



JENNIFER HOTCHKISS PHOTOS

Toxic Forage

About 20% of Angus producers have a love-hate relationship with endophyte-infected tall fescue. They love what the endophytic fungus does for their pastures, but they hate what can happen to their cattle after ingesting the alkaloids associated with it. Fortunately, reconciliation is possible.

BY BRAD PARKER

Although *infested* and *infected* aren't generally terms of endearment, sometimes they indicate a beneficial relationship. Sometimes.

Researchers estimate 90%-95% of the 35 million acres of tall fescue in the United States are infested to some extent with the fungus *Neotyphodium coenophialium* (formerly identified *Acremonium coenophialium*). The endophyte — a plant living within another plant — increases the host's tolerance to drought, disease, insects and other stressors. It also produces growth regulators that promote root development and cell division in the aboveground parts of the plant.

"It certainly improves the longevity of the stand under moderate to adverse climatic conditions and grazing management," says Henry Fribourg, professor of plant and soil sciences at the University of Tennessee, Knoxville.

What results is a low-maintenance plant that grows in poor soils and provides better erosion control than most cool-season grasses. Extremely popular in the Southeast, many cattlemen from Georgia to Missouri and from Virginia to Louisiana rely almost entirely on tall fescue for grazing. In places, infected varieties are about the only grasses that grow.

According to John Rotert, an Angus

producer from Montrose, Mo., the Kentucky-31 (KY-31) variety of tall fescue has made raising cattle possible in some areas. Where bluegrass dries up in late June to August, KY-31 keeps going.

"A lot of our pastureland is rolling country with marginal soils," he says. "With the way we manage it, those endophyte-free varieties probably wouldn't tolerate it. The old Kentucky-31 is there year after year. There weren't nearly as many cattle in this country before we got Kentucky-31."

The level of infestation within a stand directly correlates to its resilience. Low-endophyte pastures (less than 10% infested, according to Fribourg) are more susceptible

Above: Incorporating legumes, such as clover, among infested tall fescue may help dilute the concentration of alkaloids ingested by the cattle. It's important to keep the fescue grazed or clipped so it doesn't overshadow other low-lying plants in the stand.

to overgrazing and environmental stresses.

“Because you have the endophyte, the chances of losing your pasture base are greatly reduced,” says Nick Hill, professor of crop and soil sciences at the University of Georgia (UGA) in Athens.

■ **The dark side**

While *N. coenophialium* improves the plant’s survivability, the associated alkaloids in tall fescue can have negative effects on the animals that ingest them.

The alkaloid compounds act as neuroreceptors that stimulate histamine production. That causes blood vessels to constrict, reducing blood flow to the periphery and preventing the dissipation of body heat via convection. Decreased prolactin production is another response to the alkaloids, as is the impairment of the animals’ immune systems.

“Animals that are grazing endophyte-infected tall fescue won’t have the same antibody titer (concentration) as animals that are grazing endophyte-free tall fescue,” Hill says. Without the antibodies, they are more susceptible to disease.

The alkaloids also seem to produce a grazing deterrent, but scientists aren’t sure what causes the reduced intake. It may be a palatability issue, which is hard to determine since cattle can’t say how the plants taste. It may be that the elevated body temperatures or some kind of involuntary feedback decreases appetite. Or the cattle may be too uncomfortable to leave the shade for grazing.

Regardless of the cause, the results are

costly. “We have measured 25%-30% less intake in steers that had been grazing infected fescue as opposed to endophyte-free fescue,” Fribourg says.

Frank Ireland, a research animal scientist for the University of Illinois’ Dixon Springs Agricultural Center in Simpson, quotes a similar figure. He estimates a 15%-20% drop in intake. “This accounts for at least part of the reduction in weight gain and animal performance,” he says.

Grazing cattle aren’t the only ones to suffer reduced gains. Nursing calves on infected tall fescue will wean lighter because the decreased prolactin levels in the mother’s bloodstream lower her milk production.

Roy Burriss, University of Kentucky Extension beef specialist, Princeton, says he has seen weaning weights down 50 pounds (lb.) in calves on high-endophyte (at least 85% infested) tall fescue.

■ **More bad news**

The threats to profitability don’t end there. Reproductive performance also can be affected. Higher body temperatures decrease conception rates and increase the chances of intrauterine death.

Current estimates range from 15% to 50% reductions in calving rates for cattle bred in the warmer months while grazing endophyte-infested (E+) tall-fescue pastures. Typically, the scenario gets worse as you go south.

