Biodiverse Forage Mixtures for Bees and Beef Cattle

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Key words: [Biodiversity; pollinators; conservation; tall fescue]

Abstract

Introduction: Beef cattle performance in the southeastern US is limited by tall fescue (TF) toxicosis. Native warm season grasses (NWSGs) can provide alternative forage for cattle and reduce TF toxicosis. Pollinator populations, especially bees, also have been declining across North America. Introducing native wildflowers into tall fescue grasslands might improve pollinator populations. An ongoing grazing experiment in central Virginia USA is testing the feasibility of integrating wildflowers and native grasses as a way to generate ecosystem services.

Objectives: This study sought to determine whether including native grasses and wildflowers in tall fescue pasture systems could improve beef heifer performance.

Methods: The grazing experiment consists of three treatments replicated 4x: 1) tall fescue pasture diversified with native warm-season grasses and wildflowers (WF), 2) tall fescue pasture with portable shade structure to reduce heifer body temperature, and 3) a tall fescue control. All paddocks (1-ha ea.) were planted to an endophyte-infected tall fescue base. Four heifers were set stocked in each paddock. Average daily gain (ADG), body temperature, forage mass, and botanical composition were measured during 2021 and 2022 growing seasons.

Results and Discussion: Seasonal ADG did not significantly differ among treatments in 2021 and averaged 0.49 kg head^{-1} d^{-1}. In 2022, seasonal ADG for the wildflower paddocks was 0.45 kg head^{-1} d^{-1}, double the ADG of the control. Body temperature data suggest that shade reduced heifer body temperature over unshaded heifers. Forage mass was not significantly different at most timepoints, and gradually increased then declined over the course of both seasons. Tall fescue stands had few weedy species, native warm season grass stands had some weed competition, and the wildflower stands were so weedy that they required replanting.

Conclusions: Integration of native warm-season grasses into tall fescue pastures improved beef cattle performance in summer. These gains occurred even when >10% of pasture area was devoted to non-forage wildflower plantings. We suggest greater diversification of tall fescue pastures generates ecosystem services and can be compatible with robust beef cattle production in this region.

Introduction

Tall fescue is the predominant forage species in southeastern USA in eastern North America. Tall fescue is a preferred perennial grassland species because of its tolerance to producer management, mismanagement, and low input production (Fike and Pent, 2009; Kubesch et al. 2022). For the cow-calf and stocker production systems seen in the southeastern USA, tall fescue offers a simple forage program. However, because tall fescue infected with toxic endophyte can impair animal performance, as well as generally low productivity in the summer, warm-season forages are often used to maintain or improve animal performance (Fike and Pent, 2009). Though warm-season annuals, as well as introduced warm-season perennials have been used successfully in portions of the transition zone, native warm-season grasses (NWSGs) have been shown to meet producer objectives across the region. As a portion of a wider grazing management unit, NWSG can provide warm-season forage production without anti-quality effects for livestock (Keyser 2021). These NWSG species previously coexisted with flowering legumes, forbs, and even woody species that would be considered wildflowers (WF) (Keyser 2021) in natural grasslands. Pollinator populations are declining in eastern North America, and using NWSG-WF stands to provide both forage for livestock production as well as resources for pollinators. The agronomic challenges regarding wildflower establishment and management within forage-livestock systems warrant further study, as has been pursued in the course of this present research. The present study sought to determine whether beef heifer performance improves over conventional TF with the addition NWSG-WF areas to TF pasture systems.

Methods

The experiment was conducted at the Shenandoah Valley Agricultural and Education Center (SVAREC; Raphine, VA) starting in 2020. Twelve 1-ha paddocks were assigned to one of three treatments after the conclusion of the experiment described by Tracy et al. (2022). Treatments consisted of a negative control, a positive control, and the biodiverse treatment. The negative control was simply a paddock with toxic endophyte tall fescue (KY 31 E+), hereafter CONTROL. Tthe positive control was a KY 31 E+ stand with the addition of a shade structure to help reduce heifer body temperature; hereafter the positive control is SHADE. The shade treatment was considered a positive control because shade could reduce body temperatures elevated by tall fescue toxicosis and possible produce positive gains in performance. The biodiverse treatment consisted of a paddock spatially arranged such that 70% of the area was seeded to KY 31 E+, 20% to native warm-season grass (NWSG) strips, and 10% to a wildflower (WF) strip. Hereafter the biodiverse treatment is WILDFLOWER.

