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Herbage Quality, Biomass, and Animal Performance of Cattle

Part I: Forage Biomass, Botanical Composition, and Nutritive Values

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Introduction

For Virginia, the primary forage base is endophyte-infected (E+) Kentucky 31 (KY31) tall fescue. Tall fescue sets the standard against which agronomic performance of other grasses is measured. However, the decreased animal performance and disorders caused by the presence of the fungal endophyte *Neotyphodium coenophialum* reduces its suitability for many forage-livestock producers. A survey conducted by Ball, Lacefield, and Hoveland (1987) found that more than 90 percent of the fescue fields in the United States are endophyte-infected. The endophytic fungus produces ergot alkaloids that are toxic to livestock (Ball, Hoveland, and Lacefield 2002). A broad range of other alkaloids is also produced by the endophyte, but ergopeptide alkaloids are most closely associated with animal toxicity (Hill, Belesky, and Stringer 1991). Because the endophytic fungus itself produces alkaloids, endophyte-free (E-) tall fescue does not contain the toxic alkaloids that are produced in endophyte-infected fescue, and therefore does not negatively affect animals consuming it.

Quantum 542 tall fescue has recently been introduced as a “novel endophyte” tall fescue. This grass has an endophytic fungus that helps give it the positive agronomic characteristics commonly associated with varieties such as KY31 tall fescue, but the novel endophyte does not appear to cause the production of toxins found in other endophyte-infected tall fescue varieties. Moreover, research suggests that animal performance will not be compromised by the presence of the novel endophyte (Ball, Hoveland, and Lacefield 2002). However, this new variety has not been tested in Virginia under grazing conditions.

Grasslands Matua prairie grass (*Bromus catharticus* Vahl) was developed commercially in New Zealand in 1973 by Rumball, Butler, and Jackman (1974). However, there is still debate regarding the proper taxonomic name of the grass. Currently Matua is referred to as *Bromus willdenowii* Kunth. Another new cultivar, Grasslands Lakota prairie grass, has been released under the name *Bromus catharticus* Vahl. (Rumball and Miller 2003). Matua and Lakota prairie grasses are cool-season, short-lived perennial bunch grasses. They are erect-growing, typically 2 feet to 3 feet tall (60-90 centimeters) including the inflorescence. They have an appearance that is somewhat similar to orchardgrass, except that basal leaf sheaths of the prairie grasses are densely covered with fine hairs and the ligule is shorter. Seedheads are produced throughout the growing season, unlike most cool-season grasses. The newer Lakota is less susceptible to powdery mildew than Matua, which is highly susceptible in southeast conditions.

The general morphological characteristics of Matua and Lakota are similar. However, Lakota prairie grass exhibits more spreading than erect structure and has more tillers per plant when compared to Matua prairie grass. Lakota prairie grass greens-up much earlier in

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late winter/early spring than Matua prairie grass, which makes this grass highly desirable for Virginia where the forage shortage is most evident in late winter/early spring. The ability of prairie grasses to grow at cool temperatures makes them ideal forages for late-fall and early-spring grazing.

Recent research efforts with Matua at Virginia Tech examined its persistence, adaptability, and compatibility with various legumes (Guay et al. 2007). However, little is known about the performance of prairie grass under grazing conditions. Although prairie grass is a perennial grass, it also naturally reseeds. The mechanism by which prairie grass persists is not well known. Another crucial question that needs to be addressed concerning prairie grass is its persistence and reseeding rate under grazing conditions. The objective of our experiment was to determine the effects of grazing beef cattle on persistence, yield, and quality of Lakota prairie grass, KY31 endophyte-free tall fescue (KY31 E-), KY31 endophyte-infected tall fescue (KY31 E+), and Quantum 542 tall fescue.

Materials and Methods

A grazing experiment was initiated in September 2002 at the Kentland Research Farm near Blacksburg, Va. Four replicates of Lakota (a new prairie grass cultivar), KY31 E-, KY31 E+, and Quantum 542 novel endophyte tall fescues were established in a randomized complete block design on 44 acres. Seeding rates were 35 pounds per acre for Lakota and 22 pounds per acre for the fescues. Due to stand failure, the KY31 E- treatment was reseeded on March 30, 2003. Foxtail millet was grown as a break crop prior to establishment of the new grasses. In early fall, millet was harvested and plots were sprayed with Roundup prior to planting on Sept. 20-25, 2002. All pastures were fertilized according to soil-test recommendations.

Three Angus crossbred steers (average body weight of 614 pounds) were assigned to each treatment replicate, with a stocking rate of 1.1 steers per acre. Pastures were managed under rotational stocking, with each pasture subdivided into six paddocks. Animal movement from paddock to paddock was determined by available forage.

