

“Friendly” Endophyte-Infected Tall Fescue for Livestock Production

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Introduction

Tall fescue is the major cool-season perennial forage in Arkansas and much of the southeastern U.S. Tall fescue is widely grown throughout Arkansas because of its persistence, ease of management and long growing season. Most tall fescue in this region is infected with a fungus that produces livestock toxins called ergot alkaloids. This fungus (endophyte) lives within the tall fescue plant, improving its drought tolerance and stand persistence on poor soils. Therefore, there is still widespread use of toxic tall fescue in Arkansas, consisting mainly of the variety Kentucky-31.

Consumption of toxic endophyte-infected (E+) tall fescue depresses body condition, reproduction and milk production in cows and weaning weights in calves. These problems are collectively called “fescue toxicosis.” Grazing toxic E+ tall fescue pastures or consuming toxic E+ tall fescue hay decreases forage intake, lowers average daily gain and alters hormone concentrations in cattle and other livestock species.

Cattle suffering from fescue toxicosis retain rough hair coats (Figure 1), exhibit heat stress during warm periods (Figure 2) and suffer losses of ear tips and tail switches during cool periods (Figure 3). Losses in cattle production due to fescue toxicosis have been estimated at \$50 million annually in Arkansas.



Figure 1. Rough hair coats on cattle grazing toxic endophyte-infected tall fescue.

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Figure 2. Cattle on toxic endophyte-infected tall fescue pasture standing in a pond.



Figure 3. Missing tail switches on cattle grazing toxic endophyte-infected tall fescue.

Management Options for Combating Fescue Toxicosis

Sodseeding and Supplementation

Some of the management techniques promoted in the past to address the problem of fescue toxicosis included keeping tall fescue seedheads clipped, reducing late spring nitrogen fertilization, sodseeding toxic tall fescue pastures with legumes or other grasses and supplementing livestock with non-toxic hay. While there is value in implementing these practices, significant production losses may

still occur as long as toxic E+ tall fescue is included in the diet (Table 1). Sodseeding clovers or other forages into a toxic E+ tall fescue pasture may be appropriate, however, when pasture terrain or other factors make renovation with a non-toxic forage impractical.

Research indicates that mineral supplementation corrects mineral deficiency (not toxicity) problems on toxic E+ tall fescue pastures. However, mineral supplementation does not correct the negative impacts of fescue toxicosis on animal growth performance. Studies have evaluated the use of antioxidant vitamins, vasodilating vitamins,

Table 1. Effects of white clover on steer growth performance in toxic endophyte-infected tall fescue pastures

Forage	Toxic Endophyte-Infected Tall Fescue		Endophyte-Free Tall Fescue	
	Clover %	Steer average daily gain, lb	Clover %	Steer average daily gain, lb
Grass alone	0	0.79	0	2.03
Grass + Regal white clover	5 to 7	1.47	0 to 2	1.96
Grass + Durana white clover	35 to 54	2.55	35 to 53	3.21

Source: J. H. Bouton. 2002. 29th Annual Conference Proceedings. Arkansas Forage and Grassland Council.

activated carbon, iron sulfate, selenium, bentonite, fat, zeolite, hydrated sodium calcium aluminosilicate, drugs, toxin binders, modified yeast cell wall preparations, antibiotics and growth implants for alleviating fescue toxicosis in livestock. None of these products have been found to eliminate all fescue toxicosis problems without adverse side effects.

Endophyte-Free Tall Fescue

Endophyte-free (E-) tall fescue was initially tapped as a “silver bullet” for fescue toxicosis. Although E- tall fescue improves animal performance over toxic tall fescue, endophyte removal results in reduced seedling vigor and lower plant persistence. Many researchers and producers have observed accelerated stand losses in E- tall fescue pastures relative to toxic tall fescue pastures. Unlike toxic E+ tall fescue, E- tall fescue can be easily overgrazed and will not tolerate poor management.

Research at the University of Tennessee indicated that in pastures with a mix of E- and toxic E+ tall fescue, low stocking rates have little or no effect on pasture endophyte infection rate, yet moderate to high stocking rates increase the percentage of E+ plants in the pasture. In other words, E- plants did not stand up to grazing pressure as well as E+ tall fescue plants.