Angus commercial crossbred heifers (n=48) went onto the experiment for 11 weeks in June 2021 and for 16 weeks in May 2022. Heifers were weighed on 2 consecutive days immediately prior to the start of the test and again at the end of the test each season in order to account for gut fill. Heifers were weighed every 4 wk during the season to track average daily gain. These 4 wk were corresponded to months. Quadrat sampling corresponded to heifer weights on the same 4 wk basis. Eight quadrats were sampled in the shade and control treatments. Fourteen quadrats were sampled in the wildflower treatment to account for variability among the TF, NWSG, and WF portions of those paddocks. In quadrats, floral units were counted and herbage was collected to ground level. Botanical composition was assessed in June 2021 and 2022 using a modified Daubenmire method to compare compositional shifts across seasons as well as capture the cool- and warm-season species present in the paddocks (Tracy et al. 2022; Daubenmire, 1959).

Results and Discussion

Average daily gain and body temperature

Heifer ADG did not significantly differ among the treatments in 2021. Heifer ADG for all treatments was negligible at the end of the season (Figure 1a). Heifer ADG significantly differed among treatments in 2022 (Figure 1b). Heifers gained more weight in the wildflower treatment than in the shade and control treatments ($P < 0.05$). Heifer ADG in the control and shade treatments converged near 0 kg d^{-1} at the end of the season. Though heifers in the wildflower treatment continued to gain weight, they were still lower than needed to develop heifers for breeding (Keyser 2021; ~0.77 kg d^{-1}). Subsequent supplementation in the fall and winter has been a historical approach to getting around tall fescue toxicosis in this system. Heifers in the wildflower treatment had improved weight gain associated with the initial use of the NWSG areas in June and the subsequent use in August 2022. These differences in animal performance were not associated with measured variation in intravaginal temperature.

Forage mass and botanical composition

Throughout the 2021 grazing season there was a corresponding drought. This drought limited forage production and shortened the length of the 2021 season relative to the original 12-wk planned season. The control and shade treatments had more forage than the wildflower treatment in May 2021 ($P < 0.05$). The wildflower treatment had more forage than the control and shade treatments in July 2021 (Figure 2). These points in time correspond to the tall fescue reproductive growth in late spring and the vegetative growth of the NWSG in mid-summer, respectively. A mid-season rest for the NWSG reduced potential heifer ADG, but was necessary to allow those portions of the paddock to recover. No differences were seen in forages among the treatments until September 2022. Compared to 2021, precipitation was greater in 2022. Tall fescue reproductive growth as well as NWSG vegetative growth explained the trends in forage mass at the start of the season. The decline in forage mass between June and July 2022 in the wildflower treatment again corresponds to the preferential use of NWSG. TF and NWSG stands were fairly clean of weeds. The WF stands were weedy.

