

## **Novel Endophyte-Infected Tall Fescue**

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Tall fescue (*Schedonorus phoenix* (Scop.) Holub) is a cool season perennial grass that fills a critical forage production gap in the Southeast and is the predominant forage crop in much of the U.S. In fact, this species is the most widely used grass in improved U.S. pastures, occupying more than 36 million acres. Its popularity is related to establishment ease, drought tolerance, excellent grazing persistence, and a long grazing season.

Some of these desirable attributes are due to the presence of a fungus (*Neotyphodium coenophialum*) that lives inside the plant (endophyte). This fungus is transmitted from one generation to the next in the seed. It is not transmitted through pollen or from plant to plant.

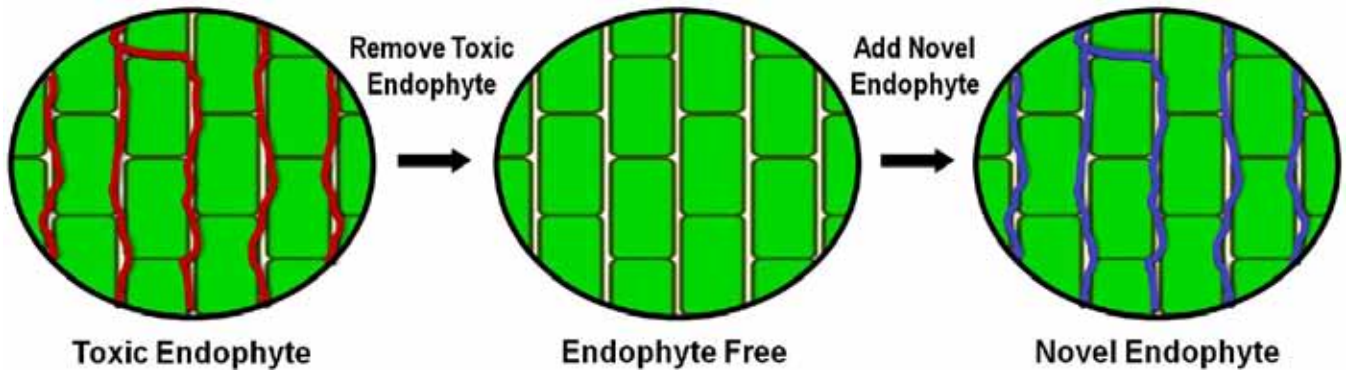
Unfortunately, this endophyte produces toxic alkaloids that greatly decrease animal gains and reproductive performance, which, conservatively estimated, costs the U.S. beef industry from \$600 million to more than \$1 billion annually. Removing the toxin-producing endophyte alleviates animal symptoms and improves animal performance but reduces the longevity, vigor, and drought tolerance of the tall fescue stand.

Recently, endophyte strains that do not produce toxic ergot alkaloids have been identified and inserted into tall fescue varieties. Replacing toxic tall fescue stands with these “novel” endophyte-infected varieties will benefit producers if new stands (1) persist as well as toxic tall fescue under grazing and (2) provide animal performance at levels comparable to endophyte-free tall fescue. This publication outlines plant persistence and animal performance characteristics of novel endophyte-infected tall fescue and provides recommended pasture renovation practices.

### **Development of Novel Endophyte-Infected Tall Fescue Products**

Many pasture and hay acres have been planted to novel endophyte tall fescues since their release in 2000. For the first several years, only one product containing a novel endophyte was available in Georgia: MaxQ™.

MaxQ™ tall fescue was jointly developed by Dr. Joe Bouton at the University of Georgia and Dr. Gary Latch at Ag-Research Limited of New Zealand. Many naturally-occurring endophyte strains had been discovered in tall fescue in the 1980s and 90s – some of which did not produce toxic ergot alkaloids. Drs. Bouton and Latch inserted these novel endophytes into “Jesup” and “GA 5,” tall fescue cultivars that were developed in Georgia (Figure 1). This resulted in two novel endophyte-containing tall fescue varieties that produced no toxic alkaloids but retained all of the positive agronomic features (excellent persistence, improved vigor, drought tolerance, etc.) of tall fescue varieties infected with the wild-type endophyte.