During the first year of the experiment, nitrogen was applied once to all the treatments in early spring 2003. In 2004 and 2005, after the initial 30 pounds per acre spring application of liquid nitrogen to all the treatments, an additional 50 pounds per acre of 46-0-0 fertilizer was applied to Lakota prairie grass after each of the sub-paddocks had been grazed by the steers for seven to10 days. The additional nitrogen application to Lakota prairie grass was based on the recommendation that this grass requires more nitrogen than tall fescue.

During the 2004 and 2005 grazing seasons, two or three of the sub-paddocks were mowed for hay during the month of June. In 2005, due to excessive forage growth driven by the nitrogen application and the ample moisture, additional (to the one annual mowing) hay was removed from the three Lakota paddocks in each replicate.

Forage botanical composition and yield were determined by clipping three 0.80-square-foot areas to 2 to 3 inches per treatment replicate. Samples from the quadrates were then separated by hand into grasses, legumes, broadleaf weed species, and dead material; the sum of the different components was used to calculate yield and botanical composition. Forage samples for chemical analyses were obtained by clipping at 2 to 3 inches above ground level every 28 days. Data were analyzed as a randomized complete block design (SAS 1982). Effect of treatment, field block, date, year, and all two- and three-way interactions were tested.

Forage Biomass Yield

The total amount of rainfall for the 2003 growing season exceeded the 2004 and 2005 seasons, as well as the 11-year average. The 2005 growing season was the driest of the three experimental years and dryer than the average of the past 11 years.

Averaged over the three growing seasons, KY31 E+ outyielded KY31 E-, Quantum, and Lakota prairie grass (figure 1). The next-highest-yielding forage was Quantum. No difference in yield was observed between Lakota prairie grass and KY31 E-. The differences in biomass between KY31 E+ and Lakota prairie grass, between Quantum and KY31 E-, and between Quantum and Lakota prairie grass were 641, 201, and 349 pounds per acre, respectively.

In 2003, which was a relatively wet year, forage biomass generally was greater than in the 2004 and 2005 growing seasons (figure 1). Although the numerical yield difference between KY31 E+ and the other three forage types was evident in 2003, the difference was not significant. In 2004, the biomass of KY31 E+ was more than Lakota prairie grass and KY31 E-. No significant difference in biomass was observed between Lakota prairie grass, Quantum, and KY31 E-. In 2005, the biomass of the four forages did not differ. However, the trend was similar to the 2003 and 2004 growing seasons. That is, KY31 E+ had the most biomass, followed by Quantum and Lakota prairie grass; KY31 E- yielded the least. For the three experimental years, the biomass of KY31 E+ was largest, followed by Quantum. Throughout this experiment, the biomass of Lakota prairie grass and KY31 E- was comparable.

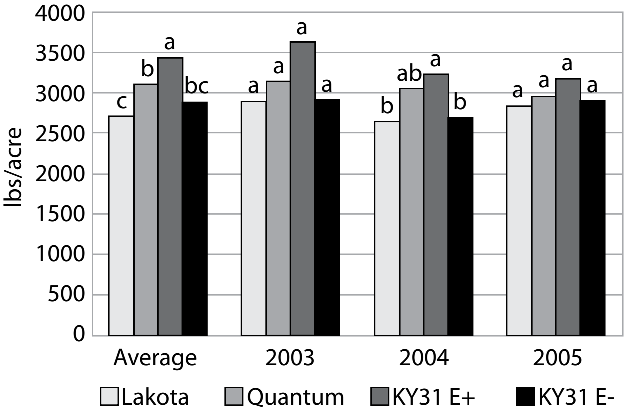

Figure 1. Influence of grazing on forage biomass yield (lb/A) of Lakota prairie grass, Quantum, KY31 E+, and KY31 E- by year and averaged over three years. All bars marked with different letters are significantly different within each year (P = 0.05).

Botanical Composition and Persistence

In 2003, the establishment year, there was no difference in botanical composition among treatments, indicating uniform stands across treatments. Although a slight decline in the treatment forages was evident in 2004, no difference in percentage-planted forage or weed species was observed. Within treatment, in 2004 the percentage-planted species, dead materials, broadleaf weeds, and grass weeds present remained constant (table 1). By 2005, the percentage of Lakota prairie grass declined significantly, followed by KY31 E-. After three years, the decline in percentage-planted forage was 50 percent for Lakota prairie grass, 29 percent for Quantum, 26 percent for KY31 E+, and 37 percent for KY31 E-. Less dead material and more broadleaf and grass weeds were observed in Lakota pastures.

Table 1. Botanical composition (%) of Lakota prairie grass, Quantum, KY31 E+, and KY31 E-.

