microbial populations away from fibrolytic microbes needed to efficiently digest fiber (Russell et al., 2016). When interseeding legumes or supplementing concentrates in an attempt to dilute ergot alkaloid intake, the positive effect of ergot alkaloid intake is confounded by the increase in digestible nutrients provided by the added forage and supplement (Kallenbach, 2015).

Another strategy that is employed to alleviate the symptoms of fescue toxicity is to maintain the plant in a vegetative growth stage. It is in the interest of forage quality to manage all forages in the vegetative phase; yet, this strategy is of even greater importance in E+ pastures. Ergot alkaloids are present in all parts of the fescue plant; but are further concentrated in seedheads as the plant matures and transitions to the reproductive growth phase. Two methods that have been used to manipulate fescue growth stage are mowing seed heads and implementation of rotational grazing (Aiken and Strickland, 2013). Frequent grazing or clipping the tops of E+ pasture swards decreases concentration of ergot alkaloids by increasing the leaf to blade to stem ratio. Another option for preventing reproductive growth in E+ pastures is chemical seed head suppression. Chemical seed suppression slows maturation of fescue plants and had been demonstrated increase forage crude protein and digestibility (Aiken and Strickland, 2013). An example of a commercially available seed head suppressant is Chaparral from Dow AgroSciences (Indianapolis, IN). Goff et al. (2014) determined that timing of Chaparral application is ideal during late spring. One potential drawback to chemical seed head suppression is reduction in forage dry matter availability; however, it has not been determined if this reduction is associated with decreased vegetative growth, reduced seed and stem growth, or greater forage intake (Aiken and Strickland, 2013).

An additional strategy to alleviate fescue toxicity symptoms is to incorporate novel feedstuffs into the supplementation and mineral programs of cattle grazed on E+ pastures. The most effective delivery method for these novel feedstuffs is to incorporate them into mineral mixes because most cattle grazed on E+ pastures are not supplemented during the time of peak ergot alkaloid concentrations. Several feed companies market products specifically designed to combat fescue toxicity, such as the Fescue EMT mineral (Cargill, Minneapolis, MN) and Endo-Fighter feed additive (ADM Animal Nutrition, Quincy, IL). Other companies recommend the use of certain product to boost performance of cattle grazing E+ pastures; several examples include VitaFerm Heat (BioZyme, Inc., St. Joseph, MO) to reduce heat stress and Bio-Mos (Alltech, Nicholasville, KY) to improve gastrointestinal health. Evaluation of the novel feedstuffs is challenging because much of the data regarding the efficacy of these products at alleviating the effects of tall fescue toxicity is proprietary and not found in peer-reviewed literature.

A recent study was conducted by Hardin et al. (2017) at Virginia Tech to evaluate the effects of supplementing sodium bicarbonate to heifers fed endophyte-infected fescue seed on growth and reproductive development. It was hypothesized that sodium bicarbonate would buffer rumen pH, increase fiber digestion, and result increased growth and efficiency during a heifer development program. Hardin et al. (2017) observed positive trends for improved ADG and feed efficiency for the first 56 days of the treatment period when heifers consuming endophyte-infected fescue seed were supplemented with sodium bicarbonate relative to those offered no sodium bicarbonate. However, the benefits of sodium bicarbonate supplementation were not sustained through 84 days of sodium bicarbonate supplementation. It is thought that sodium bicarbonate may be an effective method to alleviate the effects of fescue toxicity if cattle are able to self-select their level of supplement intake in a pasture setting; however further research needs to evaluate this nutritional strategy.

Genetic Resistance to Fescue Toxicity

The beef industry has made rapid advances in the use of genomic technology in the last decade to select for production traits such as birth weight, weaning weight, yearling weight, and marbling. The increased use of genomics has increased interest in a genetic test for cattle that have varying levels of resistance to fescue toxicity. Cow/calf and seedstock producers in the southeast have inferred that there is a genetic component for several years. It is recognized that cows with long, rough hair coats in the summer or cows naïve to E+ often wean lighter calves and have reduced conception rates relative to cows with short, slick hair coats in the summer. Gray et al. (2011) demonstrated that cows who began shedding their winter coat before May had 11.1 kg heavier weaning weights than those that did not begin shedding their winter coat until after May. Poor shedding of winter coats has been correlated to suppression of serum prolactin concentration; as such, serum prolactin concentration has been used a biological indicator of the severity of fescue toxicity. Recent research findings have linked several single nucleotide polymorphisms to decreased serum prolactin concentrations. Campbell et al. (2014) linked genotype of dopamine receptor DRD2 to decreased serum prolactin concentrations and differences in hair coat shedding when cattle were grazed on E+. Bastin et al. (2014) related differences in genotype of dopamine receptor XKR4 with decreased serum prolactin concentrations in a herd grazed on E+ pastures. Overall, more research needs to be conducted to correlate genotypes at a limited number of single nucleotide polymorphisms with economically relevant traits like weaning weight, milk production, and conception rate.

One commercially available product to test for level of susceptibility to fescue toxicity is the T-Snip test by AgBotanica, LLC (Columbia, MO). The exact single nucleotide polymorphisms that make up this test are proprietary; but, tested cattle are given T-Snip score of 0 to 5 to indicate susceptibility to fescue toxicity. A T-Snip score of 0 represents an animal most susceptible to fescue toxicity and a score of 5 represents and animal least susceptible to fescue toxicity. Masiero et al. (2016) demonstrated that cow T-Snip score has a moderate, positive correlation with calf 205 day weaning weight. As cow T-Snip score increases from 0 to 5, 205 day weaning weight increased from 467 pounds to 542 pounds. It should be noted that the majority of cattle used in genomic tests for susceptibility to fescue toxicity have Angus or crossbreds with a high percentage of Angus genetics. More research need to be conducted to validate these tests in other British and continental breeds of *Bos taurus* cattle as well as *Bos indicus* breeds of cattle.

In summary, managing fescue toxicity has been a substantial and complex challenge for the beef industry in the southeastern United States. The symptoms of fescue toxicity have far-reaching and costly effects on animal growth and efficiency, reproduction, and cattle welfare. Alleviating the effects fescue toxicity often requires a multi-faceted approach that involves pasture renovation, forage management, nutritional interventions, and selecting for cattle less susceptible to fescue toxicity. Many management strategies have been around for several decades; however, new discoveries are increasing options to combat this endemic issue.

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