The effects to the cattle industry are staggering. “If you were to look at losses that would be associated with reduced calving

and reduced weight gain, estimates range between \$700 million and \$1 billion annually,” Hill says.

On the farm, it’s difficult to value the losses, Rotert says. Early on, producers mainly worried about costs associated with the lower weights of their feeder calves.

“As we went along, we found out that it might be hurting us worse in our cow herds because of what it was doing to milk flow and fertility,” the Missouri cattleman explains. He figures the greatest losses came from not getting 2- and 3-year-olds rebred.

Duane Robertson of Robertson Angus Farm in Russellville, Mo., also says it’s difficult to get younger females to rebreed, which is a major concern for seedstock producers. It’s especially challenging within artificial insemination (AI) programs. “Most of the time we just put them with a bull and breed them naturally because conception rates are so low that it’s not practical to try to AI them,” Robertson says.

While most alkaloid-induced problems are more apparent in the summer, the toxicosis can be a year-round problem.

“The adverse clinical signs are really temperature-dependent,” Ireland says. “Any time you get really low or really high temperatures, you have the potential for problems.”

In the winter, a condition called *fescue foot* becomes a concern. With the decreased blood flow to the periphery, the chances of freezing feet, tails and ears increase.

■ **Know the signs**

While frozen extremities are the best indicator of the toxicosis in winter, there are several other signs in the summer. This doesn’t mean, however, that it’s a summertime problem only.

“It’s clear that there is more problem from tall-fescue toxicosis when the weather is hotter,” Fribourg says. “The fact that we don’t see much problem in the wintertime does not necessarily mean that there’s no effect on the animal. It’s just that it may be less of an effect.” Blood samples taken in the winter indicate the toxicosis is still present.

The most noticeable summertime indicator is the retention of the winter hair coat, which also may indicate a copper deficiency. Fribourg says it’s easy to see in Angus cattle because their normal summer coats are much shorter, smoother and shinier than their winter hair.

Although the thicker coats may contribute to the increased body temperature, they are a secondary cause.



Constricted blood vessels close to the skin are the major reason.

The chronic elevated body temperature (about 1 degree Fahrenheit higher than normal) will cause cattle to stand in water or shade instead of following their normal grazing routine. This tendency to bunch where it's cool is another giveaway.

"They spend all the time in the shade," Fribourg says. "When they leave the shade, they go to the water; then they go back to the shade." At the same time of day, he adds, cattle will be out grazing endophyte-free fescue.

When temperatures climb higher than 85 degrees, infected animals will begin to pant in efforts to expel body heat. Drooling may be an accompanying sign.

■ Basic solutions

Rotert says dealing with the endophyte is a matter of management. "You have to be able to manage those young cattle," he explains. "You don't want them in their peak production needs at the time that fescue is going dormant and in the summertime when you've got the heat because they're just not going to be tolerant."

There are several methods for reducing the effects of the toxicosis. The best management is through a whole-enterprise approach, Fribourg advises.

Add other plants. One of the easiest management practices is adding other grasses or legumes to tall-fescue pastures. The added forage dilutes the concentration of the alkaloids ingested by the cattle, Ireland says.

He quotes an industry saying: "Dilution is the solution to the pollution." There's a lot of truth to that."

As little as 25% legumes in a stand seems to counteract a big portion of the problem, Ireland adds. "Introducing some legumes would be the first dollar that I would spend."

Fribourg agrees adding legumes to pastures helps the situation, but he doesn't believe it's a dilution effect.

Rotert chose to overseed his fescue pastures with clover and lespedeza to help offset the toxicosis. The legumes also help fill the void left when the fescue goes dormant in the warm season.

It's a challenge to keep legumes in the stand, however. Fribourg still recommends overseeding clover. Ladino white clover is the easiest to maintain, he says, if the pasture is kept at a pH of 5.5 to 6.5, phosphorous and potassium are added, and

Knowing infestation levels assists planning

The level of endophyte infestation can vary dramatically among tall-fescue pastures or within a pasture. To better manage for the effects of toxicity (see main story), producers should know those levels.

Once the infestation levels are mapped, the less infested areas should be grazed during the breeding season, according to Roy Burris, University of Kentucky Extension beef specialist. He recommends grazing the more infested areas in cooler weather or using those plants to make hay that can be fed in the winter.

