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A New Tall Fescue with a Beneficial Endophyte

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ABSTRACT

Researchers from the University of Arkansas, University of Missouri, and the USDA-Agricultural Research Service cooperated in an effort to produce a new cultivar of tall fescue (*Festuca arundinacea* Schreb.) containing an endophyte (*Neotyphodium coenophialum*) which does not produce ergot alkaloids. Our objective was to select and introduce an endophyte which was not toxic to livestock be that retained the beneficial characteristic of enhancing plant drought tolerance. Studies were conducted in Arkansas and Missouri to test the safety and persistence of the cultivar HiMag with a nontoxic endophyte, referred to here as ArkPlus. ArkPlus was shown to produce steer weight gains as high as HiMag fescue without endophyte, and significantly higher than Kentucky-31 fescue with its natural, toxic endophyte. Stand persistence of ArkPlus was as good as toxic Kentucky-31 and better than endophyte-free HiMag in southwest Arkansas. ArkPlus Brand tall fescue is currently being marketed by FFR Cooperative and through its associated cooperatives throughout most states in the southeast.

INTRODUCTION

The introduction of new tall fescue varieties containing beneficial endophytes is probably the biggest advance in forage science to occur in the last few decades. These varieties have potential for improving livestock performance on pastures in much of the eastern and southern U.S. while providing a reliable, persistent source of cool-season perennial grass forage.

The problems of fescue toxicosis have been well known since the early 1980s when it was demonstrated that a fungus (called "endophyte") growing in the plant produced toxins which reduce the feed intake, growth rate, milk production, and reproduction of cattle. Hoveland (1993) estimated annual losses reaching $600 million for beef cow-calf production. Losses in stocker, dairy, and horse production enterprises would boost that even higher. Practically all other livestock, such as horses and sheep, are negatively affected as well. Almost all the acreage of tall fescue in the eastern and southern U.S. is of the cultivar 'Kentucky-31', which was mostly established during the 1950s to 1970s, before the role of the endophyte in causing livestock disorders was known.

The first approach to alleviating the problem was to eradicate existing stands of tall fescue that contained the endophyte and replant either with other forage species such as bermudagrass, orchardgrass, clovers, and/or wheat, or with endophyte-free varieties of tall fescue. Many of the endophyte-free fescue plantings were made on shallow, droughty soils. Drought stress, overgrazing, and competition from weeds and warm-season grasses resulted in many poor stands of endophyte-free fescue.

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Research at the University of Arkansas and other southern states demonstrated that the endophyte provided some protection to the fescue plant against drought stress, pest feeding, and overgrazing (West, 1994). Although there have been cases of endophyte-free fescue plantings that were successful because of good soil conditions and careful management, their planting has fallen into disfavor.

It became apparent that a new, non-toxic type of endophyte was needed to (1) alleviate fescue toxicosis while (2) assuring good stand persistence under unfavorable growing conditions and less-than-ideal management. This approach to solving an endophyte-related livestock problem started with researchers in New Zealand, who found strains of endophyte in perennial ryegrass that lacked the toxins causing ryegrass staggers while retaining insect resistance. Later, they applied the same technique to solving fescue toxicosis. The result is an endophyte known commercially as MaxQ™, which has been inserted into a variety developed by Joe Bouton at the University of Georgia called Jesup (Bouton et al., 2002).

The University of Arkansas has also developed a nontoxic endophyte, which was inoculated into the cultivar HiMag from the University of Missouri. HiMag with the new, nontoxic endophyte is now being marketed as ArkPlus Brand tall fescue through FFR Cooperative and its associated cooperatives, Missouri Farmers Association, Southern States Cooperative, and Tennessee Farmers Cooperative.

Field testing has shown that steer weight gains from May through November were as good on ArkPlus as on endophyte-free tall fescue, and both were greater than cattle grazing Kentuck-31 (Table 1). Physiological indicators of fescue toxicosis, such as hair coat scores, respiration rates, and rectal temperature, had values that were not different from endophyte-free HiMag, indicating that there was no fescue toxicosis in animals grazing ArkPlus (Table 1).

Table 1. Steer performance averaged over two locations (Fayetteville, AR, and Mt. Vernon, MO) and two years. ArkPlus is a brand of tall fescue containing an endophyte that does not contain ergot alkaloids.

Measurement	KY-31	ArkPlus	HiMag (endo-free)
Daily liveweight gain (lbs.)	0.75^{a}	1.32^{b}	1.34^{b}
Hair score (1 is slick, 5 is rough)	4.0^{a}	2.4^{b}	2.2^{b}
Respiration rate (breaths per minute)	107^{a}	83^{b}	79^{b}
Rectal temperature (°F)	106.0^{a}	104.5^{b}	104.0^{b}

Means in the same row followed by different superscript letters are significant different ($P<0.05$).