“Friendly” Endophyte-Infected Tall Fescue

Until recently, producing and utilizing tall fescue was a double-edged sword. A choice had to be made between either good plant persistence and poor animal performance (toxic E+ tall fescue) or good animal performance and poor plant persistence (E- tall fescue). This changed when “friendly” E+ tall fescue hit the market. Friendly E+ tall fescue is also referred to as “novel” or “non-toxic” E+ tall fescue. It contains endophytes that do not produce the ergot alkaloid livestock toxins. Friendly E+ tall fescue combines the plant persistence advantages of toxic E+ tall fescue with the animal performance advantages of E- tall fescue.

Tall fescue infected with the MaxQ™ endophyte in both the Jesup and Georgia-5 varieties (Pennington Seed, Inc., Madison, GA) was the first commercially available friendly E+ tall fescue. MaxQ™ E+ tall fescue has been evaluated under demanding management conditions (i.e., in competition with bermudagrass and under heavy stocking rates) in multiple university research trials across the southeastern United States. Both plant persistence and livestock (beef cattle, dairy cattle, sheep and horse) performance results from these studies have been consistent and promising.

The University of Arkansas has also been active in friendly E+ tall fescue research, and seed from the Arkansas program is marketed as ArkPlus brand tall fescue (FFR Cooperative, Lafayette, IN). ArkPlus is derived from the HiMag tall fescue variety. Research trials are ongoing across the region examining livestock and plant performance of MaxQ™ and ArkPlus E+ tall fescue as well as other friendly E+ tall fescues that have not yet reached commercial stages.

Friendly Tall Fescue Research Results

Plant Persistence

Extensive testing in Georgia over five years (including some of the hottest and driest years on record) has shown stand survival of Jesup MaxQ™ E+ tall fescue to be nearly twice that of Jesup E- tall fescue. Three years into a grazing tolerance study conducted by the University of Kentucky, stand survival of Jesup MaxQ™ E+ tall fescue was statistically similar to Jesup toxic E+ tall fescue and exceeded Jesup E- tall fescue.

These results are promising; however, long-term stand survival of friendly E+ tall fescue pastures in Arkansas needs further evaluation. The degree to which friendly endophytes improve stand persistence during drought is yet unknown. Arkansas research trials in Fayetteville were performed on deep, moist soil very suitable for tall fescue. Preliminary data from south Arkansas suggest that friendly endophytes enhance drought tolerance of tall fescue in pastures.

Cow-Calf Performance

Two factors that dramatically impact the profitability of a cow-calf operation are calving rate and weaning weight. Improvement to these production factors will increase the pounds of calf that can be marketed within a given calving season or year. Lower pregnancy rates, calving rates and calf weaning weights have been observed in many research efforts in cows and heifers grazing toxic E+ versus E- tall fescue.

Cows and heifers must be in proper body condition for optimal reproductive performance. In a trial at the University of Georgia, Angus and Angus x Hereford cows of similar body condition were assigned to either toxic E+ or MaxQ™ E+ tall fescue pastures at calving. Cows grazing toxic E+ tall fescue gained only half as much body condition from calving to weaning as cattle grazing MaxQ™ E+ tall fescue in adjacent pastures over the same

period. Average daily gain was also three times higher in cows grazing the MaxQ™ E+ pastures over the toxic E+ tall fescue pastures. When adjusted 205-day weaning weights were compared, steer calves raised on MaxQ™ E+ pastures had a weaning weight advantage over calves raised on toxic E+ tall fescue pastures that averaged approximately 66 pounds over the three-year study period. Their heifer counterparts had a weaning weight advantage of approximately 44 pounds over heifer calves raised on toxic E+ tall fescue pastures.

Stocker Cattle Performance

Research shows that average daily gains are higher in cattle stocked on E- or friendly E+ tall fescue than on toxic E+ tall fescue (Table 2). Arkansas and Missouri researchers observed rough hair coats, elevated respiration rates and elevated rectal temperatures in cattle grazing toxic E+ tall fescue compared to cattle grazing ArkPlus or E- tall fescue. Stocker cattle growth performance on MaxQ™ E+ tall fescue has also been evaluated against toxic E+ and E- tall fescue in several research trials throughout the southeastern U.S. with consistent results.

