

# Research Progress On the Fescue Endophyte Problem

Carl S. Hoveland and Joseph H. Bouton  
*Crop & Soil Sciences Dept., Univ. of Georgia, Athens, GA*

**T**all fescue is the best cool season perennial grass in most humid areas of the United States. It has many excellent attributes such as long productive season, and tolerance to drought, poor drainage, soil acidity, overgrazing, and pests. Unfortunately, poor animal performance has long been a problem but the cause was unknown until about 1980 when scientists in Georgia and Alabama discovered a fungal endophyte (a fungus that lives within the plant but has no external symptoms of infection) which causes toxicity problems in livestock. The fungus produces an ergot alkaloid, ergovaline, which often results in reduced cow pregnancy, low calf weaning weights, and scruffy looking animals. Horses are also affected as mares fail to milk and often lose their foal. With severe toxicity, the losses can be high in livestock but an even greater problem is the subtle losses from less severe toxicity which result in slightly lowered conception rates and reduced growth rates in calves. Since the initial discovery, important research discoveries have been made on both harmful effects and benefits of the fungus, how it functions in pastures, ways to reduce the problems, and development of new varieties with the potential to eliminate the problem and even extend tall fescue adaption beyond present production areas into stressful environments such as the Coastal Plain.

## Dilution

Endophyte-infected tall fescue pastures that contain clover or other grasses have less animal toxicity problems. Palatable winter weeds or crabgrass in summer greatly reduce toxicity problems. As a result, extension recommendations are to plant clovers or other grasses to dilute the forage intake of the animal. Also, feeding hay other than tall fescue hay on infected pastures dilutes the problem. Joe Burns, extension specialist (now retired) in Tennessee coined the phrase, 'The solution to

pollution is dilution.' This approach generally works in areas where clovers do well but in other areas clovers are undependable and insufficient amounts are present to offset the grass toxicity.

## Endophyte-free tall fescue

The fungal endophyte lives its entire life cycle within the tall fescue plant and is not visible except by microscopic examination of the grass interior. Unlike most fungi, it does not produce spores so this fungus is spread only through infected seed. Storage of infected seed under normal conditions generally results in death of the endophyte after a year or more. This fact means that it is possible to produce endophyte-free tall fescue that will not produce the toxic alkaloid. Thus, pastures completely free of the fungal endophyte will remain that way for a very long time unless contaminated by infected seed being established by feeding infected hay or cattle moving seed from one pasture to another. The endophyte cannot be transferred by an infected plant to infect an adjacent endophyte-free plant. This made possible the development of endophyte-free tall fescue varieties.

After release of the first endophyte-free tall fescue varieties, excellent animal performance resulted but during hot dry summers many cattle producers reported severe stand losses in their new pastures. It was soon found that although endophyte-free tall fescue eliminated the animal toxicity problems, the plants were less tolerant of drought and close continuous grazing in summer than endophyte-infected tall fescue. Endophyte-free tall fescue could be utilized for pasture and survive but it had to be managed better - rotational stocking, or leaving a stubble of 3 to 4 inches in summer or removing cattle in mid-summer to other grass pastures. In 1998, Jesup endophyte-free tall fescue was released by the University of Georgia because it is more tolerant of drought and close grazing than other endophyte-free

varieties but still not as tough as infected tall fescue. With good grazing management, this variety can be very useful in improving animal performance by eliminating toxicity problems.

## Effects of the endophyte on the tall fescue plant

Clover or alfalfa plants infected with nitrogen-fixing bacteria in root nodules have a symbiotic relationship - the plant furnishes some sugars and other food for the bacteria while the bacteria indirectly supply nitrogen to the plant. Likewise, the fungal endophyte has a symbiotic relationship with the tall fescue plant - the fungus receiving food and lodging from the plant and the fungus benefitting the plant in a number of ways. Endophyte-infection stimulates root growth and deeper root development (favoring drought tolerance), greater tillering which increases forage yield, and soil nematode resistance. Grazing tolerance is also improved but the reasons for this are not well understood. These benefits are responsible for the excellent persistence and productivity of endophyte-infected tall fescue in stressful environments and under severe grazing pressure.

## Effects of the endophyte on plant competition

When endophyte-free and infected tall fescue plants are growing together in a pasture, the infected plants will eventually dominate the endophyte-free plants because of their superior ability to tolerate drought, overgrazing, and pests. This is why it is essential to eliminate all of the existing endophyte-infected plants before planting endophyte-free seed in a new pasture.

The fungal endophyte gives an advantage in competition of tall fescue with other grasses and legumes. Experiments in central and south Georgia with both clipping and grazing showed that endophyte infection greatly improved survival and productivity of tall

fescue in bermudagrass. A 3-year grazing study with beef cows and calves on mixed endophyte-free tall fescue-bermudagrass pastures showed that tall fescue stands weakened when continuously stocked but survived and was more productive when rotationally stocked. Clover yields and stands in tall fescue clipped every three weeks were not affected by the endophyte. However, alfalfa productivity was lower in endophyte-infected than in endophyte-free tall fescue sod.

### **Non-toxic endophytes in tall fescue**

Since the fungal endophyte is so beneficial to tall fescue, the ideal situation would be to have a 'friendly' endophyte that would not produce the toxic alkaloid but provide the advantages of drought and grazing tolerance, increased vigor, and pest resistance to the host plant. The discovery of non-toxic or 'friendly' endophytes has opened such an opportunity. Strains of nontoxic endophytes can be inserted into endophyte-free tall fescue to furnish

excellent animal performance but be just as vigorous and long-lived as toxic varieties.

Scientists at Grassland Division of AgResearch in New Zealand mastered this technology and in cooperative research with the University of Georgia developed the first tall fescue varieties in the world containing non-toxic or 'friendly' endophytes. Non-toxic endophytes have been inserted in elite adapted endophyte-free Georgia 5 and Jesup varieties. They have been tested in rigorous grazing trials (with summer drought) for the past two years with excellent results. Survival under continuous close grazing all summer in bermudagrass sod has been excellent and similar to toxic infected tall fescue. Planting of these unique varieties should result in dependable long-lived tall fescue pastures that furnish excellent animal performance for any class of livestock.

Georgia 5 and Jesup varieties with the non-toxic endophytes are being grown for seed in Oregon and exclusively marketed by Pennington Seed who own the license for using these endophytes. Limited seed are being planted in

practical pasture demonstrations on farms in autumn 1999 but larger seed supplies will be available for sale to livestock producers in autumn 2000. More information will be provided on these two varieties at a later date.

### **Conclusions**

Tall fescue is well adapted to a wide range of soils and management conditions and is highly regarded in spite of toxicity problems. This problem can be reduced by dilution - planting clovers or other grasses. Endophyte-free tall fescue eliminates the toxicity and resulting reduced animal performance but careful grazing management in summer is essential to maintain stands and productivity. With bermudagrass in the pasture, it becomes more difficult to maintain endophyte-free tall fescue unless rotational stocking is used. Insertion of non-toxic 'friendly' endophytes into elite tall fescue varieties offer excellent possibilities for greater animal productivity on pastures of this excellent grass.