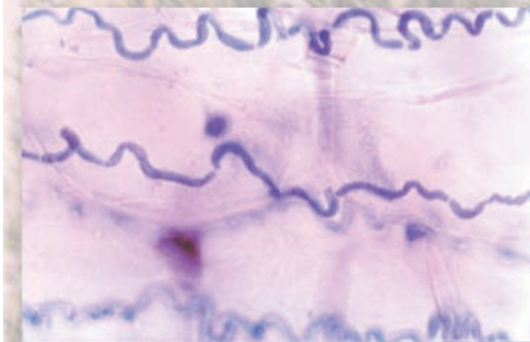
Producers should be careful not to overgraze less infested stands, advises Henry Fribourg, professor of crop and soil sciences at the University of Tennessee, Knoxville. Low-endophyte fescue plants are more susceptible to overgrazing, and infected plants gain a competitive advantage in moderate- to heavy-grazing situations. Fribourg says infestation rates in a pasture could increase 14%/year under those circumstances.

Testing pastures will not only help develop grazing and haying strategies, but it can indicate when re-establishing a stand could be considered. According to Nick Hill, professor of crop and soil sciences at the University of Georgia, economic losses may be noticed at 20% infestation, sometimes less; but markets and operation types will determine when renovating a pasture is cost-effective.

Producers can have their infestation levels determined by submitting samples to the Fescue Diagnostic Laboratory at Auburn University, Auburn, Ala. If plants are grown from seed for testing, the process can take three months. Tests on tillers or seeds take a week or two, according to Larry Dalrymple, research technician in the diagnostic laboratory.

The cost is \$20/sample for Alabama residents and \$30/sample for out-of-state clients, and results are returned with a short publication including management tips for endophyte-infected tall fescue.

For more information or to learn about collecting a proper sample, see the laboratory's Web site (www.ag.auburn.edu/plp/fescue.htm) or call Dalrymple at (334) 844-5003.



The *Neotyphodium coenophialium* fungus lives within some fescue plants. Those plants contain ergot-like alkaloids, which have negative effects on cattle performance. The dark line in this picture is the endophyte growing inside the tissues of a fescue plant.

the fescue is kept short enough so as not to shade the clover.

If legumes are added, carefully examine the use of added nitrogen, which will make the fescue grow faster and will take away the legumes' competitive advantage.

Hill recommends using alfalfa because it stands upright, reducing the chance that the fescue will overshadow it. It also provides more biomass (greater dilution) than clover, but it's not as persistent as its low-lying cousin.

If other plants are introduced, their growth habits will be an important point of consideration. Hill emphasizes that they must match the producer's grazing program, whether that be continuous or rotational.

Keep the fescue vegetative. Since the highest concentration of the endophyte is in

the stems and seed heads, Ireland advises keeping fescue pastures in a vegetative state. "If we can keep those [stems and seed heads] from developing and keep the plant vegetative, we can reduce our endophyte levels," he says. This can be accomplished by keeping the pastures grazed or through mechanical clipping.

Fribourg adds that vegetative fescue offers higher-quality forage. He says that otherwise there's no discernible difference between endophyte-free and endophyte-infected tall fescue in regards to measurable forage quality.

Evaluate breeding seasons. Ireland suggests breeding when temperatures are lower, in late April to early June for instance. Fall breeding is another option. He says setting the breeding season to avoid higher

temperatures may improve conception rates by 15%-18%.

“Basically, on endophyte-infected tall fescue, if we haven’t got the cows bred by the middle of June, in our environment, they just don’t breed until the next fall,” the animal scientist explains.

Rotert’s experiences have led him to the same conclusion. His 2-year-olds calve in February and early March so they can recover and rebreed by mid-June. “If they weren’t bred by the first of July, they were probably going to be open when fall came and we weaned calves,” he says.

Burris adds that having females in good condition (body condition score [BCS] 5-6) will increase their chances of conceiving before the hot weather in late June and early July. “If you’re breeding on high-endophyte fescue pastures, that makes it more critical that your cows come out of the winter and go into the breeding season in good condition,” he says. “Breeding on high-endophyte pastures when it’s hot is more difficult.”

Of course, whenever the average temperature is greater than 90 degrees, with or without the endophyte, thermal stress can reduce pregnancy rates, Burris reminds producers.

The Kentucky beef specialist also mentions fall calving. “That puts you in a time of year when the weather is not a problem so the cows calve in favorable conditions. Then you can breed them back on stockpiled fescue in December or January.”

Rotert encourages that strategy. “You’ll have a lot less effect of the endophyte on those fall-calving cows because they’re going into cooler weather,” he says, adding that fall calving also can provide better marketing and management opportunities.