	Treatments			
Component	**Lakota**	**Quantum**	**KY31 E+**	**KY31 E-**
		2003		
Planted species	95.5^{Aa1}	96.0^{Aa1}	91.8^{Aa1}	88.3^{Aa1}
Dead	3.0^{Ab2}	3.8^{Ab2}	3.2^{Ab2}	4.3^{Ab2}
Broadleaf	1.3^{Ab2}	0.0^{Ab2}	0.0^{Ab1}	3.8^{Ab1}
Other grasses	0.1^{Ab2}	0.2^{Ab2}	5.1^{Ab12}	3.6^{Ab2}
		2004		
Planted species	83.9^{Aa2}	89.6^{Aa1}	86.6^{Aa1}	87.8^{Aa1}
Dead	8.6^{Ab1}	7.7^{Ab2}	7.7^{Ab2}	6.9^{Ab2}
Broadleaf	2.3^{Ac2}	0.8^{Ac2}	0.6^{Ac1}	1.5^{Ac1}
Other grasses	5.2^{Abc2}	1.9^{Ac2}	5.1^{Abc2}	3.9^{Abc2}
		2005		
Planted species	50.6^{Ca3}	71.1^{ABa2}	73.9^{Aa2}	62.5^{Ba2}
Dead	8.5^{Bc1}	17.5^{Ab1}	17.1^{Ab1}	17.1^{Ab1}
Broadleaf	8.9^{Ac1}	3.4^{Bc1}	1.1^{Bd1}	4.0^{Bc1}
Other grasses	32.2^{Ab1}	8.0^{Cc1}	7.8^{Cc1}	16.5^{Bb1}

Note: Capital letters denote significance across component; lowercase letters denote significance across treatments; numbers denote year effect.

The persistence and overall productivity of Lakota prairie grass declined with time. The persistence of Lakota prairie grass is solely dependent on the plant reseeding itself (Jung, Shaffer, and Everhart 1994). Lakota prairie grass is a bunch type of grass, without rhizomes or stolons. Individual prairie grass plants do not attain the density of those grasses that propagate by rhizomes and vigorous tillering; thus, prairie grass stands are typically thin and disappear within three to five years of establishment. Therefore, the long-term persistence and productivity of this grass might be improved by allowing it to produce a sufficient amount of seed for reseeding and by allowing adequate rest periods between cuttings or grazing (Jung, Shaffer, and Everhart 1994).

For the fescue varieties tested, our results indicated the highest persistence for infected varieties and lower persistence for uninfected varieties of tall fescue. Bouton et al. (2002) obtained similar results. Among the tall fescues at the end of the three experimental years, the biomass, forage-yield distribution, and persistence of KY31 E+ were superior to all the treatments. However, the performance of Quantum was often similar to KY31 E+. The overall performance of KY31 E- was much lower than Quantum and KY31 E+ but slightly higher than Lakota prairie grass.

Nutritive Value

In 2003, grass type had no effect on crude protein (CP). Average CP over seasons and forage types was 16.3 percent. In 2004, the CP of Lakota was more than Quantum (17 percent versus 15 percent, respectively). In both the 2003 and 2004 growing seasons, no difference in neutral detergent fiber was observed between treatments. In 2003, no effect of grass treatment on invitro dry matter digestibility (IVDMD) was observed. In 2004, however, a difference in IVDMD was observed between KY31 E+ and Quantum (64 percent versus 61 percent). During both the 2003 and 2004 growing seasons, the greatest trends in nutritive values were related to season rather than treatment. As the season progressed from spring to summer to fall, the nutritive values of all the treatments declined from spring to summer and then increased again slightly in the fall (data not shown).

Conclusion and Recommendation

The biomass yield of KY31 E+ was often more than Lakota and KY31 E- but similar to Quantum. By the third year of establishment, the stand of KY31 E- was much thinner than either Quantum or KY31 E+. Hoveland et al. (1983) reported that although endophyte-free tall fescue offers advantages in animal production, plant performance is sacrificed. Similarly, Hill, Belesky, and Stringer (1991) documented that endophyte-infected tall fescue plants were larger and more competitive than endophyte-free plants when the two were planted together in a Georgia study.

At the end of the three experimental years, we tested the endophyte level of the three fescues and determined that no encroachment of KY31 E+ had occurred. The endophyte levels of KY31 E+ and Quantum were 89 percent and 90 percent, respectively, while KY31 E- remained endophyte-free. The decline in biomass yield of the Lakota stands can be attributed to the lack of nitrogen fertilization following grazing or cutting in 2003 and conditions that attributed to seedling smothering in 2005.

The productivity and longevity of Lakota prairie grass is highly dependent on reseeding and proper fertilization. If managed properly, the grass can be a great alternative to those producers currently dependent on KY31 E+. No major differences in nutritive values among treatments were observed. However, the CP of Lakota prairie grass was slightly more than the three fescues tested.

Based on our three-year experiment, we conclude that properly managed Lakota can outperform all the fescues tested. Among the fescue treatments, steers grazing on KY31 E- performed well, however stand persistence was less than that of Quantum and KY31 E+. Although the biomass yield of KY31 E+ was more than all other treatments, animal performance was compromised by the presence of the fungal endophyte. Quantum equipped with the novel endophyte had yields similar to KY31 E- and KY31E+ during most months, but exhibited better animal performance than KY31 E+, making it a viable alternative to KY31 E+ for livestock producers.

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