Figure 1. ADG

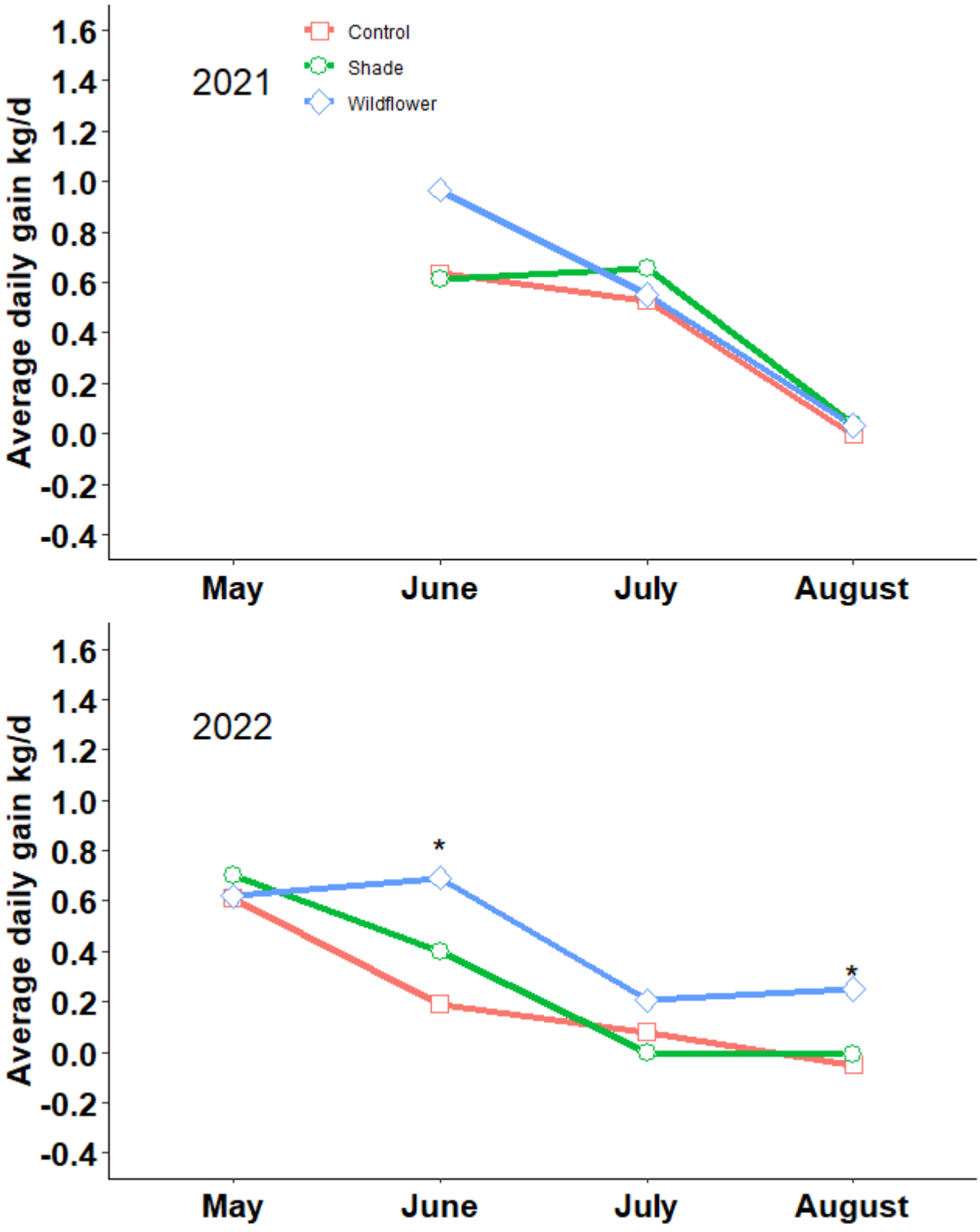
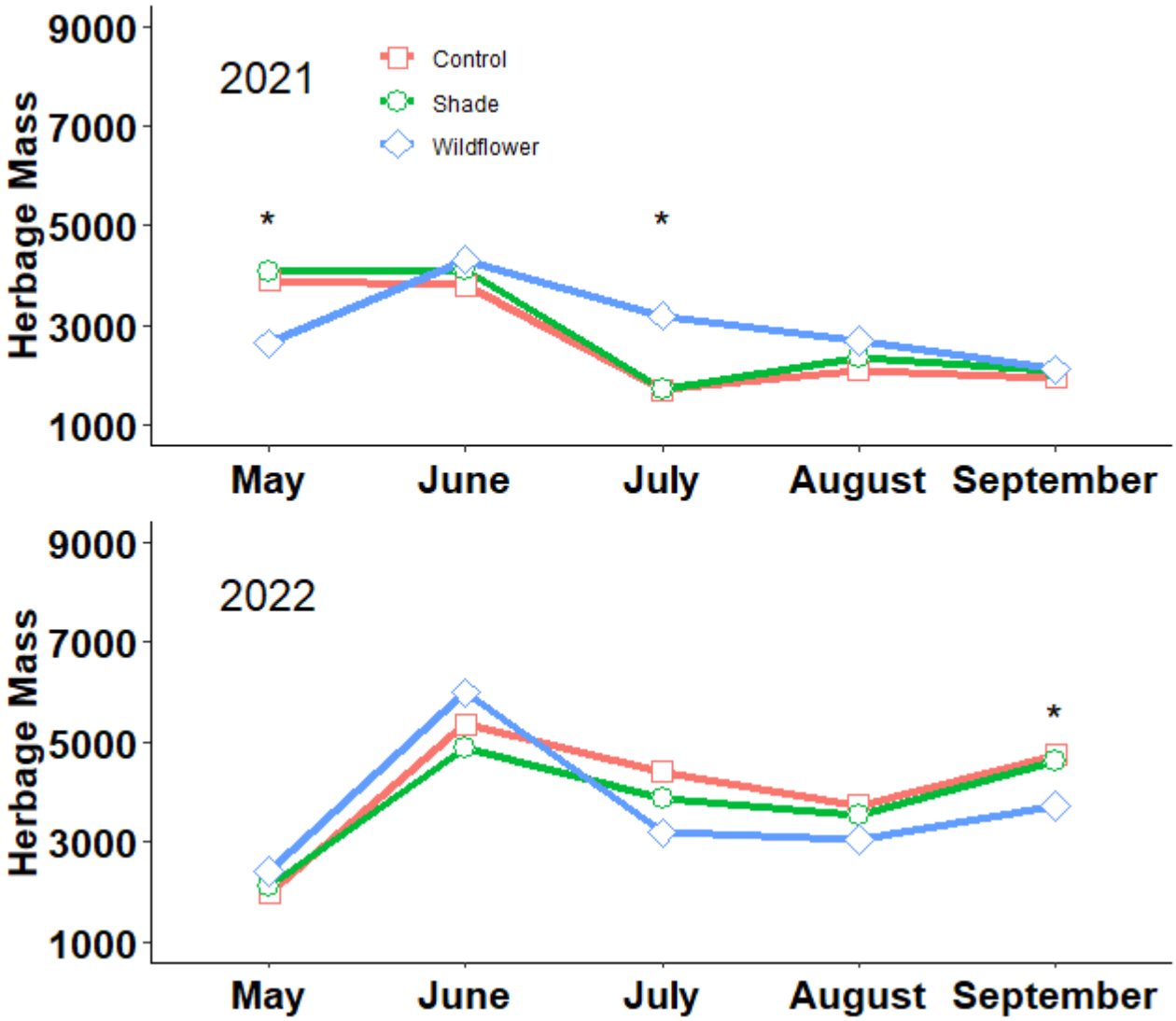


Figure 2. Herbage mass



Conclusions and/or Implications

Animal performance was improved with the increased diversity of forage species. Heifer body temperatures were not consistently reduced by the addition of shade structures or increased forage species diversity. Forage production was comparable among treatments during a majority of sampling periods. Preliminary results suggest that tall fescue grazing systems diversified with NWSG (for cattle) and wildflowers (for bees) can be compatible with achieving sustainable beef cattle performance.

Acknowledgements

This grazing experiment was supported by USDA-NIFA grant 2018-06745: Bee-friendly Beef: Developing Biodiverse Grazing Systems in Virginia. Assessments were done with the help of the SVAREC crew, David Bellangue, Velva Groover, Kelly Winklepleck, Dillon Golding, Natalie Falls, and Harry Stewart. Special thanks to Sarah Grace Kubesch for maintaining the family turkey ranch during sampling trips for this research.

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