No matter the breeding season, Burris advises using a mineral mix with higher levels of copper and selenium to improve conception rates.

Condition your cattle. Burris says the poorer performance on infected tall fescue presents an opportunity to condition calves before shipping. He recommends weaning in late October and starting the calves on dry feed to help them recover from the toxicosis.

“It probably benefits us through rapid and efficient gains during that period of time. It also benefits the feeders in that they get a calf that’s over the toxicosis, is probably more ready to go and is better able

to withstand the rigors of shipping,” he explains.

Robertson says he backgrounds his cattle with 2-4 lb. of medicated grain each day to help offset the toxicosis. “You have to do that to get the gains where they would otherwise be if you weren’t dealing with the fescue,” he says.

He also conditions his spring-calving cows with nonfescue hay from February to April to prepare them for the breeding season.

■ Stockpiling fescue

When enough rain falls in September and October, producers have the option of stockpiling fescue. Fribourg says it’s a useful practice for providing reasonable-quality forage from November through January.

Another advantage to stockpiling is that the infected plants are fed in cooler weather, reducing the severity of the toxicosis. Fribourg says the timing is beneficial for the animal, but it doesn’t reduce the endophyte level.

“Once the plant is infected, it’s infected forever,” he explains, as is any seed it produces. Older seed with decent germination is less likely to have live endophyte in it, Fribourg says, so it will grow like low-endophyte fescue. In short, it won’t tolerate stress as well as its parent.

Ireland emphasizes the importance of stockpiling only fall regrowth because the plant is in its reproductive stage and highest in endophyte concentration in the spring.

Not everyone encourages stockpiling infected fescue, though. Hill believes the practice is tenuous. “It appears as though the older the tissue in the leaves, the more toxins that you are going to find,” he says, adding that stockpiling accumulates foliage. “The probability of having high-alkaloid forage is better if you stockpile.”

The professor from Georgia does say, however, that stockpiled infected fescue would be acceptable for grazing brood cows that only need a maintenance diet.

■ Going to the extreme

Some may be tempted to eliminate the endophyte problem rather than manage around it. The decision to attempt establishing a new stand will depend upon markets and the type of operation, Hill says. Higher-valued purebred cattle present a lower tolerance level to the problems the alkaloid causes.

“If you have adverse effects on reproduction at 20%-30% infestation, that’s

when you would want to consider eliminating the endophyte because it’s costing you,” Hill says. In commercial herds it’s not as clear, but he suggests 40%-50% infestation may be a good benchmark at which to begin exploring the option.

If the decision is made to start a new stand, the old fescue should be grazed or clipped to prevent heading for a year, Hill says. The pasture should then be reseeded with a no-till drill.

Fribourg doesn’t recommend such action because it’s difficult to find an alternative forage crop that offers a reasonable certainty of survival. At \$150-\$200/acre to re-establish a stand, it’s not something you want to do often.

Renovating pastures doesn’t appeal much to Rotert. “I don’t think it would be very practical,” he says. “A lot of our pastureland is pretty rough ground, and it’s not tillable, so it would be pretty difficult to try to renovate.”

He doubts half his ground could be replanted, and he doubts even more the new stand would survive without becoming reinfested. Typically, low-endophyte stands only last four or five years before dying or becoming infested from neighboring pastures.

Robertson tried to reseed some pastures with endophyte-free fescue, but it died after two or three years, he says. He finally decided it would be better to leave the environment alone so it matches that of his bull customers. “We need to have cattle that can work in the same environment,” he explains.

Fribourg sums up the issue this way: “I would hope that producers don’t act precipitously in tearing up good fescue pastures to establish a miracle crop because there are very few miracle crops.”

■ “Friendly” endophytes

Although it is not a miracle crop, there may be new hope for improving producers’ relationships with *N. coenophialium* — a “friendlier” endophyte.

Scientists in the United States and New Zealand have isolated some strains that do not produce the major problem-causing alkaloids. “What we are studying now is if, when we use those endophytes in tall fescue, the host still has the good side effects,” Fribourg says.

He explains that no strains are proven to work in that matter, although one from Georgia seems to work there. “That’s the only place it’s been tested, to my

Genetics may be an answer

In a herd grazing endophyte-infected tall fescue, some animals may display the signs of toxicosis while others may not. That has led scientists to explore the possibility that certain lines of cattle are genetically resistant to the problem.

Physiologically, cattle of *Bos indicus* descent are better suited to deal with the toxicosis as a side benefit of their natural heat tolerance. Of course, it's not feasible for seedstock producers of *Bos taurus* breeds to introduce those genetics into their herds.