Stand survival of all fescue types declined from 2000 to 2003 in the hot, drought-stressed environment of southwest Arkansas (Table 2). Endophyte-free HiMag appears to have declined faster than the infected Kentucky-31 and ArkPlus, and virtually disappeared from the stands by 2002. ArkPlus has declined similarly to toxic Kentucky-31.

Table 2. Percentage stand density of tall fescue at the University of Arkansas Southwest Research and Extension Center at Hope, AR. Replication was inadequate for statistical analysis.

Date	KY-31	ArkPlus	HiMag (endo-free)
Mar 29, 2000	71	67	67
Oct 5, 2000	25	37	16
Nov 12, 2001	47	48	32
Oct 24, 2002	18	20	2
July 7, 2003	14	9	1

New tall fescue cultivars containing improved endophytes show excellent promise to support rates of animal production as high as those with endophyte-free fescue. This would be particularly attractive for grass-based dairies, stocker operations, and purebred cattle producers. Commercial cow-calf producers would benefit as well from the beneficial endophytes because of improved calf crops and weaning weights. Wildlife managers would find these new fescues more suitable as a wildlife food source than the common, toxic fescue. The new fescues would also have potential as a phosphorus-mining crop on land receiving animal waste or sewage sludge because high nitrogen rates will not promote fescue toxicosis with the new endophytes.

The common Kentucky-31 fescue with its toxic endophyte is an aggressive plant which is relatively unpalatable to cattle. Therefore, toxic fescue plants often retain a larger ungrazed stubble and leaf area than the more palatable endophyte-free fescue. This makes the toxic fescue more competitive against weeds and bermudagrass, and possibly helps retain a deeper root system. It is possible that the lack of toxicity in the fescues with beneficial endophytes results in the plants being grazed too short and therefore having reduced competitiveness and shallower roots. For that reason, we recommend that continuous overgrazing of tall fescue containing improved endophytes should be avoided, especially in times of drought.

The seed of tall fescue with new endophytes costs significantly more than that of common, toxic fescue or of endophyte-free varieties. Therefore, precautions need to be followed to assure successful stand establishment and continued lack of toxicity for future years. Here is a checklist of practices that will improve the chances of successful establishment and persistence of these improved fescues.

1. Prevent seed production on existing, toxic fescue fields by mowing or haying. Also, do not feed hay containing seeds of toxic fescue on the fields to be reseeded, or to cattle moving to such fields.
2. Eradicate existing, toxic tall fescue by a combination of herbicides, tillage, and(or) smother crops, like wheat or rye for winter cover and sudangrass or millet for summer cover. These intervening crops can be utilized by grazing or harvesting for hay/silage.
3. Correct soil deficiencies in fertility and pH by incorporating fertilizers and lime in late summer. Make final spot applications of Roundup herbicide to kill old fescue plants and escaped bermudagrass.
4. Plant the new seed by drilling into a prepared seedbed or no-till drill into herbicide-killed smother crop or weeds. If annual ryegrass or cheat are normally problems in that field, allow a rain to get the grasses up, kill the weeds with a burn-down herbicide, and then no-

till drill. Seeding rates should be 15-20 lbs/acre of pure live seed into a well-prepared seedbed, or 20-25 lbs/acre if using no-till drilling.

5. Control thick stands of broadleaf weeds as needed in late fall, early spring (March), and(or) late spring (May) with an appropriate herbicide. Late-fall control of broadleaf weeds (e.g. buttercups, henbit) will allow winter/early spring overseeding of legumes such as clovers and lespedeza. In that case, do not apply broadleaf herbicides in the spring. Grassy weeds need to be clipped or grazed to prevent seed production.
6. Fertilize with nitrogen as needed in early spring to promote dense tillering and leaf production, if legumes are not seeded.
7. Graze spring and summer growth to remove leaf area exceeding 5-6 inches, and remove cattle when stubble reaches 3-4 inches. During summer drought periods, remove cattle from pasture to avoid excessive grazing. Keep cattle off until fall green-up.
8. After one year of good stand establishment, proceed with stocking cattle at the carrying capacity of that land. Continue to prevent movement of toxic seed from other fields into the new stand by not feeding mature fescue hay from toxic fields on the new field, and keeping off toxic fescue fields for at three days before rotating them to new fields. That allows any seed containing toxic endophytes to be voided from their digestive tract. These are all methods that apply to the establishment and management of endophyte-free fescue and fescue with beneficial endophytes. But unlike the endophyte-free fescues, the new varieties with improved endophytes lend an added advantage in keeping your production system in business during drought.

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