**Figure 1.** Hyphae of the fungal endophyte grow between the cells (green) of the tall fescue plant. When building a novel endophyte-infected tall fescue, the toxic endophyte (red lines) is removed from the tall fescue plant to create an endophyte-free plant. Then, the novel endophyte (blue lines) is introduced into the plant.

These novel endophyte tall fescue varieties were tested extensively in Georgia, both on experiment stations and producer farms. The success of these yield, persistence, and animal performance trials led to the eventual release of both “Jesup MaxQ™” and “GA 5 MaxQ™.” Pennington Seed, Inc. (Madison, Ga.) obtained the rights to sell these novel endophyte varieties in North America. Although both were sold initially, Pennington Seed eventually simplified the production and marketing of the novel endophyte varieties and sold only “Jesup MaxQ™.”

Additional novel endophyte tall fescues are being developed by Ag-Research, UGA, and other public and private plant breeders. These newer novel endophyte tall fescue products will be different from “Jesup.” They will allow producers to select a novel endophyte tall fescue variety that better matches their climate or production goals. More information on novel endophyte tall fescue varieties that are currently recommended for use in Georgia may be found on the “Forage Species and Varieties Recommended for Use in Georgia” Web site (<http://www.caes.uga.edu/commodities/fieldcrops/forages/species.html>).

## Will Novel Endophyte-Infected Tall Fescue Persist?

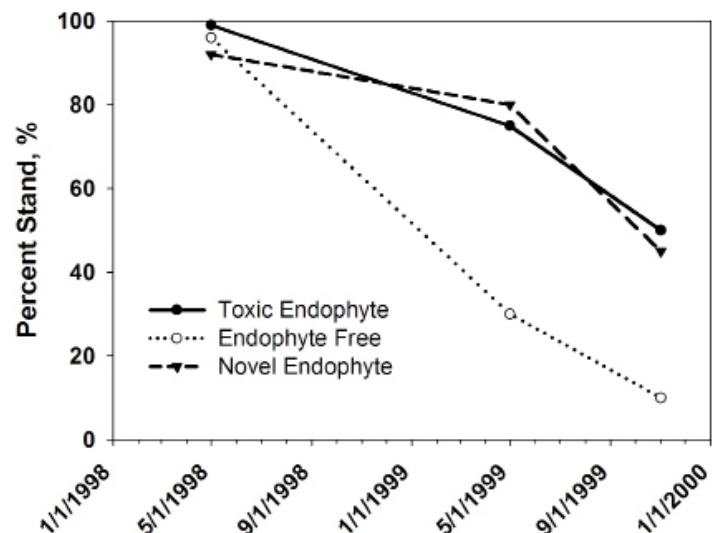
Soon after researchers discovered the wild-type toxic endophyte in the 1980s, they noted that it could be removed from the tall fescue seed and that endophyte-free stands could be established. Gains and reproductive performance of animals grazing endophyte-free tall fescue showed much higher animal performance than toxic tall fescue. However, the stands in endophyte-free tall fescue pastures frequently failed to persist. Researchers found that the endophyte causes the tall fescue plant to be more vigorous and tolerant of heavy grazing and other stress. Without this added tolerance, endophyte-free tall fescue stands do not survive long, particularly under grazing.

Because of the potential for stand losses, many producers choose to plant more “dependable” toxic tall fescue and tolerate economic losses associated with the toxins. Novel endophyte tall fescue must persist substantially better than endophyte-free tall fescue to justify the higher costs of seed and renovating existing tall fescue stands.

Before the release of the MaxQ™ tall fescue products, tests of novel endophyte tall fescue persistence were performed near Eatonton and Calhoun, Ga. One test compared the stand persistence of novel endophyte (“Jesup MaxQ™”), endophyte-free, and toxic tall fescue planted into a bermudagrass sod near Eatonton, Ga., and subjected to severe grazing conditions (Figure 2). These plots were established on droughty soils and grazed closely (under continuous stocking) during two successive summers to accelerate stand decline and evaluate endophyte effects on plant persistence.

