Nitrogen Fertilizer Increases Toxicity of Kentucky 31 Fescue

Most Missouri fields are populated by Kentucky 31 tall fescue, a variety infected with a toxic endophyte (often designated E+). E+ tall fescue can be toxic to cattle when concentrations of the ergot alkaloid, ergovaline, exceed 200 parts per billion; higher concentrations of the toxin have a higher impact on animal health. Some classes of livestock should not eat toxic fescue. For example, pregnant mares should not consume toxic tall fescue during the last 90 days of pregnancy.

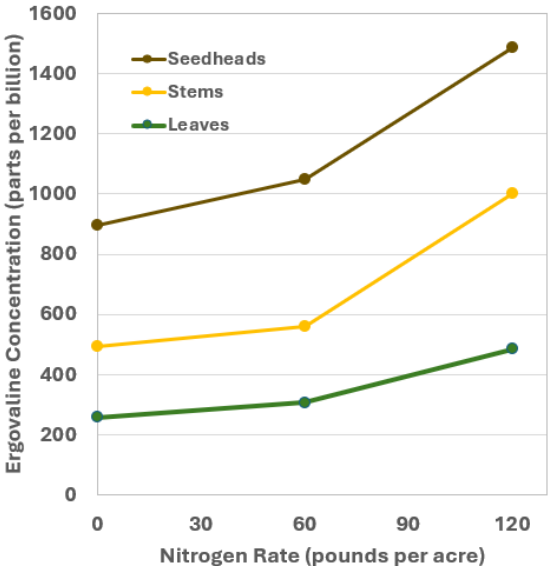

Figure 1. Tall fescue ergovaline concentrations increased faster at the highest N fertilizer rate (134.8 kg N ha^{-1}). Concentrations were highest in tall fescue seedheads. Figure adapted from Rottinghaus et al., 1991.

Tall fescue yield is highly responsive to nitrogen fertilizers. Unfortunately, application of nitrogen fertilizer increases toxic ergot alkaloid production. Figure 1 documents nitrogen fertilizer increases toxicity in above-ground parts of the plant, with higher nitrogen rates having a more negative impact. While all parts of the plant contain the toxic alkaloid, seed heads are the most toxic and the most sensitive to higher rates of nitrogen. Toxin levels in E+ tall fescue vary during the year and among stands.

Toxin levels vary widely during the growing season by part of the plant (Fig. 2). As seedheads mature, ergovaline concentrations increase dramatically. Toxin levels quadrupled between April and June at the University of Missouri Southwest Research Center summarizing two years of growth (Fig. 3). Subsequent summer forage growth after removal of seed heads typically has lower endophyte concentrations but then reaches its highest peak again in September.

Given the prevalence of E+ tall fescue in Missouri and the level of toxicity typical for E+ stands, producers should manage all stands as if they are highly infected to minimize risk animal health and daily gains. Understanding where in the plant and when toxicity is at its highest leads directly to management practices to limit the impact of toxic fescue on animal performance.

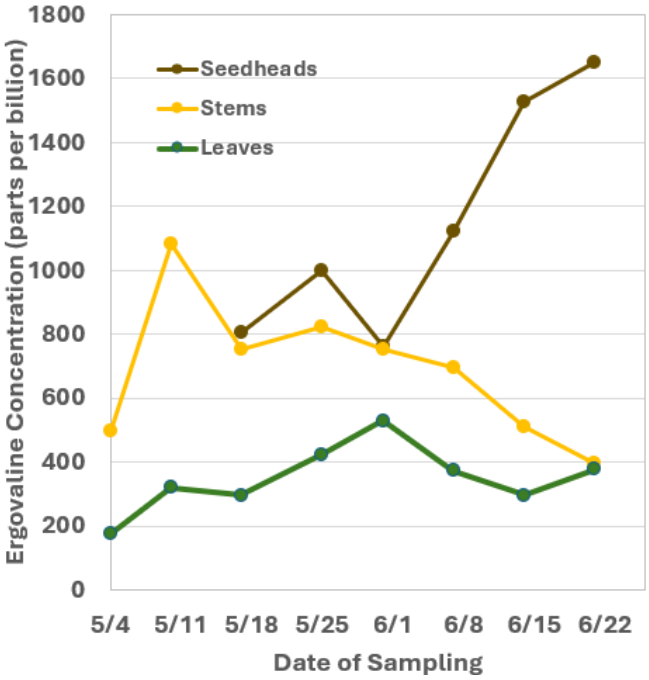

Figure. 2. Impact of maturing tall fescue plant parts on ergovaline concentrations in E+ tall fescue. Ergovaline levels spike in the seedheads as they mature. Data from Rottinghaus et al., 1991.

