TALL FESCUE GRAZING RESEARCH[1]

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'Kentucky-31' tall fescue, like it or hate it, covers 5 million acres of Kentucky and if you do not have it on your farm, it is likely that one of your bordering neighbors does! Tall fescue owes its persistence and productivity in large part to a fungal endophyte that infects most plants. This endophyte produces an array of alkaloids that benefit the plant in tolerating heat, drought, and grazing. Unfortunately, the endophyte also produces ergot alkaloids that can cause "fescue toxicosis" in cattle. Cattle inflicted with toxicosis have reduced dry matter intake, elevated body temperature, and often retain their winter hair coats in the summer. Weight gain by yearling cattle can be very poor (< 1.0 lb/day) and calving percentages of cow herds can be substantially reduced.

Endophyte-free varieties of tall fescue were commercially released in the 1980s, but proved to lack persistence in pastures; however, other approaches have been developed to manage around fescue toxicosis. Cattle performance on endophyte-infected tall fescue can be at acceptable levels if ergot alkaloids in the diet are diluted by interseeding clovers, or by feeding concentrates or by-product feeds. Another alternative is by planting tall fescue varieties infected with novel endophytes that do not produce ergot alkaloids and therefore are not toxic (as opposed to the wild type endophyte in Kentucky-31 tall fescue that produces toxic concentrations of ergot alkaloids (1). AgResearch Ltd. (New Zealand) successfully patented seven strains of tall fescue novel endophytes. Following grazing evaluations by the University of Georgia of tall fescue host (genotype) and novel endophyte combinations, the AR542 novel endophyte strain was inserted in Jesup and 'Georgia-5' and marketed as MaxQ® (2).

The purpose of this paper is to provide an update on research that has evaluated cattle performance and physiology of cattle grazing novel endophyte tall fescue, and persistence and productivity of novel endophyte tall fescue under long-term grazing. Novel endophytes currently under development will also be discussed

[1] Mention of trade names or commercial products in the article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA.

Livestock Performance on Novel Endophyte Tall Fescue

Weight gains of cattle and sheep have been consistently higher when grazing novel endophyte tall fescue pasture than on wild-type tall fescue pasture (Table 1). In an experiment with cow-calf pairs, calf birth and weaning weights were greater on Jesup

MaxQ® than on wild-type fescue pastures (9). Increased dry matter intake in cattle is one reason for the greater ADG achieved with novel endophyte tall fescue (3). Dry matter intake of Jesup MaxQ® hay by cattle was 12% greater than wild-type Jesup hay, and digestibility of dry matter and crude protein in MaxQ® hay were 3.3 and 4.4 percentage units, respectively, greater than in wild-type hay (3). Parish and others (8) also reported greater DM intake by steers on Jesup MaxQ® pasture than those on wild-type Jesup pasture.

Table 1. Percentage increase in average daily gain (ADG) with novel endophyte tall fescues relative to wild-type endophyte in tall fescue for grazing experiments with different classes of cattle and sheep.

Livestock	Class	NE/Tall fescue cultivar	Percentage increase in ADG [u]	Reference
Cattle	Steers	AR542/Jesup	+152[v]	8
Cattle	Suckling calves[x]	AR542/Jesup	+17[v]	9
Cattle	Postpartum cows	AR542/Jesup	+142[v]	9
Cattle	Steers	4/HiMag[y]	+58[v]	7
Cattle	Heifers	AR542/Jesup	+40[v]	4

[u] Increase relative to wild type endophyte tall fescue
[v] Control treatment was wild type endophyte in Kentucky-31 tall fescue
[x] Heifers and steers
[y] 'HiMag' tall fescue infected with novel endophyte strain 4
[z] Control treatment was wild type endophyte in Jesup tall fescue

Rectal temperatures of steers grazing Jesup MaxQ® fescue pasture in Georgia during the spring were less than those grazing wild-type endophyte-infected Jesup, and similar to those grazing endophyte-free Jesup (8). Steers grazing HiMag tall fescue with either of two novel endophyte strains were observed to shed their rough hair coats while those on wild-type Kentucky-31 fescue retained them (7). Results of these experiments have provided strong indication of successful alleviation of fescue toxicosis and improved animal performance with novel endophyte tall fescues.

Persistence of Novel Endophyte-Infected Tall Fescues

After MaxQ® was put on the market in 2001, the major question has continued to be if removing ergot alkaloids affects stand persistence. This question can now start to be answered with results of long-term grazing experiments that evaluated persistence

(Table 2). The earliest grazing research, during the development of Jesup MaxQ®, utilized sheep continuously grazing small plots (2). Although only 23.5% of the Jesup MaxQ® plants survived after two grazing seasons, Jesup with the wild-type endophyte also had poor persistence survival (36.3%) because both were subjected to intensive grazing and aggressive competition from bermudagrass. Following three years of grazing of late-summer and fall stockpiled growth, Burns et al. (3) reported that stand survival of Jesup MaxQ® (58%) and wild-type Jesup (71%), and both were more persistent than endophyte-free Jesup (75%). In another experiment, minimal losses in stands of Georgia-5 MaxQ® tall fescue were found following four years of continuous grazing by steers in the fall and spring (6). Stocking rates during the spring averaged 1350 lb body weight/acre. At the conclusion of a 6-year grazing experiment (4), Jesup MaxQ® had 73% ground cover, which was similar to wild-type endophyte-infected Jesup (74%) and greater than for endophyte-free Jesup (67%).