Because of the grazing pressure severity and the bermudagrass competition present in these pastures, the stand ratings for all of the entries, including toxic tall fescue, declined. Nevertheless, the novel endophyte tall fescue persisted as well as its toxic endophyte-infected cohort and both were more persistent than the endophyte-free plantings. The novel endophyte tall fescue maintained stands equal to toxic tall fescue over a four-year period. Similar results were also obtained in grazing trials near Calhoun, Ga.

Pure stands of novel endophyte tall fescue have also been evaluated for grazing persistence at several State Experiment Stations throughout the country, including the Southeast (except Florida). In addition to these trials, novel endophyte tall fescue has been successfully maintained in pastures throughout the South. In each case, novel endophyte tall fescue persistence has been similar to toxic tall fescues. In pure stands and under normal grazing conditions, it is reasonable to expect that novel endophyte tall fescue will survive as well as toxic tall fescue and will persist much better than endophyte-free tall fescue.



**Figure 2.** Stand persistence of novel endophyte-infected (“Jesup MaxQ™”), toxic endophyte-infected, and endophyte-free tall fescue in bermudagrass sod after two years of close grazing near Eatonton, Ga. (Bouton et al., 2000).

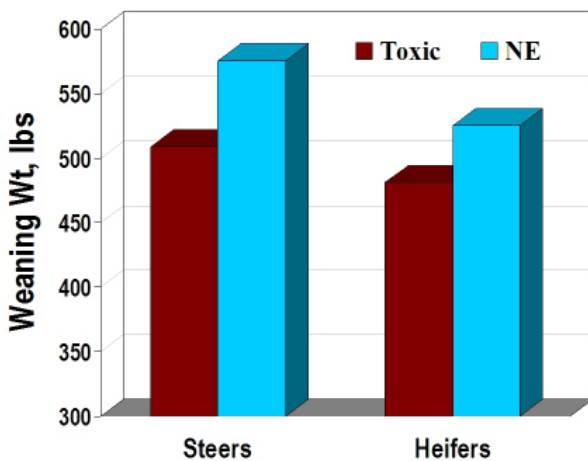
# How do Animals Perform on Novel Endophyte-Infected Tall Fescue?

## Cow-Calf Performance

Most cattle operations in the Southeast are cow-calf producers. To justify higher seed costs and the cost of renovating existing tall fescue stands, the novel endophyte tall fescue must substantially increase the weaning weight of calves and/or the pregnancy/calving rate of the cows. Cow-calf performance data on novel tall fescue remains limited; however, initial results appear promising.

In a study conducted in northwest Georgia, cows grazing novel endophyte infected tall fescue tended to have higher body condition scores and weights than cows that grazed toxic tall fescue. Steer and heifer calves grazing novel endophyte tall fescue also had approximately 50 and 60 pounds greater weaning weights, respectively, than their cohorts grazing toxic tall fescue (Figure 3). Unfortunately, cattle numbers were too small in this study to determine if reproductive characteristics were positively affected by the use of novel endophyte tall fescue.

A larger study was performed at the University of Arkansas where 136 pregnant cows (1078 ± 14 lbs) were split between novel endophyte and toxic tall fescue pastures. The performance of these cows and their calves has been tracked for the past two years (Table 1). From this study on cow-calf performance, it appears that novel endophyte tall fescue substantially improves both the calf weaning weight and the cow pregnancy rate. Furthermore, these data suggest that replacement heifer performance is also improved when these animals graze novel endophyte tall fescue.



**Figure 3.** Calf weaning weights of cattle grazing toxic or novel endophyte (NE; “Jesup MaxQ™”) tall fescue stands. Values are averages of two years’ data collected near Calhoun, Ga. (Bouton et al., 2000, and Watson et al., 2001).