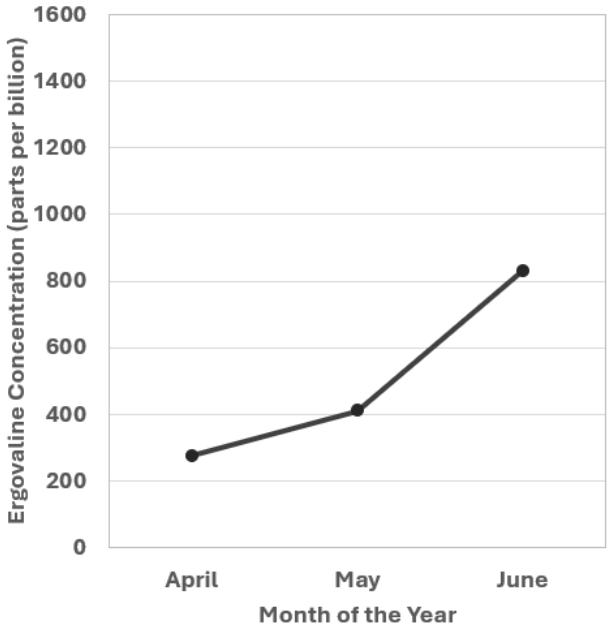

Figure 3. Whole-plant ergovaline concentrations quadrupled during the spring in tall fescue pastures at Southwest Missouri Research Center. Data is averaged over two years for a fescue pasture that did not receive spring nitrogen (Bailey et al., 2024).

Strategies to limit the impact of nitrogen fertilizer on the toxicity of E+ tall fescue

Listed below are strategies to reduce the toxicity of tall fescue and/or reduce the toxicity of the forage fed. These strategies do not prevent toxins in tall fescue from affecting livestock but reduce toxin levels fed to the animal. Farmers fertilizing E+ tall fescue should employ one or more of these strategies to limit impact of tall fescue on their cattle.

1. Limit nitrogen fertilizer applications on toxic tall fescue.

There is substantial research documenting that lower nitrogen rates reduce ergovaline concentrations in E^+ tall fescue (e.g. Fig. 1). In many experiments, limiting nitrogen from all fertilizer sources to 60 lb N/A or less frequently maintains ergovaline concentrations at similar levels as un-fertilized controls.

2. Selectively graze or selectively harvest and feed hay from toxic tall fescue.

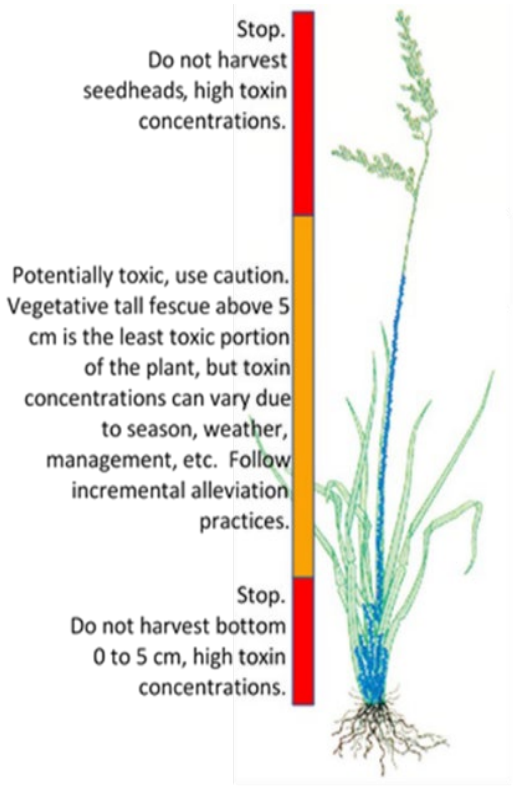

Figure 4. Schematic depicting what plant parts are highly toxic and should not be harvested. Adapted from Ball et al. (2019). Endophyte mycelium colonization is depicted in blue and is highest near the plant base and in reproductive stems.

Figure 3 summarizes the parts of the plant with the highest toxin levels. Eliminating the consumption of mature seed heads in toxic tall fescue should be a high priority of any strategy to reduce the toxicity of tall fescue forage. Graze when fescue is fully vegetative. Hay up to the boot stage. If seedheads have formed or are forming, consider clipping seed heads before harvesting or grazing.

Do not over-graze toxic fescue. The bottom two to three inches of the plant contains high concentrations of endophyte. Additionally, leaving at least three inches of forage promotes faster regrowth after grazing or haying.

5. Dilute toxic fescue with other feed.

For pastures, inter-seeding a legume has many benefits for toxic fescue stands. A well-managed inter-seeded legume such as red clover or lespedeza can meet the spring and summer nitrogen needs of tall fescue stand. While this nitrogen increases toxicity of the tall fescue, the legume will comprise a significant percentage of the forage on offer, diluting the toxicity of the forage on offer to livestock. When feeding hay, consider mixing other sources of feed to dilute the tall fescue on offer.

4. How you manage excess forage matters!

Stockpile tall fescue forage in the fall. Ergovaline concentrations in stockpiled tall fescue peak in September and then decreased during the winter (Figure 5). By late winter concentrations are low and considered nontoxic and cattle grazing E+ tall fescue performed as well as cattle on nontoxic tall fescue.

