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Endophytes: Bane or Boon?

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FORAGE GRASSES

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Tall fescue (Festuca arundinacea Schreb.) is a major forage grass in the United States and is grown on an estimated 35 million acres. It is the most important cool season perennial grass grown in Mississippi. Tall fescue is adapted to a wide range of soil and climatic conditions, easy to establish, tolerates poor grazing management, and stands persist almost indefinitely. Nearly all of the tall fescue grown in Mississippi is the variety, Kentucky 31. It is a productive variety that furnishes 200 to 250 grazing days each year.

Even though tall fescue has a lot of excellent agronomic characteristics, it is widely criticized for causing poor animal performance and other livestock health problems. One of the most serious problems of cattle grazing fescue is poor weight gains with an associated series of signs called the "summer syndrome" or fescue toxicity that was named by Dr. Joe Robbins of the USDA Lab in Athens, Georgia. It is characterized by one or more signs which can include rough hair coats, long periods of standing in water, lameness, loss of the tip of the tail, diarrhea, appearance of increased respiration with a preference for shade, elevated body temperature, and nervousness (Figure 1).

One of the first papers describing endophytes in tall fescue was published in 1941. Neill's paper entitled "The Endophytes of Lolium and Festuca", appeared in the December 1941 issue of The New Zealand Journal of Science and Technology. The endophyte, Epichloe typhina (Pers.) Tulog, now known as Acremonium coenophialum Morgan-Jones and Gams and considered responsible for fescue toxicity, was described in detail in this report. However, the information presented in this paper was essentially lost to the scientific community for years, probably due to the events of World War II.

This information and its subsequent importance was rediscovered in the 1970's by two different research teams. One of the teams was located at the USDA Agricultural Research Service Russell Agricultural Center in Athens, Georgia. Dr. Joe Robbins of the Russell Center visited a farm owned by A. E. Hayes near Madison,

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Figure 1. A cow displaying severe, classical symptoms of fescue toxicity. Note rough coat, loss of one hoof and poor physical condition attributed to continuous grazing on tall fescue severely infested with Acremonium Coenophialum.

Georgia. Mr. Hayes had two 40-head herds of cattle, each grazing on different 80-acre tall fescue pastures. One herd had shown symptoms of fescue toxicity for several years, while the other herd had shown none. Dr. Robbins and his team began looking for some agent or agents that were responsible for the difference in performance between the two herds. In 1976, they began investigating the tissue inside the fescue plant. They found a fungus, now identified as Acremonium coenophialum. When plant tissue from the two pastures was examined, the pasture producing a high incidence of fescue toxicity was nearly 100% infected with the fungus, while the other pasture was only 10% infected.

Concurrent research developments at Auburn University and its Black Belt substation could prove to be the most significant breakthrough for cattlemen in recent years. Their results showed that beef gains of tall fescue pastures could be doubled by overcoming a single problem--the fungus that infests the grass. L. A. Smith and colleagues at the substation found that fungus-free tall fescue supported an average daily steer gain of 1.48 pounds and per acre beef gain of 395 pounds, nearly double that of fungus-infested pastures, Table 1. Steers grazing fungus infested fescue had rough hair, and they did not shed their winter coats. They also showed body temperatures 2°F higher than normal, excessive salivation, and nervousness. Hot weather magnified these adverse symptoms. We visited these experiments in mid-June, 1984, and the differences in the cattle grazing the infected and fungus-free fescue was so dramatic that a grade school child could tell them apart.

In another experiment, fescue hay and fescue seed from fungus-free and fungus-infested pastures were used in a feeding trial. Cross-bred steers weighing 530 pounds were assigned to four diets containing either 60% fungus-free seed, 60% infested seed, 85% chopped fungus-free hay, or 85% chopped infested hay. The test rations were fed during late summer when temperatures reached 94 - 99°F.

Average daily gains of steers fed the fescue rations were typical of those made by steers grazing fungus-free and fungus-infested fescue, but body temperatures were elevated only half as much by the fungus, Table 2. Feed intake was lower for steers eating diets containing infested hay and seed. Forage intake of grazed steers was not measured, but higher stocking rates on infested pastures were indicative of reduced forage consumption. Steers fed the fungus-infested seed showed signs of severe heat stress and rapid breathing. All steers eating rations containing infested feed were highly excitable.

The fungus (Acremonium coenophialium) occurs between cell walls of fescue leaves and stems and cannot be seen externally. It does not appear to be transmitted from one plant to another. Fungus-free pastures adjacent to infested pastures have remained "clean"

Table 1. Steer performance on tall fescue pastures as affected by fungus, black belt substation, auburn university, 1978-80

Pasture	Beef gain per acre	Av. daily gain	Body temp.	Hair coat rating[1]
	Lb.	Lb.	°F	
Free of Fungus	395	1.48	102.7	1.3
Fungus present	210	.65	104.8	3.2

[1]Rating: 1 = slick; 5 = rough

Table 2. Steer performance as affected by fungus - infested tall fescue steed or hay Auburn University, Auburn, Alabama.

Diet	Daily gain	Daily feed	Body temp.
	Lb.	Lb.	°F
Fungus-free seed . .	2.11	14.1	102.3
Infested seed. . . .	.44	9.1	103.2
Fungus-free hay. . .	1.45	10.5	102.2
Infested hay	.63	9.2	103.3

for over 5 years. The fungus apparently is transmitted through the seed. A survey of several tall fescue pastures in Mississippi showed a heavy infestation of this fungus.

