Preliminary Results: Complementary C_4:C_3 Grazing Systems

M. Berry, P. Keyser, S. Jagadamma, H. Nauman, K. Coffey,
C. Nieman, P. Owens, A. Ashworth, E. Bisangwa

Keywords: Native grasses, cow-calf operations, fescue belt, grassland ecology

Abstract. Native warm-season grasses (NWSG) can produce high quality forage and high rates of gain for beef cattle. However, little data is available on how NWSG affect the productivity of cow-calf operations on a farm scale. Therefore, we implemented an experiment at three sites, Booneville, AR, Linneus, MO and Louisville, TN, with cow-calf pairs (mature cows over ≥3 years old, spring calving). We evaluated two forage systems that mix either a drought or drought/flood tolerant native C_4 species [big bluestem (BB) blend or eastern gamagrass (EG)] with a cool-season perennial, tall fescue (TF), and compared them to the most frequently used forage system within the Fescue Belt region, one that relies on TF only. The TN study site contains EG, with big bluestem at the MO site, and both big bluestem and EG at the AR site. Cattle (n = 12 pairs per experimental unit) were weighed yearly before initial grazing and again after final removal. Forage samples (n = 15) were collected at the beginning of grazing and once every twenty-eight days during the grazing season, and finally, at the conclusion of grazing. Harvested forages were tested for forage nutritive content (CP, NDF, ADF) using NIRS. Hay produced per forage system was documented by counting bales and weights of subsamples. The AR site was not able to participate in the first year of the study. Overall, there were no statistical differences between treatments in the first grazing season for either cattle or forage measures. However, cattle spent less time on NWSG in 2021 at the TN site to enable renovation of EG to be completed. Also, TF stands had a significant proportion of volunteer warm-season grasses within the pastures. Data from the second year of the study are currently under analysis.

Introduction

Approximately 40% of the nation's cow-calf operations are located in the eastern United States (Livestock Marketing Information Center, 2018), where a cool-season grass, tall fescue (TF; *Schedonorus arundinaceus*) is the predominant forage. With over 15 million ha growing this forage, the region is commonly denoted as the Fescue Belt. Cow-calf producers typically use TF because of its simple management, productivity, and lack of pests (Sleper & West, 1996). As a C_3 grass, TF provides a considerable amount of forage in the spring, with some additional growth during fall. During June–August however, TF is semi-dormant, particularly during periods of drought or intense heat. Pastures comprised of only TF provide only limited grazing during these months, leading to a 'summer slump.' In addition, fescue toxicosis, a condition caused by the presence of an endophyte in TF that results in depressed reproduction and weight gain in cattle (Paterson et al., 1995) is a serious concern for producers. Warm-season (C_4) grass pastures can provide the necessary forage during summer, eliminating the need for hay and supplementing the poor forage quality of TF during this time period (Fike and Pent, 2019). While there are a number of studies evaluating steer (Burns and Fisher, 2013, Backus et al., 2017, Brazil et al., 2021) and heifer (Boyer et al., 2020, Lowe et al., 2016, Keyser et al., 2022) responses to NWSG, little data is available on how such grasses affect the productivity of cow-calf operations or how such forages can impact an overall forage system at the farm scale.

Methods and Study Site

Three locations were used in this study: the Blount Unit, East Tennessee AgResearch and Education Center, Louisville, TN (35.84354, -83.95493), the Forage Systems Research Center in Linneus, MO (39.85857, -93.13840) and the Dale Bumpers Small Farms Research Center in Booneville, AR (35.08808, -93.99347). This study consisted of two treatments, replicated twice at each location. Treatment 1 was characteristic of the most common grazing system in the region, a cool-season pasture dominated by toxic endophyte-infected TF and serves as the control. Treatment 2 is a complementary cool-season/warm-

