Steer Performance as Affected by Fungal Endophyte on Kentucky 31 Tall Fescue Pasture

CIRCULAR 270 MARCH 1984

ALABAMA AGRICULTURAL EXPERIMENT STATION
AUBURN UNIVERSITY
GALE A. BUCHANAN, DIRECTOR AUBURN UNIVERSITY, ALABAMA

CONTENTS

FIRST PRINTING 5M, MARCH 1984

Steer Performance as Affected by Fungal Endophyte on Kentucky 31 Tall Fescue Pasture

C.S. HOVELAND, 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*

TALL FESCUE *(Festuca arundinacea)* forage, although having satisfactory quality as measured by crude protein and dry matter digestibility, generally has resulted in poor performance of grazing animals *(2)*. Average daily gains (ADG) of steers rarely exceed 1 pound per day over the grazing season *(3)*. The poor animal performance observed on tall fescue has been associated with a fungal endophyte present in pasture *(1, 5)*, hay, and seed *(8)*. In contrast, ADG on fungus-free tall fescue pasture at the Black Belt Substation averaged 1.78 pounds per day over a 3-year period *(4)*.

The fungal endophyte associated with poor animal performance on tall fescue was originally identified as *Epichloe typhina (1)*, but has more recently been redefined as *Acremonium coenophialum (6)*. The fungus appears to be seed transmitted only and lives in plant stems, leaves, and seed, probably stimulating the plant to produce a substance which is highly toxic to livestock. The fungus is not visible externally on the plant nor does it adversely affect plant growth. Soil type does not appear to be associated with either the fungus or poor cattle performance *(5)*.

EXPERIMENTAL PROCEDURE

This report summarizes the results of steer performance trials conducted over 4 years (1978 to 1982) at the Black Belt Substation,

[1]Professor, Department of Agronomy and Soils (now at Agronomy Department, University of Georgia, Athens, Georgia); Associate Professor, Department of Animal and Dairy Sciences; Professor and Assistant Professor, Department of Agronomy and Soils; Associate Professor, Department of Botany, Plant Pathology, and Microbiology; Associate Professor, Department of Research Data Analysis; Superintendent, Associate Superintendent, and Assistant Superintendent, Black Belt Substation, respectively.

Marion Junction, Alabama, on Kentucky 31 tall fescue pastures either infested with or free of fungal endophyte.

Pasture Management

Kentucky 31 tall fescue was seeded during October 1974 on six 3-acre paddocks, each containing approximately equal areas of Sumter clay and Houston clay. The pH of these alkaline soils was 7.6. Later, in 1978, three of these paddocks were found to be nearly free of the fungal endophyte. Three other nearby paddocks which had been seeded in 1970 on mostly Eutaw clay were heavily infested. The acid Eutaw clay soils had been limed to a pH of 6.4.

Grass residue was mowed and removed from these six paddocks each September. Nitrogen at 100 pounds per acre was applied in September and again in February. Phosphorus and potassium were applied according to soil test recommendations. Estimates on botanical composition were made at monthly intervals during the grazing season. Forage samples collected in May 1980 were analyzed for calcium, magnesium, and potassium. Pastures were sampled each May and examined microscopically for the fungal endophyte, *Acremonium coenophialum.*

Management of Grazing Animals

Crossbred steers weighing approximately 500 pounds were purchased each September and preconditioned on dallisgrass *(Paspalum dilatatum)* or fungus-infested tall fescue pasture supplemented with grain for approximately 6 weeks before going on the experimental paddocks in mid- to late October. During January and February when sufficient grazing was not available, steers were removed from the paddocks and fed johnsongrass *(Sorghum halepense)* hay and a corn-cottonseed meal (20 percent protein) supplement. During the grazing season, animals were weighed at 28-day intervals and additional animals were added during peak periods of pasture growth to keep grazing pressure constant.

Rectal temperatures and haircoat ratings were obtained on all tester steers in late May or early June each year. Each steer was carefully examined for evidence of the fescue foot syndrome. At the end of the 1980 grazing season, one steer was chosen at random from each paddock and slaughtered so veterinary pathologists could check for any abnormalities.