Grazing behavior studies at the University of Georgia indicate that cattle grazing toxic E+ tall fescue spend more time idling (neither grazing nor ruminating), more time standing instead of lying (probably an attempt to dissipate body heat), take fewer bites and chews and have lower forage intake than cattle grazing E- or MaxQ™ E+ tall fescue. Results from the Georgia stocker cattle research trials also show that cattle grazing toxic E+ tall fescue have elevated body temperatures during warm periods and depressed body temperatures during cool periods, while cattle grazing MaxQ™ E+ or E- tall fescue have body temperatures closer to normal values.

Horse Production

Toxic E+ tall fescue has long been taboo for use as horse pasture or hay. Toxic E+ tall fescue affects all classes of horses, but the most dramatic effects are seen in pregnant mares. Other classes of horses exhibit an increased risk of laminitis, and prolonged exposure may result in weight loss for inactive geldings. Reduced growth rate in yearlings has also been documented. Toxic E+ tall fescue causes pregnant mares to have depressed serum prolactin and progesterin concentrations. The absence or reduction of these hormones results in prolonged gestation, premature placental separations or “red bagging,” foaling difficulty or dystocia, increased placental retention and placental thickening (which

makes it difficult for the foal to break through the bag). Many mares also have agalactia or low milk production, low IgG levels in colostrum (important for proper immune function), increased foal mortality and produce weak and dysmature foals.

Very low levels of toxic E+ tall fescue can cause problems in the mare. Severe effects on equine reproductive performance can be seen with as little as 10 percent or less of toxic E+ tall fescue in a forage stand. Therefore, inclusion of clovers or other forages in a toxic E+ tall fescue pasture does not effectively dilute toxicosis effects in broodmares.

Expect trouble if broodmares are allowed to graze toxic E+ tall fescue. These mares need to be monitored closely during late gestation for udder development and relaxation in the vulva and muscles around the tail head. Low or absent milk production is likely, and rebreeding may be difficult. Be prepared to administer colostrum to the foal immediately after birth. Commercial milk replacers or nurse animals may be needed if agalactia or low milk production is a problem. Treatment for septicemia and infusion of intravenous fluids may also be necessary.

Use of oral Equidone® (domperidone) therapy for 10 days prior to foaling is another option. Clemson University studies spanning the last decade provided evidence that Equidone® (domperidone) is safe and effective for the prevention and treatment of fescue toxicosis in horses. Consult a veterinarian for dosing recommendations. Typically, domperidone is administered at a rate of 5 cc per 500 kg (1100 lb) of body weight starting 10 days prior to the anticipated foaling date up to foaling. On farms with a history of severe fescue toxicosis or where mares remain on toxic E+ tall fescue up to foaling, domperidone treatment may be needed up to 15 to 25 days prior to the anticipated foaling date.

Domperidone can also be used to bring agalactic mares into milk or increase milk production in low milking mares as a result of fescue toxicosis. In this case, mares should be dosed with domperidone twice daily for two days followed by once daily administration for an additional three days. Cost of domperidone treatment may vary, but count on paying at least \$10 per day. Since domperidone stimulates gut motility, it should not be used in horses with suspected or known gastrointestinal blockage. In addition, domperidone may cause a false positive on the milk calcium test used to predict foaling and potential leaking of milk and loss of colostrum.