**Table 1.** Cow-calf performance on toxic or novel endophyte (NE) tall fescue stands.<sup>†</sup>

	Toxic	NE
<b>Cow Performance</b>		
Wt. at end of breeding, lbs.	1110	1236
Wt. at end of weaning, lbs.	1005	1122
BCS at end of breeding <sup>‡</sup>	5.4	5.7
Pregnancy Rate, %	44.7	85.1
<b>Calf Performance</b>		
Actual Weaning Wt., lbs.	461	529
Adj. (205 d) Weaning Wt., lbs.	436	504
ADG (birth to wean), lbs. <sup>§</sup>	1.7	2.1
<b>Replacement Heifers</b>		
Actual Weaning Wt., lbs.	459	498
Calving Rate, %	64.1	90.6

<sup>†</sup> Adapted from University of Arkansas Experiment Station Reports by Coffey et al. (2007 and 2008).

<sup>‡</sup> BCS: Body Condition Score.

<sup>§</sup> ADG: Average Daily Gain.

## Stocker Performance

Stocker cattle performance has been examined for several years at the Central Georgia Research and Education Center near Eatonton, Ga. (Table 2). Similar studies throughout the Southeast have shown similar results, indicating that stocker gains are substantially higher for calves on novel endophyte tall fescue pastures than for those on toxic endophyte-infected tall fescue pastures. Many of these studies also indicate the stockers on novel endophyte tall fescue pastures have smoother hair coats and lower body temperatures, and spend more time grazing and less time standing in the shade or in pools of water (Figure 4).



**Figure 4.** Cattle grazing toxic tall fescue (foreground) spent less time grazing than cattle grazing MaxQ™ (in background). Endophyte-free tall fescue had higher intakes and performance (Parish, 2001).

**Table 2.** The effect of endophyte status on stocker performance on tall fescue in the fall and spring. †

	ADG (lbs/hd/d)	Gain (lb/acre)	Stocking Rate (hd/acre)	Grazing Time (days)
<b>Fall</b>				
Toxic Endophyte-Infected Jesup	1.5	137	1.5	63
Endophyte-Free Jesup	2.3	211	1.5	63
Jesup MaxQ™	2.1	188	1.5	63
<b>Spring</b>				
Toxic Endophyte-Infected Jesup	0.8	119	1.6	91
Endophyte-Free Jesup	2.2	313	1.6	91
Jesup MaxQ™	1.8	251	1.6	91

†Adapted from Parish (2001).

Adding clover to both toxic endophyte-infected tall fescue pastures and novel endophyte tall fescue pastures will improve stocker gains (in addition to the benefit of replacing the toxic endophyte) (Table 3). Therefore, adding a legume to novel endophyte tall fescue is highly recommended.

**Table 3.** The effect of tall fescue endophyte status and the use of white clover in the pasture on stocker performance. †

	ADG (lbs/hd/d)	Gain (lb/acre)
Toxic Endophyte	1.1	126
Novel Endophyte	1.8	186
Toxic + White Clover	1.6	150
NE + White Clover	2.6	252

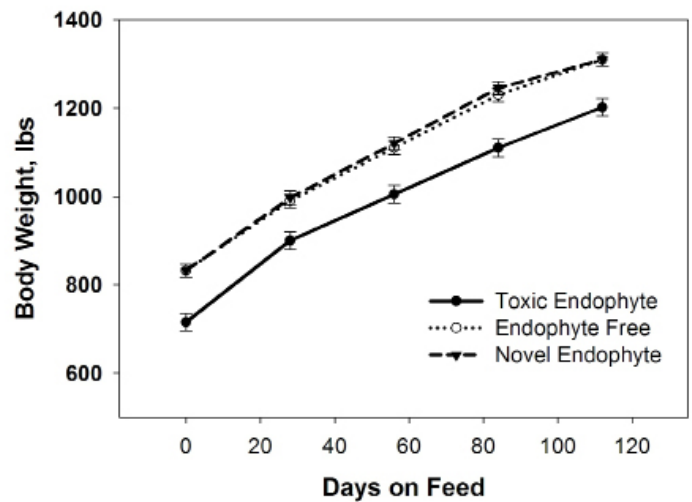
† Bouton, Andrae, and Hill (unpublished data).