RESULTS AND DISCUSSION

Pastures

All pastures averaged 90 percent or more tall fescue over the 4-year period, table 1. Fungus-free tall fescue had 6 percent winter annual weeds the first 2 years, while during the third and fourth years both bermudagrass *(Cynodon dactylon)* and dallisgrass increased slightly. Fungus-infested tall fescue paddocks had a gradual increase in dallisgrass over the first 3 years and a decrease the fourth year.

Mineral content of the fungus-infected and fungus-free tall fescue differed, probably a result of soil differences. Calcium content of fungus-free tall fescue on the Sumter and Houston clay soils was higher than on the fungus-infected grass on the Eutaw clay soil, averaging 0.71 and 0.44 percent, respectively. The magnesium content of fungus-free tall fescue was lower than that of the fungus-infected grass, averaging 0.15 and 0.29 percent, respectively. The high calcium, low magnesium content of forage is common on Sumter and Houston soils. Both phosphorus and potassium levels were adequate for cattle and similar for fungus-infected and fungus-free fescue, averaging 0.35 and 2.50 percent, respectively.

Plants in the fungus-infested tall fescue paddocks were heavily infected, with the fungal endophyte *(Acremonium coenophialum)* being present in nearly 94 percent of the individual plant samples collected during May in each of the 4 years. The fungus-free tall fescue paddocks averaged less than 5 percent infected plants. The reason for this difference in fungal infection is not known, but the paddocks may have been planted with different seed lots of the Kentucky 31 variety. The seed that produced fungus-free paddocks

TABLE 1. ESTIMATED BOTANICAL COMPOSITION OF TALL FESCUE PADDOCKS DURING FOUR GRAZING SEASONS

Fescue infection status and grazing season	Fescue	Dallis-grass	Bermuda-grass	Weeds
	Pct.	*Pct.*	*Pct.*	*Pct.*
Non-infected				
1978-79	94	0	0	6
1979-80	93	0	1	6
1980-81	91	3	5	1
1981-82	93	3	3	1
Fungus-infected				
1978-79	90	6	0	4
1979-80	86	9	0	5
1980-81	87	13	0	0
1981-82	95	4	1	0

could have originated from a rare fungus-free Kentucky 31 seed field or been old seed in which the fungus died during storage.

One of the fungus-free paddocks was adjacent to an infested paddock that was used in a previous experiment (5). This uninfested paddock has remained nearly fungus-free since the paddocks were planted in 1974. This indicates that the rate of fungal spreading from one area to another, if it occurs, must be extremely slow for this seed-borne endophyte. No endophyte was found in dallisgrass.

Cattle Performance

The grazing season over the 4-year period averaged from October 23 to December 24 and February 26 to June 16. During the winter of 1979-80, the steers were off the paddocks longest, from December 7 to February 21, because of unusually cold weather. Grazing was terminated each year in late May to early July when tall fescue went into summer dormancy.

Animal grazing days per acre totaled 30 percent greater on fungus-infected than on fungus-free tall fescue, table 2. This difference was a result of higher stocking rates on the fungus-infected grass, which suggests that fungus infection decreased forage consumption. Earlier results (7) have shown that forage dry matter production of fungus-infected and fungus-free grass is essentially equal. Steers spent less time grazing fungus-infected tall fescue than fungus-free fescue throughout the season, but the problem was more severe during warm weather. Then, steers on fungus-free tall fescue were commonly observed to be grazing, figure 1, while steers on fungus-infected grass spent more time in the shade or pacing the paddocks, figure 2. The additional grass available on fungus-infested paddocks because of reduced grazing required adding animals to maintain similar forage utilization as on fungus-free grass.