Past recommendations for horse production on toxic E+ tall fescue have emphasized removing

Table 2. Stocker cattle average daily gains grazing tall fescue

Study Location and Duration	Cattle	Tall Fescue Cultivar	Endophyte Status	Average Daily Gain, lb	Reference
Fayetteville, AR; 2-year study	steers	HiMag	4 (ArkPlus)	1.43	West et al.
			9	1.36	
			Endophyte-free	1.55	
		Kentucky-31	Toxic endophyte-infected	0.93	
Calhoun, GA (Northwest Georgia Branch Station); 3-year study	Angus x Hereford steers and heifers	Kentucky-31	AR542 (MaxQ™)	1.61	Parish et al. SERAIEG-8 Proceedings
			Endophyte-free	1.57	
			Toxic endophyte-infected	1.08	
Eatonton, GA (Central Georgia Branch Station); 3-year study	Hereford steers	Georgia-5	AR542 (MaxQ™)	2.09	Parish et al. SERAIEG-8 Proceedings
			Jesup	AR542 (MaxQ™)	
		Jesup	Endophyte-free	2.14	
			Toxic endophyte-infected	0.68	
Winnsboro, LA (Macon Ridge Research Station); 2-year study	steers	Jesup	AR542 (MaxQ™)	2.5	Alison. 2002. SERAIEG-8 Proceedings
			Georgia-5	AR542 (MaxQ™)	
		Georgia-5	Endophyte-free	2.6	
			Toxic endophyte-infected	1.7	
Mount Vernon, MO; 2-year study	steers	HiMag	4 (ArkPlus)	1.21	West et al.
			Endophyte-free	1.21	
		Kentucky-31	Toxic endophyte-infected	0.55	
Raymond, MS (Central Mississippi Research and Extension Center), 1-year study	steers	Jesup	AR542 (MaxQ™)	0.87	Macon et al. 2002. SERAIEG-8 Proceedings
		Georgia-5	AR542 (MaxQ™)	0.91	
		Kentucky-31	Endophyte-free	0.94	
Grand Junction, TN (Ames Plantation); 3-year study	Angus steers	Kentucky-31	AR542 (MaxQ™)	1.62	Waller et al. 2001. Univ. of Tennessee Annual Dept. Rep.
			Endophyte-free	1.64	
			Toxic endophyte-infected	1.06	

pregnant mares from toxic pasture and hay at least 60 to 90 days prior to foaling. Recent research on early embryonic death in pregnant mares indicates that removing broodmares from toxic E+ tall fescue during breeding and early gestation may be sensible as well. This research from Mississippi State University suggests that in horses toxic E+ tall fescue affects normal estrous cycle activity and is potentially embryotoxic when compared to E- or MaxQ™ E+ tall fescue. Safety trials with pregnant mares at Mississippi State University have demonstrated prolonged gestation, abortion, agalactia and dystocia in mares grazing toxic E+ tall fescue while none of these complications were observed in mares grazing E- or MaxQ™ E+ tall fescue.

Management Considerations

Autumn planting of friendly E+ tall fescue is recommended. Successful establishment depends on proper renovation and conversion of existing tall fescue and weeds. The “spray-smother-spray” method is usually most effective. This method involves spraying the existing sod with a nonselective herbicide, planting an annual forage smother crop and then spraying any residual forage left after the smother crop is harvested. This can be accomplished as a spring-summer rotation or as a one-year rotation.

Spring-Summer Renovation

For the spring-summer rotation, renovation of existing toxic E+ tall fescue fields to friendly E+ tall fescue should begin in the spring prior to planting. Toxic E+ tall fescue seedhead formation should be prevented by close grazing or clipping. Clipping may be the preferable method to ensure that seedheads are not formed, since it may be difficult to achieve adequate stocking rates to effectively control seedhead formation. During spring, a chemical kill of existing toxic E+ tall fescue plants should be performed. A nonselective, systemic herbicide should be used. Contact your local Extension office for chemical recommendations. After the grass is dead, plow or disk the stand and prepare a seedbed. No-till drilling is recommended for erosive ground in place of conventional tillage. This is a good time for lime application if soil tests call for it.

Planting a summer annual smother crop is useful for providing competition for and shading out any toxic E+ tall fescue plants or seedlings that may have survived the spring chemical kill. Pearl millet and sorghum-sudan hybrids work well as smother crops and provide good summer grazing. Use of sorghum-sudan should be avoided, however, if horses will be allowed to graze the pastures to

prevent problems with cystitis, a condition that can result in paralysis and urinary disorders. A chemical kill of the summer annual crop should be performed at the end of the summer grazing period and in time for autumn planting.