## Subsequent Feedlot Performance

Following three of these grazing studies in Georgia, the stocker cattle were finished on high-concentrate diets and their feedlot performance was tracked. No difference in animal performance, feed efficiency, or most carcass quality measurements were found in calves that had grazed novel endophyte, endophyte-free, or toxic endophyte tall fescue. However, because of improved stocker performance, the cattle that grazed endophyte-free and novel endophyte tall fescue entered the feedlot heavier and reached targeted harvest weights sooner (Figure 5). While there appeared to be no feedlot performance depression from fescue toxicosis, heavier weights going into the feedlot will either (1) increase finished weights or (2) decrease time-on-feed, both of which translate into more profitable beef production.

## Equine Performance

Mares in late gestation are particularly sensitive to alkaloids produced by toxic endophytes. To date, there is limited research studying the effects of novel endophyte tall fescue on mare performance in late gestation and early lactation. In a study conducted in Mississippi, five mares grazed either novel endophyte, endophyte-free, or toxic tall fescue pastures. Of the mares that grazed toxic endophyte tall fescue, 80 percent did not produce milk, 40 percent had compromised deliveries, 60 percent had retained placentas, and one mare (20%) aborted. No problems were noted for mares grazing endophyte-free or novel endophyte tall fescue. Mares grazing toxic endophyte-infected pastures also had longer gestation periods and thicker placental membranes than mares that grazed novel endophyte or endophyte-free tall fescue pastures. These findings suggest that the risk to pregnant mares grazing properly established novel endophyte tall fescue with no toxic contaminants appears to be low to nonexistent.



**Figure 5.** Subsequent feedlot performance of cattle that grazed toxic, endophyte-free, and novel tall fescue during the stocker phase. Cattle originally grazed pastures in Eaton and Calhoun, Ga., and were finished in Stillwater, Okla. (Duckett et al., 2001).

# Renovating Infected Fescue Pastures

Completely renovating toxic endophyte-infected tall fescue pastures to establish a novel endophyte tall fescue variety is a major operation. The renovated pasture will be out of production for several months. Make plans to supply extra feed or reduce animal numbers during this period. There are four steps in this renovation program: (1) prevent seedhead production in the existing toxic endophyte-infected stand, (2) destroy the existing stand, (3) seed the new variety, and (4) manage the new planting.

**Step 1: Prevent Seedhead Production** – The endophyte in tall fescue is spread via seed. If seed is produced by the existing toxic endophyte tall fescue stand, then chances are high that toxic endophyte-infected plants will regenerate in the new stand. Therefore, it is critical to prevent the existing tall fescue stand from producing a seedhead during the spring prior to planting a novel endophyte tall fescue.

Mow stands when seedheads begin to develop but before they fully emerge. Two such mowings prior to viable seed production are normally required to prevent seed formation. While heavy grazing may prevent some seedhead production or merely delay seedhead emergence, mowing will almost certainly be required.

**Step 2: Destroy Old Stands** – There are two methods for destroying an existing stand of toxic tall fescue. The first method, generally referred to as the “spray-smother-spray” method, involves preventing seedhead formation as described above, spraying the existing stand with a moderate to heavy rate of glyphosate (commonly known by the trade names Roundup, Glyphomax, Touchdown, etc.), growing a smother crop (usually a warm season annual grass, such as pearl millet) during the summer, and then spraying surviving tall fescue plants and weeds again in the fall with a moderate to heavy rate of glyphosate before planting the new stand. Unfortunately, this method is very expensive and more problematic for most small producers than the “spray-spray-plant” method.