Similarly, toxicity of tall fescue decreases in baled hay. Baling hay at or before the boot stage limits the toxicity of the plant and improves hay quality. After baling, toxicity of the bale declines at least 30% in the first month and more the longer the bale is stored. This is not true for toxic fescue ensiled or harvested as baleage; these high-moisture options preserve the toxins in the forage.

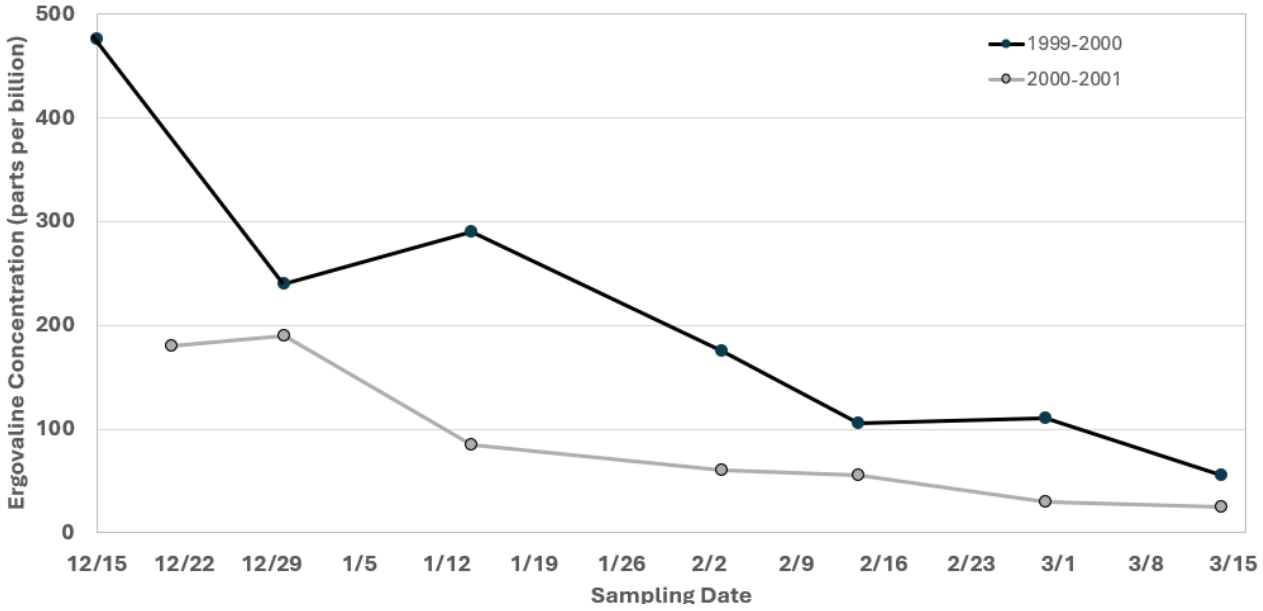

Figure 3. Tall fescue ergovaline concentrations sampled from stockpiled stands at the Southwest Missouri Research Center. Ergovaline concentrations decreased through the winter and varied by year. From Kallenbach et al., 2003.

5. Renovate pasture by removing toxic tall fescue and planting new non-toxic novel endophyte varieties.

Feeding toxic tall fescue reduces animal performance. Ultimately, farmers seeking to maximize animal performance should consider a plan to replace toxic fescue stands over time. More guidance on the successfully upgrading tall fescue fields and the associated costs see https://grasslandrenewal.org/.

Summary

Toxic tall fescue is likely to be present in most Missouri pastures for the foreseeable future. Fescue pasture need nitrogen to thrive; failure to provide a nitrogen source such as fertilizer or an inter-seeded legume to hay fields and pastures will rapidly reduce productivity and the quality of the stand. However, applying high rates of nitrogen with no consideration of the toxic components of the forage will lead to low performing animals and in some cases serious health issues.

This guide offers a series of practices that reduce the toxicity impact of nitrogen on the forage on offer to livestock. Consider combining strategies to meet your forage needs while limiting risk from toxicity of E+ tall fescue.

Selected Reading:

Replacing toxic fescue with nontoxic fescue forage. By Craig Roberts and John Andrae. American Society of Agronomy. 2023. https://acsess.onlinelibrary.wiley.com/doi/epdf/10.1002/crso.20272.

Tall fescue toxicoses. By Craig Roberts. MU Extension guide G4669. 2000. https://extension.missouri.edu/publications/g4669.

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Ball, D.M., G.D. Lacefield, and C.S. Hoveland. The wonder grass. The story of tall fescue in the United States. 2019 Oregon Tall Fescue Commission, Salem, OR. ISBN-13: 978-0-578-48501-0

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Rottinghaus, G.E., Garner, G.B., Cornell, C.N., and Ellis, J.L. 1991. HPLC method for quantitating ergovaline in endophyte-infected tall fescue: seasonal variation of ergovaline levels in stem with leaf sheaths, leaf blades, and seed heads. J. Agric. Food Chem. 39:112-115.