What can cattlemen do about fescue toxicity? Fescue toxicity is controlled by grazing fungus-free fescue or reduced by diluting infested fescue with another crop such as white or red clover (Figure 2). The first step in management is to test the fescue pastures to establish the level of fungus that is present. If the pastures have over 5% infestation, some control measures are probably warranted. Several states have established Fescue Diagnostic Laboratories for testing fescue tissue and seed, and they offer several suggestions for consideration. There are several situations in which a livestock producer or seedsman could use the testing service to advantage. First, it can be used to determine the presence (and, if present, the level of infestation) or absence of the fungus in an existing tall fescue pasture. This can be done by collecting plant samples from a pasture and submitting them for analysis.

An analysis for the fungus can also be performed on fescue seed. For example, a producer who is interested in buying or selling fescue seed and wants to know the level of fungus in that seed lot can submit a sample for analysis; the laboratory will report the approximate percentage of seed infected with the fungus. Similarly, a producer who has seed on hand which was harvested from his or her farm can have an analysis performed for the purpose of determining whether or not the seed can be used to establish new fescue pastures with low levels of fungus infestation. Since the fungus is known to be seed transmitted, seed analysis prior to establishing a new pasture can help prevent the further establishment of infested fescue pastures. Two states, Alabama and Mississippi, now require the level of endophyte to be shown on the seed tag.

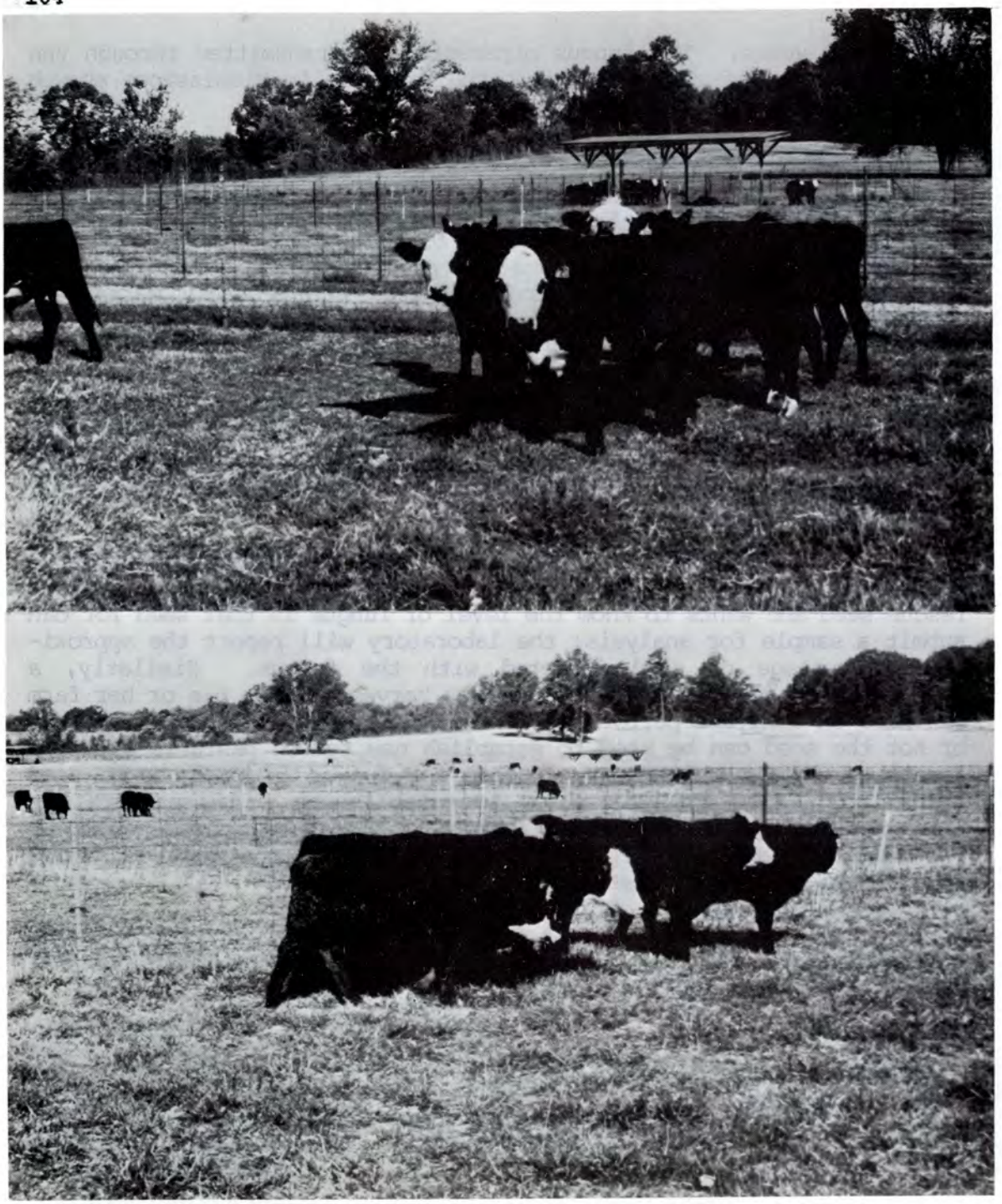

Figure 2. Steers of the same age gained at nearly twice the daily rate when pastured on endophyte free tall fescue (above) as when pastured on heavily infested tall fescue (below)

QUALITY ASSURANCE TECHNIQUES

1. Guidelines for the Diffusion Mediated Volatile Aldehyde Assay. D. O. Wilson, Jr., and M. B. McDonald, Jr., Ohio State University, Columbus, OH.

2. Guidelines for Endophyte Detection Procedures for Plant and Seed Tissue. Compiled by Charles Sciple, Miss. Dept. of Agri. & Comm.; D. J. Blasingame and M. V. Patel, Miss. Coop. Ext. Service.