One-Year Renovation

The one-year renovation is preferable to the spring-summer renovation because it allows more time to kill the old toxic tall fescue stand and to build soil fertility to optimum levels. The one-year renovation is similar to the rotation described above, but it includes renovation practices that start in late summer or autumn one year prior to tall fescue planting. At this time, existing toxic E+ tall fescue should be sprayed with a grass-killing herbicide according to local Extension recommendations. On land with low erosion potential, plow or disk the dead stand. Then drill a winter cereal crop such as rye or wheat into the disked field. Do not plant annual ryegrass. No-till drilling of a winter annual is appropriate on erosive ground. Lime can be applied at this time or during the following spring if needed. The cereal forage can be used for grazing during the winter.

Do not feed toxic E+ tall fescue or annual ryegrass hay on these fields during the winter. If toxic E+ tall fescue or annual ryegrass hay is fed on another field, then do not move animals consuming the hay to the fields undergoing renovation to friendly E+ tall fescue without a minimum three-day cleanout period. When spring arrives, graze the cereal pasture closely to minimize stem and seedhead production. Mow annual grasses to prevent seedhead production. Continue to follow hay-feeding precautions to prevent the transfer of toxic E+ tall fescue or annual ryegrass seed. In early summer, plant an annual forage crop as described previously for the spring-summer rotation.

Autumn Planting

In the autumn, fields should be fertilized according to soil tests. Scout fields for escape toxic E+ tall fescue plants. Final seedbed preparation is best in late summer or early autumn after some rains. Nitrogen, not to exceed 35 to 40 pounds per acre, can be applied prior to final seedbed preparation or topdressed after tall fescue emergence. Phosphorus and potash should also be applied according to soil test recommendations. Friendly E+ tall fescue seed should be no-till drilled in sod or conventionally drilled to a 1/4-inch to 1/2-inch depth into a firm, prepared seedbed at a seeding rate of 20 pounds of pure live seed per acre. Do not plant too deeply. Broadcast seeding may also work if

followed by a harrow or cultipacker to ensure good seed-to-soil contact. Seeding rates may need to be increased slightly with broadcast seeding.

Do not sow friendly E+ tall fescue seed in pastures that have recently been in annual ryegrass. Annual ryegrass is a prolific seed producer, is very competitive with tall fescue and may shade out young tall fescue plants during establishment. Do not seed annual ryegrass with friendly E+ tall fescue seed. Red or white clover can be planted at low rates (typically no more than 5 pounds per acre of red clover or no more than 1 pound per acre of white clover) with the tall fescue. Clovers will limit broadleaf weed control options during the autumn establishment period and can be planted later after the tall fescue stand is established.

Grazing Management

Cattle should be kept off of newly seeded friendly E+ tall fescue pastures until the young plants have developed adequate root systems to serve as ground anchors when grazed. Clovers and annual lespedezas can be sod-seeded or broadcast-seeded in February or March following autumn tall fescue planting. When growth of tall fescue resumes in the spring, fertilize with nitrogen around 60 to 70 pounds per acre if no legumes have been seeded. Spray broadleaf weeds according to local Extension recommendations.

Once the tall fescue plants become approximately 8 to 10 inches tall, they may be ready for grazing. Manage stocking rates and grazing days in order to maintain 4 to 6 inches of stubble height on the pasture. This will help limit stand losses and help ensure a productive stand of friendly E+ tall fescue for years to come. Part of the success that producers have with maintaining productive stands of toxic E+ tall fescue is due to the negative effect of the livestock toxins on forage intake. Research at the University of Georgia shows that forage intake is greater on friendly E+ tall fescue than on toxic E+ tall fescue. Therefore, friendly E+ tall fescue stands require a higher level of grazing management than toxic E+ tall fescue stands and should not be overgrazed.

Instead of grazing, the stand may be harvested for hay or silage in the spring. Control seedheads of annual grasses such as annual ryegrass and cheat by mowing before seeds ripen. Hay or graze off excess tall fescue growth in early summer. Maintain 4 to 6 inches of forage height during the summer. Stocking rates should be carefully managed during drought conditions as well. Rotational grazing may be useful in managing forage height. Do not graze in late summer unless soil moisture conditions

allow active growth. Resting tall fescue during late summer allows plant carbohydrate reserves to build up for the autumn growth flush.