While he was associated with the University of Missouri-Columbia (MU), Frank Ireland observed some Angus sire lines that seemed resistant to the toxicosis. Now a research animal scientist for the University of Illinois, Ireland is continuing his work with the infected-tall-fescue issue.

A theory he has borrowed from equine research is that some families have different base levels of the hormones affected by the alkaloid associated with the endophyte. If their base hormone levels were high, the toxicosis wouldn't have as much of an effect.

One of Ireland's collaborators at MU was Jerry Lipsey, who is now executive vice president of the American Simmental Association. He says the number of observations required made it difficult to reach any definite conclusions, but there did seem to be evidence that there were genetic differences among families within any breed.

Lipsey believes some lines of cattle are better suited to filtering or degrading the toxins. "It would be reasonable that one of the sites of endophyte tolerance would be in specific organs, especially the liver," he says.

Whatever the cause, some Angus producers in the "Fescue Belt" are basing genetic selections on the apparent resistance to the toxicosis.

"We've noticed for a long time that there are differences in cattle's ability to handle the fescue," says Duane Robertson of Russellville, Mo., who's been selecting for endophyte tolerance in his stock for more than 10 years. "It's a slow process



Retaining the winter hair coat into the summer is a good indicator that cattle are being affected by alkaloid toxicosis in infected tall-fescue pastures. Within any herd, some individuals may exhibit signs of the toxicosis while others do not.

because you have so many other things for which to select, but it will benefit us in the long run."

He's so committed to breeding a tolerant animal that Robertson won't use a sire whose progeny are affected, regardless of his expected progeny differences (EPDs) for other traits. "They're not able to reproduce here," he explains. "Those females will almost always come up open as 2-year-olds if they're not somewhat adapted to the environment."

John Rotert, Montrose, Mo., says he observed tolerance in a bull from MU. "He certainly passed that on to his progeny. Those were shorter-haired, had really fine hair coats and shed a little quicker," he says.

Both Rotert and Robertson use shedding as the main indicator of endophyte tolerance. "Normally, those cattle that are able to shed their hair early and stay short-haired throughout the summer while on fescue will get along in the environment pretty well," Robertson says.

Lipsesey says he doesn't know if shedding alone is good enough for basing genetic decisions, but it is one piece of the puzzle. "Those cattle that simply hold their

hair through May and June would be subject to some distinct level of stress," he explains.

Although no one has determined the heritability of those characteristics, it is worthwhile for producers who rely on infected tall fescue to consider a genetic component to their management strategy.

"In my judgment, it would take several lifetimes to develop enough genetics for that to become widely used," Rotert says of genetic selection, but he encourages other breeders to look for tolerance to the endophyte in their breeding programs.

Robertson agrees, "Whether you're in commercial or purebred cattle, you need to be aware of the differences and observe them in breeding stock. Ask questions about the fescue adaptability of those cattle."

knowledge," the professor from Tennessee says. "We're looking at it now, but we don't have enough data to say anything about it."

UGA's Hill says the endophyte-infected, nontoxic fescue is providing twice the rate of gain as plants harboring the normal wild-type endophyte. "We're hoping to capitalize on the benefits of the endophyte without the detriment to the animal," he explains. "We've got some data coming off pastures now that suggest we're doing just that."

He says the new fescue variety has been licensed to Pennington Seed Co., and it should be available in the fall of 2000.

■ A new approach

The nontoxic endophyte isn't the only new development coming from UGA. The

university recently patented a vaccine to combat the toxicosis.

Normally, Hill explains, antibodies are produced in response to glycoproteins. Since the alkaloids produced by *N. coenophialium* aren't proteins, continual exposure to the toxins doesn't stimulate the immune system.

"The trick to developing a vaccine is to get prolonged immunogenic activity, and that's what we're working on," he says. "It's still proprietary; but I can say that we're working on it, and we're getting some positive results."

Also in the race to develop an antitoxin are the University of Tennessee and Virginia Tech, Hill says.

■ The more you know

By studying the problem and evaluating overall management strategies, producers can decide on the best course of action in dealing with endophyte-infected tall fescue.

"You have three choices," Burris says. "Get rid of it, dilute it or manage around it. Maybe some of all of those is best."

Rotert emphasizes the important role infected tall fescue has played in the Southeast's cattle industry and encourages his fellow producers to stay informed on the issue.

"People have to know its downfall and manage it," he says. "We just have to learn to work with what we've got."