Novel endophyte-infected tall fescues have shown to persist under grazing. However, while wild-type endophyte-infected tall fescues persist under lax management, low inputs of management cannot be assumed with novel endophyte tall fescues. High establishment costs, including pricing of novel endophyte tall fescue seed, make it imperative to minimize stand loss. It was estimated to take 7 years to recover establishment costs if the discount of cattle exhibiting fescue toxicosis is not included in the market price, and 3 yr if it is (5). Also, as previously discussed, DM intake of novel endophyte-infected tall fescue is greater than of wild type tall fescue. Therefore, carrying capacities for novel endophyte-infected tall fescue likely will be lower than for wild type endophyte-infected fescue during periods of high ambient temperature and humidities. During the late spring through summer, reduced grazing activity of cattle on wild type fescue pasture can be expected as heat-stressed cattle spend more time in the shade and standing in ponds. Conversely, cattle on novel endophyte fescue pasture will not be as vulnerable to severe heat stress and will continue to graze resulting in greater dry matter intake and lower pasture carrying capacity.

Ongoing Development of Novel Endophyte Tall Fescues

The University of Arkansas has received a patent on an endophyte strain that was collected in Morocco. It has been announced there will be a commercial release of this novel endophyte inserted into a fescue cultivar developed by the University of Missouri.

Barenbrug USA has tested several fescue lines with different endophyte strains. Their novel endophyte-infected tall fescue was commercially released under the trade name BarOptima PLUS E34®.

AgResearch Ltd. has continued collaborative work with the University of Georgia, with additional tall fescue/endophyte strains being tested. The Noble Foundation (Ardmore, OK) also is collaborating with AgResearch Ltd. in testing two tall fescue populations in combination with two novel endophyte strains, AR542 and AR584. It is likely that new AgResearch novel endophyte tall fescue cultivars will contain strain

AR584, due to its greater persistence in seed during storage. AgResearch Ltd. breeders are also working to select novel endophyte tall fescues adapted to North America for improved palatability.

Table 2. Percentage stand survival of novel endophyte and wild-type endophyte tall fescues at the conclusion of grazing.

NE/tall fescue cultivar	Grazing management	Grazing intensity	Years of grazing	Percentage stand survival of novel endophyte fescue at the conclusion of grazing	Percentage stand survival of wild type fescue at the conclusion of grazing	Reference
AR542/Jesup[y]	Continuous grazing with lambs	Variable stocking to maintain a 3.0 inch grazing height	2	23.5	36.3	1
AR542/Georgia 5[z]	Continuous grazing with steers	Variable stocking to maintain 1000 to 1500 kg liveweight/ha	4	98.7	99.6	6
AR542/Jesup	Stockpiled growth grazed by steers after Aug. 15th	Grazed with steers to 3 to 4 inch stubble height	3	47	64	3

[y] Planted into bermudagrass [*Cynodon dactylon* (L.) Pers.] sod
[z] Measured at a site in south-central Oklahoma

Grazing Evaluation of a Tall Fescue Developed by the University of Kentucky

Dr. Tim Phillips, a forage breeder with the UK Plant and Soil Sciences Department, selected and developed a tall fescue (KYFA9301) from a Kentucky-31 population that has potential in the upper transition zone. A grazing evaluation was conducted in 2008 and 2009 at the UK Animal Research Center in Woodford County. Three replications of four entries [wild-type Kentucky-31, Jesup MaxQ® (AR542 novel endophyte), and KYFA9301, with and without the AR584 novel endophyte] were grazed by yearling steers in 2.5-acre pastures. The pastures were grazed from May 6th to July 23rd in 2008 (78 days) and April 2nd to June 25th in 2009 (84 days). Variable stocking with put-and-take steers was used to maintain a targeted forage availability of 2000 to 2500 lbs dry matter/acre.

The three non-toxic entries, MaxQ and endophyte-free (EF) and with AR584 novel endophyte (NE) KYFA9301, provided higher average daily gain and weight gain/acre than Kentucky 31 (Table 3). Although Kentucky 31 pastures carried more steers, the higher average daily gain of the steers grazing the non-toxic entries compensated for their lower pasture carrying capacities and generated greater weight

gain per acre. Interestingly, of the 3 non-toxic fescues, endophyte-free KYFA9301 supported the highest stocking rates. This would indicate KYFA9301 may not need an endophyte; however, there should be caution in acceptance of this interpretation. This will need to be supported by more research that imposes long-term, intensive grazing or clipping. It is likely that a novel endophyte will be needed to improve persistence.

Table 3. Steer performance and pasture productivity averaged over the 2 years for wild-type Kentucky 31 (KY31), Jesup MaxQ, and endophyte-free (EF) and novel endophyte (NE) KYFA9301 tall fescues.

Tall fescue entry	Average daily gain	Gain per acre	Pasture carrying capacity	Stocking rate	
	lb/day	lb/acre	steer days/acre	Steers/acre	lb BW/acre[1]
KY31	1.35	258	190	2.35	1636
Jesup MaxQ	1.90	314	168	2.08	1486
EF KYFA9301	1.65	302	183	2.27	1593
NE KYFA9301	1.66	292	176	2.17	1534

[1] Pounds of body weight per acre

Conclusions

Research shows that tall fescue infected with the wild type endophyte can be replaced with novel endophyte tall fescue to alleviate toxicosis and provide animal performance that is comparable to endophyte-free fescue. Furthermore, novel endophyte tall fescue can persist under grazing and provide insect deterrence while improving tolerances to drought and heat stresses, but more careful grazing management is recommended than with wild-type tall fescue to protect against the possibility of overgrazing and stand loss to insure recovery of higher establishment costs. Sustainability will likely depend on adjusting grazing management to account for lower pasture carrying capacities in the late spring and summer when cattle on novel endophyte tall fescue consume more herbage relative to those on wild-type tall fescue. It should be recognized, however, that reductions in stocking rates may be compensated by improved animal performance, such as calf weight gain, weaning weights, thrift, and reproductive efficiency.

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