Contamination Prevention

Will friendly E+ tall fescue plants convert to toxic E+ plants? Can endophytes be transferred via pollen from a toxic E+ pasture to a neighboring friendly E+ tall fescue pasture? The answer to both of these questions is “No.” Tall fescue endophytes are transmitted via E+ seed only. Toxic E+ plants must develop from toxic E+ seed. Similarly, friendly E+ plants must develop from friendly E+ seed. In order for a friendly E+ pasture to become contaminated with toxic E+ tall fescue, viable toxic E+ seed must already be present in the pasture or be introduced into the pasture. Therefore, it is a good idea to keep seedheads clipped on toxic E+ tall fescue plants in adjoining pastures.

Recent research conducted at The Ohio State University suggests that MaxQ™ E+ tall fescue stands are less susceptible than E- stands to contamination by toxic E+ tall fescue. However, management practices to minimize contamination are advisable. When moving cattle or other grazing livestock to a friendly E+ tall fescue pasture from a toxic E+ tall fescue pasture, be sure the animals undergo a minimum three-day “cleanout” period on a forage or feed other than toxic E+ tall fescue. This will minimize the transfer of toxic E+ tall fescue seed to the friendly E+ pasture. Viable toxic E+ tall fescue seed containing live endophytes has been recovered from the feces of both cattle and horses grazing toxic E+ tall fescue. Feeding hay containing toxic E+ tall fescue seed on friendly E+ tall fescue pastures may be another potential source of contamination and should be avoided. In addition, toxin levels are very stable in toxic E+ tall fescue hay and may induce toxicosis problems when consumed by livestock even after hay has been stored for several years.

Seed Storage

Endophytes can die within tall fescue plants, so E+ plants may become E- under certain conditions. Endophyte-free plants would not be expected to persist as long as E+ plants in the same pasture, however. Endophytes are actually more fragile in tall fescue seed than in tall fescue plants. Therefore, friendly E+ tall fescue seed must be handled properly to maintain viable endophyte presence. Proper storage conditions include avoiding storing seed in direct sunlight or in hot, humid places. High levels of moisture during storage can increase endophyte losses. Refrigerated storage is best.

Implications

Research indicates that friendly E+ tall fescue is an effective alternative to E- tall fescue for good cattle performance without toxicity problems or sacrifices in plant persistence. Proper establishment and management practices to minimize stand contamination with toxic E+ tall fescue seed and stand losses are vital considerations when renovating with friendly E+ tall fescue.

Since friendly E+ tall fescue seed is a value-added product, it is expensive relative to toxic E+ tall fescue seed. Pasture renovation costs and lost grazing should also be taken into account when deciding to renovate with friendly E+ tall fescue. Establishing friendly E+ tall fescue pastures should be considered a long-term investment and, if managed properly, may prove to be a cost-effective management option for alleviating fescue toxicosis. For more information on friendly E+ tall fescue or related topics, contact your county Extension office.

Points to Remember



Endophyte presence in tall fescue (whether toxic or friendly) enhances plant persistence, so E+ seed should be handled and stored properly to maintain viable endophyte presence.



Do not establish friendly E+ tall fescue into toxic E+ tall fescue fields without proper seedhead control and plant eradication (spray-smother-spray) of the toxic E+ tall fescue.



Minimizing ryegrass competition is critical to the survival of young tall fescue plants and the development of a productive tall fescue stand.



Livestock growth and reproductive performance on friendly E+ tall fescue is similar to that on E- tall fescue and superior to that on toxic E+ tall fescue.



Forage intake is higher on friendly E+ tall fescue than on toxic E+ tall fescue, so manage stocking rates to prevent overgrazing.



When moving livestock onto friendly from toxic E+ tall fescue pasture, make sure they have not consumed toxic E+ tall fescue pasture or hay containing seed for at least three days.



Do not feed toxic E+ tall fescue hay containing seed on friendly E+ tall fescue pastures.

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