Beef gain per acre over the 4-year period averaged 42 percent greater on fungus-free than on fungus-infected tall fescue, table 3. Gains were nearly doubled during the first 2 years. The added beef

TABLE 2. STEER GRAZING DAYS ON INFECTED AND FUNGUS-FREE TALL FESCUE

Fescue infection status	Total animal grazing days per acre				
	1978-79	1979-80	1980-81	1981-82	Mean
	No.	*No.*	*No.*	*No.*	*No.*
Fungus-free	250 a*	284 a	188 a	238 a	240 a
Fungus-infected. . . .	328 b	326 b	247 a	343 b	311 b

*Means within a column having the same letter are not significantly different at 5 percent level.

TABLE 3. TOTAL BEEF GAIN PER ACRE OF STEERS GRAZING INFECTED AND FUNGUS-FREE TALL FESCUE

Fescue infection status	Beef gain per acre				
	1978-79	1979-80	1980-81	1981-82	Mean
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Fungus-free	355 a*	436 a	437 a	478 a	426 a
Fungus-infected. . . .	186 b	235 b	431 a	352 b	301 b

*Means within a column having the same letter are not significantly different at 5 percent level.

TABLE 4. AVERAGE DAILY GAIN OF STEERS GRAZING INFECTED AND FUNGUS-FREE TALL FESCUE

Fescue infection status	Average daily gain				
	1978-79	1979-80	1980-81	1981-82	Mean
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Fungus-free	1.42 a*	1.53 a	2.32 a	2.01 a	1.82 a
Fungus-infected. . . .	.57 b	.72 b	1.75 b	1.03 b	1.00 b

*Means within a column having the same letter are not significantly different at 5 percent level.

gain per acre is a reflection of the 82 percent increase in average daily gain of steers on fungus-free as compared to fungus-infected grass, table 4. The high ADG obtained on fungus-free tall fescue was comparable to that on high quality small grain or annual ryegrass *(Lolium multiflorum)* pasture. The slow gain of steers grazing fungus-infected tall fescue was not just a "summer syndrome." The ADG of steers on fungus-infected grass generally dropped in autumn soon after the steers were placed on fungus-infected grass and remained below that of steers on fungus-free grass throughout the late winter and early spring grazing period, getting worse as weather became warmer in late spring.

Steer grazing gains during the first, second, third, and fourth years averaged 153, 138, 41, and 82 percent higher on fungus-free than on fungus-infected tall fescue. A question arises as to why steer performance on fungus-infected grass during the third grazing season was superior to that of the 2 previous years and the fourth year. One explanation might be the greater amount of dallisgrass present in fungus-infested paddocks during the third year, which allowed some dilution of the toxic tall fescue, table 1. Since dallisgrass is palatable and of high nutritive quality, this possibility exists. However, dallisgrass is a warm season species and availability of this forage was low in spring when fescue toxicosis symptoms were greatest, making this an unsatisfactory explanation. Another possible explanation for the higher performance during the third year

TABLE 5. GAIN PER STEER ON INFECTED AND FUNGUS-FREE TALL FESCUE

Fescue infection status	Gain per tester steer				
	1978-79	1979-80	1980-81	1981-82	Mean
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Fungus-free	269 a*	297 a	344 a	377 a	322 a
Fungus-infected. . . .	108 b	140 b	258 a	192 b	174 b

*Means within a column having the same letter are not significantly different at 5 percent level.

on fungus-infected grass may be related to rainfall. During the first, second, and fourth years, rainfall was reasonably well distributed. However, during the 1980-81 grazing season, summer, autumn, and winter rainfall was about one-half of that in the other years. One may speculate that drought stress could reduce the production of a toxic substance by the fungus.

Individual steers made weight gains 85 percent greater on fungus-free than on fungus-infected grass, table 5. Steer size and appearance were greatly different. However, when steers were slaughtered and examined by veterinary pathologists, the only difference found was the size of the carcass. No abnormalities were found in any body organs.

Steers on fungus-infected grass had typical external symptoms of fescue toxicosis and were in poor condition as compared to those on fungus-free grass, figures 3 and 4. Hair coats of steers on fungus-infected grass were rough and failed to shed in spring. These steers salivated excessively, were nervous, were extremely intolerant of heat, and remained in the shade much of the day. Panels had to be placed around water troughs to keep the steers from standing in the water. Rectal temperatures were elevated as with a low-grade fever, table 6. No signs of the more severe form of toxicosis, fescue foot, were found on any animal during the 4-year period.