The “spray-spray-plant” method was developed by researchers at UGA. Their research showed that spring seedhead suppression and applying glyphosate (Roundup) in late summer and again four to six weeks later (followed by planting within one day of the second herbicide application) will successfully kill the existing fescue. The timing of this application protocol is critical, as sufficient regrowth by the survivors of the first application is needed to get a complete kill.

Destroying the stand with an herbicide using either of these two methods will be faster, cheaper, and much more effective than multiple tillage operations. Plowing alone will not sufficiently kill the existing stand and is not recommended. However, there may be some cases where preparing a tilled seedbed is desirable. In this case, the same protocol of two herbicide applications (regardless of method) is recommended prior to seedbed preparation.

**Step 3: Seed the New Variety** – Planting with a no-till drill should follow immediately (within one day) after the second glyphosate application. Killing fescue pastures with an herbicide and sod-seeding into the killed sod is advantageous for pastures with severe slopes. Plantings can also be made into a firm, prepared seedbed. In the Piedmont region, successful plantings can be made between mid-September and late October. Plantings in the Limestone Valley/Mountains region should occur between early September and early October. Spring seedings are generally not successful and are not recommended. Regardless of region, a planting rate of 15 to 20 pounds per acre is required for successful stand establishment.

Drought and insects frequently cause problems with fall seedings. Dry weather can reduce germination and delay seed emergence. Stands that are not well-established by December can winter-kill. Insects (grasshoppers and pygmy mole crickets) that inhabit the sod can damage new seedlings.

**Step 4: Manage Novel Endophyte Tall Fescue** – Like all tall fescue plantings, new plantings need special treatment. Do not cut or graze new plantings until the plants have grown at least 6 inches. Even then, only a light grazing is recommended to avoid stand damage. A light mowing can help control weeds and encourage the tall fescue to grow (i.e., tiller) and thicken-in; however, take care not to cut tall fescue below a height of 6 inches in the spring following establishment.

An early hay cutting (before May) should not be taken from new tall fescue seedings. If the novel endophyte tall fescue has been clipped to control weeds in early spring, a late hay cutting (after mid-May) can be successfully made if the planting resulted in an acceptable stand. The tall fescue stand should be managed to allow light to reach the base of the plants, which will encourage tillering; however, do not defoliate the plants too frequently or too severely.

Soon after the stand has been established (April or May following a fall seeding), novel endophyte tall fescue should be tested for the extent of novel endophyte infection. This will ensure that the novel endophyte is present in the tall fescue, that at least 80 percent of the tall fescue contains the novel endophyte, and that little or no toxic endophyte-infected tall fescue is present. More information on testing the endophyte status of tall fescue stands can be found at: <http://www.caes.uga.edu/commodities/fieldcrops/forages/questions/testingtallfescue.html>.

Although novel endophyte tall fescue generally is as persistent as toxic endophyte-infected tall fescue, some management differences are worth noting. Like all tall fescues, at least 2 ½ to 3 inches of growth should be maintained on novel endophyte tall fescue stands at all times. Unlike toxic tall fescue, livestock may not continue to graze novel endophyte varieties during tall fescue's summer dormancy or in periods of drought (Figure 4). Severe overgrazing can cause stand loss that may not have occurred with toxic endophyte-infected tall fescue. Therefore, it is critical to reduce the stocking rate or rotate the animals to warm season pastures to avoid overgrazing novel endophyte tall fescue, especially when pastures are dormant or under moisture stress.

## Summary

Tall fescue varieties containing a novel endophyte (e.g., Jesup MaxQ™) produce animal gains similar to endophyte-free tall fescue. The persistence of novel endophyte-infected tall fescues approaches or equals toxic endophyte-infected tall fescue and makes the novel endophyte tall fescue products an attractive alternative to either toxic or endophyte-free tall fescue in the pasture. A novel endophyte tall fescue is recommended when establishing or renovating an existing pasture in an area where tall fescue is desired. Information about recommended varieties of novel endophyte tall fescue may be found on the “Forage Species and Varieties Recommended for Use in Georgia” Web site (<http://www.caes.uga.edu/commodities/fieldcrops/forages/species.html>).



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