season system. The warm-season system consists of eastern gamagrass (EG) (TN), big bluestem (BB) (MO) and both BB and EG (AR). Cows (mature cows ≥3 years old, spring calving) with calves were randomly assigned (n = 12 pairs) to one of four groups that were similar in parity, body condition, and weight. Unshrunk cattle weights were taken on two consecutive days, prior to and following the movement on and off NWSG in April/May and again in August/September. Two additional weights were taken annually, at breeding and at weaning. Weights were taken on calves at birth, when cow/calf pairs enter NWSG in spring, when cow/calf pairs are removed from NWSG in late summer, and finally, at weaning. Native grass pastures were grazed May–September on a rotational basis with cattle moved within assigned paddocks based on stand condition. TF pastures were grazed April – November with rotations also based on stand condition. Two TF paddocks within each replicate were allotted annually for hay production during spring and, subsequently, for fall stockpiling. Forage mass was collected from 15, $0.25 m^2$ randomly located quadrats within an actively grazed paddock per treatment unit at the beginning of grazing, and once every 28 days during the grazing season, and finally, at the conclusion of active grazing per each experimental unit. Harvested forages were tested for crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF). Samples were dried in a forced air oven at 55C for 72 hours; then, samples were ground using a Wiley Mill (Thomas-Wiley Laboratory Mill Model 4, Arthur H. Thomas Co., Philadelphia, PA) passing through a 2-mm screen; followed by a cyclone sample mill (UDY Corporation, Fort Collins, CO) grind to pass through a 1-mm screen (McIntosh et al., 2022). Ground samples were analyzed using Near-Infrared Spectroscopy technology (FOSS 5000, FOSS NIRSystems, Inc.) for crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF), with all predicted results presented at 100% dry matter (DM). Response variables of cattle weights, forage mass and nutritive value parameters, and soil properties will be analyzed using a mixed model analysis of variance (ANOVA) test using PROC UNIVARIATE in SAS® software, Version 9.4 (SAS Institute, Cary, NC, 2013) and considered significant at $\alpha = 0.05$ for each of the three sites. Response variables will also be tested for normality using PROC UNIVARIATE in SAS® software, Version 9.4 (SAS Institute, Cary, NC, 2013). If all variables meet assumptions of normality, then no transformation will be made. Due to concerns of differing farm management, each site will be treated independently of the other.

Results and Discussion

At the AR site, due to delays in installation of grazing infrastructure, the project was not initiated until 2022. Data in this report consists of 2021 data from the MO and TN sites. Treatments were not significant in 2021 for any cattle or forage parameters. Potentially, the decreased grazing time in NWSG pastures for both locations did not allow for these grasses to provide a noted benefit. While grazing days by animal unit means did not differ ($P > .05$), While there were no significant differences between treatments, cattle spent less time on EG pastures at the TN location because of poorly stocked stands resulting from management during previous research combined with poor establishment success during renovation preceding the current study. EG pastures averaged a 49% stocked. Further, the TF pastures at the TN location have a considerable percentage of warm-season grasses (averaged 44%) growing within gaps in the TF pastures, such as foxtail (*Setaria* spp.), johnsongrass (*Sorghum halepense*) and dallis (*Paspalum dilatatum*). While efforts are ongoing to maintain stronger TF dominance within the TF stands, it was a significant concern for the 2021 season and may explain the lack of variation within the data.

In MO, cattle were able to maintain summer grazing on TF pastures because of above annual rainfall during 2021. The grazing season in MO extended well into winter for the TF-only groups because of the lower stocking density (12 ha available for grazing vs. only 8 in the complementary system). Forage from the MO site is currently under analysis for nutritive value, but forage from both treatments at the TN location were comparable for CP, TDN, and aNDF.

Table 1: Forage and cattle data in 2021 from both tall fescue-only systems (TF) and tall fescue/big bluestem component (TF/BB) in Linneus, MO and tall fescue/eastern gamagrass (TF/EG) in Louisville, TN.

Location	Treatment	Weaned (kg/ha)	Birth weight (kg)	205-day adjusted weaning weights (kg)	Grazing days (AUD/ha)	Hay yield (kg/ha)	CP (%)	TDN (%)	aNDF (%)	FM (kg/ha)
TN	**TF**	288	36	265	724	16,941	14.6	62.3	64.5	4,378
	TF/EG	265	36	269	346	14,732	15.8	15.8	63.9	3,943
MO	**TF**	538	37	290	705	9,279	N/A*	N/A	N/A	1,026
	TF/BB	597	37	339	357	5,069	N/A	N/A	N/A	1,271

*NIRS analysis not completed at time of this publication.

Table 2: Grazing days (AUD/ha) means from both tall-fescue only systems (TF) and tall fescue/big bluestem component (TF/BB) in Linneus, MO and tall fescue/eastern gamagrass (TF/EG) in Louisville, TN in 2021. Spring refers to initiation of grazing in April/May to placement on NWSG pastures. Summer NWSG and Summer TF refer to grazing periods on TF and NWSG during the NWSG grazing period. Fall refers to the grazing period after removal from NWSG pastures to conclusion of grazing season for the 2021 year.