The results of this grazing experiment show that uninfected tall fescue has the potential for producing excellent gains by growing beef animals. Evidence strongly suggests that the fungal endophyte, *Acremonium coenophialum*, is the cause of fescue toxicosis and poor

TABLE 6. BODY TEMPERATURE OF STEERS GRAZING INFECTED AND FUNGUS-FREE TALL FESCUE

Fescue infection status	Body temperature				
	1978-79	1979-80	1980-81	1981-82	Mean
	°F	°F	°F	°F	°F
Fungus-free	102.7 b*	102.7 b	103.3 b	102.5 b	102.8 b
Fungus-infected. . . .	104.8 a	104.8 a	104.9 a	103.5 a	104.5 a

*Means within a column having the same letter are not significantly different at 5 percent level.

FIG. 1-4: 1—Steers on fungus-free pasture graze heartily and show good condition; 2—steers on infected fescue spend time standing in shade and not grazing; 3—steers from infested pasture have rough hair coats and show poor condition; 4—slick hair coats and good condition characterize steers from fungus-free tall fescue pastures.

animal performance. Since endophyte-free tall fescue pastures appear to remain free of this seed-transmitted endophyte for a long time, producers have an opportunity to greatly enhance livestock performance. Destruction of old fungus-infested sod and replanting with fungus-free seed of a new variety such as AU-Triumph or year-old Kentucky 31 seed (where the fungal endophyte may have died) are practical ways to realize the potential for better animal performance from tall fescue. Current research indicates that seed treatment with certain fungicides (when cleared by EPA) may also allow the establishment of endophyte-free pastures from infected seed.

The Auburn University Fescue Toxicity Laboratory, which began operation in June 1983, can determine the degree of infection of vegetative samples collected from established tall fescue pastures or the suitability of a source of seed for establishing an endophyte-free tall fescue pasture. Details of costs and how to submit samples may be obtained from county Extension offices or by writing to Fescue Toxicity Diagnostic Center, Auburn University, Alabama 36849.

SUMMARY

A grazing study with yearling steers was conducted for 4 years at the Black Belt Substation on Kentucky 31 tall fescue pastures either (1) infested with the fungal endophyte *Acremonium coenophialum* associated with fescue toxicosis or (2) free of the endophyte.

Average daily gain (ADG) over the 4 years was 82 percent higher on fungus-free than fungus-infected tall fescue, 1.82 vs. 1.00 pounds.

Beef gain per acre averaged 42 percent higher on fungus-free than fungus-infected tall fescue, 426 vs. 301 pounds. Stocking rate was higher on fungus-infected than on fungus-free tall fescue because steers consumed less forage on fungus-infested pastures.

Steers on fungus-infected tall fescue had typical symptoms of fescue toxicosis: elevated body temperature, rough hair coats which they did not shed in spring, intolerance to heat, excessive salivation, and nervousness. In contrast, animals on fungus-free grass were in excellent condition with slick hair coats, tolerant of heat, and grazed during the daytime when their counterparts sought the shade.

The results indicate that the fungal endophyte is associated with poor performance of steers on tall fescue pastures. In the absence of the endophyte, ADG of steers on tall fescue is high and similar to that on small grain pasture.

Pastures free of the fungus have remained free for many years, probably because this fungus is only known to be transmitted through the seed.

The practical impact of these results is that animal performance on tall fescue can be greatly increased when pastures are established from seed free of the fungal endophyte. The Fescue Toxicity Diagnostic Center, Auburn University, Alabama 36849, can determine the status of the endophyte in seed intended for planting.

LITERATURE CITED

(1) BACON, C.W., J.K. PORTER, J.D. ROBBINS, AND E.S. LUTTRELL. 1977. *Epichloe typhina* from Toxic Fescue Grasses. Appl. Environ. Microbiol. 34:526-581.

(2) BUSH, L. AND R.C. BUCKNER. 1973. Tall Fescue Toxicity. pp. 99-112. *In.* A.G. Matches (ed) Anti-quality Components of Forages. Crop Sci. Soc. Amer. Spec. Pub. No. 4.

(3) HARRIS, R.R., E.M. EVANS, J.K. BOSECK, AND W.B. WEBSTER. 1972. Fescue, Orchardgrass, and Coastal Bermudagrass Grazing for Yearling Beef Steers. Ala. Agr. Exp. Sta. Bull. 432.

(4) HOVELAND, C.S., R.L.HAALAND, C.C. KING, W.B. ANTHONY, J.A. MCGUIRE, L.A. SMITH, H.W. GRIMES, AND J.L. HOLLIMAN. 1979. Tall Fescue and Phalaris Pasture for Steers. Ala. Agr. Exp. Sta. Bull. 515.

(5) _____, E.M. CLARK, J.A. MCGUIRE, L.A. SMITH, H.W. GRIMES, AND J.L. HOLLIMAN. 1980. Association of *Epichloe typhina* and Steer Performance on Tall Fescue Pastures. Agron. J. 72:1064-1065.

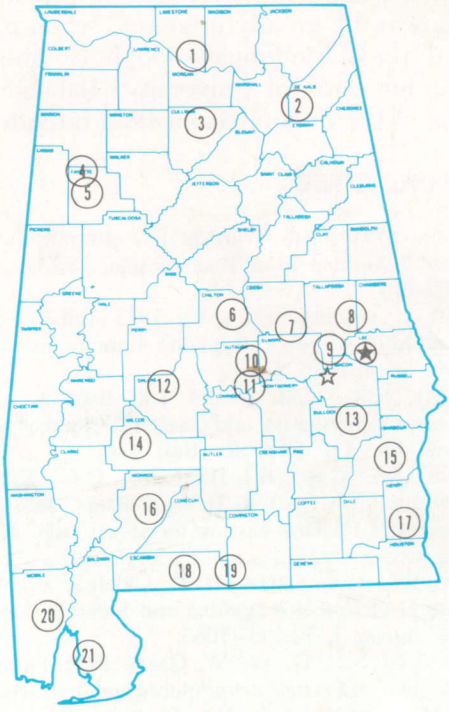
(6) MORGAN-JONES, G. AND W. GAMS. 1982. Notes on Hypomyceta XLI. An Endophyte of *Festuca arundinacea* and the Anamorph of *Epichloe typhina*, a New Taxa in One of the New Sections of *Acremonium. Mycotaxon 15:311-318.*

(7) PEDERSEN, J.F., C.S. HOVELAND, AND R.L. HAALAND. 1982. Performance of Tall Fescue Varieties in Alabama. Ala. Agr. Exp. Sta. Cir. 262.

(8) SCHMIDT, S.P., C.S.HOVELAND, E.M. CLARK, N.L. DAVIS, L.A. SMITH, H.W. GRIMES, AND J.L. HOLLIMAN. 1983. The Association of an Endophytic Fungus with Fescue Toxicity in Steers Fed Kentucky 31 Tall Fescue Seed or Hay. J. Animal Sci. 55:1259-1263.

Alabama's Agricultural Experiment Station System
AUBURN UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.
☆ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Chilton Area Horticulture Substation, Clanton.
7. Forestry Unit, Coosa County.
8. Piedmont Substation, Camp Hill.
9. Plant Breeding Unit, Tallassee.
10. Forestry Unit, Autauga County.
11. Prattville Experiment Field, Prattville.
12. Black Belt Substation, Marion Junction.
13. The Turnipseed-Ikenberry Place, Union Springs.
14. Lower Coastal Plain Substation, Camden.
15. Forestry Unit, Barbour County.
16. Monroeville Experiment Field, Monroeville.
17. Wiregrass Substation, Headland.
18. Brewton Experiment Field, Brewton.
19. Solon Dixon Forestry Education Center, Covington and Escambia counties.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.