Location	Treatment	Spring	Summer NWSG	Summer TF	Fall	Total
TN	TF/EG	53	388	86	196	724
TN	TF	35	0	183	128	346
MO	TF/BB	77	462	7	159	705
MO	TF	51	0	157	149	357

Conclusions

Production systems in the eastern U.S. Fescue Belt rely heavily on cool-season grasses, with TF as the principal forage. However, fescue toxicosis and the "summer slump" are challenging for producers. A complementary grazing system that incorporates NWSG has the potential to mitigate these two issues. While treatments did not differ significantly in this study for 2021, this is potentially due to the lack of grazing time on the NWSG stands and to the influence of warm-season grasses within the TF pastures at the TN site. This could potentially indicate that a mixed TF stand may be a beneficial alternative. These results also reiterate the importance of taking full advantage of grazing NWSG during summer, in order to reap their full benefits. If producers do not utilize NWSG pastures in the duration of their productive season, their potential may not be realized.

Acknowledgements

We thank the USDA AFRI for funding this project (Award no. 2021-67019-33426), the University of Tennessee Center for Native Grasslands Management, the University of Arkansas, the University of Missouri, the staff at Dale Bumpers Small Farm Research Center, Missouri Forage Systems Research Center staff, the staff at East Tennessee Research and Education Center, Blount Unit and the many field technicians who helped to make this project a success.

References

Backus, W.M., Waller, J.C., Bates, G.E. Harper, C.A., Saxton, A., McIntosh, D.W., Birckhead, J., Keyser P.D. (2017). Management of native warm-season grasses for beef cattle and biomass production in the Mid-South USA, *Journal of Animal Science*, Volume 95, Issue 7, Pages 3143–3153.

Brazil, K. A., Keyser, P. D., Bates, G. E., Saxton, A. M., & Holcomb, E. D. (2020). Continuous grazing of mixed native warm-season grass in the fescue belt. *Agronomy Journal*, 112, 5067–5080. https://doi.org/10.1002/agj2.20426.

Burns, J.C., & Fisher, D.S. (2013). Steer performance and pasture productivity among five perennial warm-season grasses. *Agronomy Journal*: Vol. 105:113-123.

Boyer, C., Zechiel, K., Keyser, P.D., Rhinehart, J., Bates, G.E. (2020). Risk and returns from grazing beef cattle on warm-season grasses in Tennessee. *Agronomy Journal*. Volume 112, Issue 1, Pages 301-308.

Carter, J. M., Aiken, G.E., Dougherty, C.T. and Schrick, F.N. (2010). Steer responses to feeding soybean hulls and steroid hormone implantation on toxic tall fescue pasture. *Journal of Animal. Science:* Vol. 88, 3759–3766.

Fike, J.; Pent, G. *Tall Fescue, Endophytes and Alkaloids, and Fescue Toxicosis*; SPES-114P; Virginia Cooperative Extension Publication: Blacksburg, VA, USA, 2019.

Keyser, P. D., Zechiel, K. E., Bates, G. E., Ashworth, A. J., Nave, R. L. G., Rhinehart, J. D., & McIntosh, D. (2022). Evaluation of five C4 forages in the tall fescue belt. *Agronomy Journal*, 114, 3347–3357. https://doi.org/10.1002/agj2.21195

Klotz, J.L., Aiken, G.E., Egert-McLean, A.M., Schrick, N., Chattopadhyay, N. & Harmon, D.L. (2018). Effects of grazing different ergovaline concentrations on vasoactivity of bovine lateral saphenous vein. *Journal of Animal Science*. Vol. 96, 3022–3030

Livestock Marketing Center. (2018). https://lmic.info/page/about-lmic

Lowe, J.K., Boyer, C.N, Griffith, A.P., Waller, J.C., Bates, G.E., Keyser, P.D., Larson, J.A., Holcomb, E. (2016). The cost of feeding bred dairy heifers on native warm-season grasses and harvested feedstuffs, *Journal of Dairy Science*, Volume 99, Issue 1, Pages 634-643.

McIntosh, D., B. J. Aderson-Husmoen, R. Kern-Lunbery, P. Goldblatt, R. Lemus, T. Griggs, L. Bauman, S. Boone, G. Shewmaker, and C. Teutsch. 2022. Guidelines for Optimal Use of NIRSC Forage and Feed Calibrations in Membership Laboratories (Second Edition). The University of Tennessee Press, Knoxville, TN.

Paterson J., Forcherio C., Larson B., Samford M., Kerley M. (1995). The effects of fescue toxicosis on beef cattle productivity. *Journal of Animal Science*, Vol. 73(3):889-98.

Sleper, D. & West, C. (1996). Tall fescue. In L. E. Moser, D. R. Buxton, & M. D. Casler (Eds.), *Cool-season forage grasses* (Vol. 34).