Forage Production Characteristics and Performance of Growing Beef Heifers Grazing Native Warm-Season Grass Mixtures

By

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Abstract

A 2-yr study was conducted at Black Belt Research and Extension Center in Marion Junction, AL to evaluate the effect of nitrogen (N) fertilizer application rate on forage production, nutritive value, sward characteristics, and performance of beef heifers grazing a mixture of big bluestem, little bluestem, and indiangrass. Six, 2-ha plots were randomly assigned to one of two treatments (0 or 67 kg N ha^{-1} applied in early April; n = 3 replications per treatment). Paddocks were continuously stocked with 4 weaned Angus × Simmental beef heifers from late May/early June through mid-to-late August during 2018 and 2019, respectively. Additional put-and-take cattle were used to manage forage to a target height of 38 cm. Forage mass and canopy sward heights were collected every 2 wk during the trial. Visual ground cover ratings, canopy light interception, and botanical composition were measured at the beginning and end of the trial in each yr. Hand-plucked samples were collected every 2 wk during the grazing trial to determine forage nutritive value. Data were analyzed using the PROC MIXED procedure in SAS 9.4, and differences were declared significant when $P \leq 0.05$. Nitrogen-fertilized NWSG had greater CP concentration ($P < 0.0001$), sward heights ($P = 0.0003$), and canopy light interception at the beginning of the season ($P = 0.0049$) than unfertilized paddocks. Unfertilized NWSG had greater digestibility than those fertilized with N ($P = 0.0004$). However, there were no differences ($P \leq 0.05$) among N-fertility treatments for mean forage production (mean: 4489 kg DM ha^{-1}), heifer ADG, or BCS across the 2-yr study. Forage production and sward heights peaked in June, then decreased through mid-to-late summer. Botanical composition data indicated that indiangrass decreased from 64% to 61% ($P = 0.0022$) and weed pressure increased from 11% to 15% ($P = 0.0064$) across the summer grazing season. Canopy light interception decreased by 51.4% from early June to August

in fertilized NWSG and 26.4 % in unfertilized paddocks, respectively. These data illustrate that NWSG systems may provide a viable grazing system in the summer months under reduced N inputs.

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List of Abbreviations

67N	67 kg N ha^{-1}
BW	Body weight
CP	Crude protein
DM	Dry matter
IVDMD	*In vitro* dry matter digestibility
IVTD	*In vitro* true digestibility
N	Nitrogen
NDF	Neutral-detergent fiber
NWSG	Native warm-season grasses

I. REVIEW OF THE LITERATURE

Black Belt Region

Geographical Location

Extending from south-central Alabama and into northwest Mississippi, the Black Belt region is a large crescent-shaped area of land that is characterized by its unique soil type and vegetation (Rankin, 1974). Ocean sediments gave rise to both the Black Belt's sedimentary soils as well as the Selma chalk. Erosion removed the layer of gravel, sands, and sandy clays that formerly covered the Selma chalk. This exposure of the Selma chalk has led to the presence of alkaline soils in the Black Belt (Rankin, 1974), which make growing conditions for forage crops more unique than in other parts of Alabama. Considering the unique soil type characteristics and their presence in the state, the Black Belt physiographic region includes the following fourteen counties: Bullock, Choctaw, Dallas, Greene, Hale, Lowndes, Macon, Marengo, Montgomery, Perry, Pickens, Russell, Sumter, and Wilcox.

Soil Challenges

The Black Belt soil region's uncommon features have given rise to some distinctive challenges for production agriculture. The first major challenge the Black Belt region faces is its extremes in soil pH. The Selma chalk and clay deposits overlying it have produced both alkaline and acidic soils, respectively. These extremes are found randomly mixed throughout the region (Rankin, 1974).

Montmorillonite clay, found in both the acidic and alkaline soils in the Black Belt, causes the soil to shrink and swell as the soil moisture changes. This feature can cause large cracks to form as the soil dries out, which further complicates cultivation in the region (Rankin, 1974). Fencing, as well as other infrastructure needed for pasture-based livestock systems, can be impacted by the shrink and swell that occurs with soil moisture changes. These clayey soils have slow water infiltration and permeability and moderately high water-holding capacity (Mitchell et al., 2006). The combination of these unique characteristics can complicate agricultural efforts in the region, which in turn has impacted the forage species that have been utilized for pasture-based livestock production.

Cattle Production in the Region

While the land area has its own unique set of production challenges, the Black Belt region represents a considerable portion of Alabama's beef cattle industry. According to the USDA NASS (2018), surveys indicate that the number of cattle and calves on farms in the state of Alabama totaled 1.34 million on January 1st of 2018, and the counties that compose the physiographic Black Belt region make up nearly 23% of that total. Montgomery county, which is located in the center of the Black Belt region, had 75,000 cattle and calves on farms, which was the highest inventory of any county in the state. In 2017, cash receipts from cattle and calves totaled $500 million, and was second only to cash receipts from broilers (USDA NASS, 2018), which illustrates the importance of forage-based agriculture for supporting these production values.

Forage Systems Adapted to the Region

Tall Fescue

Tall fescue (*Lolium arundinaceum*) is one of the main forage species grown in the Black Belt region (Anonymous, 2001). The cool-season perennial's active growing season spans September through December and March into June or July (Ball et al., 2015). From an agronomic standpoint, it is a desirable forage crop because of its range of adaptation and tolerance to continuous, close defoliation. (Paterson et al., 1995). However, most of the tall fescue in the region is infected with the fungal endophyte *Epichloë coenophiala*. The Black Belt Research and Extension Center is the site of the first study linking *Epichloë coenophiala* with fescue toxicity in beef cattle. This historic finding explained the poor performance of cattle grazing tall fescue (Ball et al., 2019). This endophyte produces an ergot alkaloid called ergovaline, which causes a variety of serious symptoms in grazing livestock that are referred to collectively as fescue toxicosis (Klotz and Nicol, 2016). Cattle that experience fescue toxicosis have decreased weight gain, milk production, conception, and serum prolactin levels. In addition, they are unable to dissipate body heat due to vasoconstriction (Paterson et al., 1995), which leads to elevated body temperatures, more time spent in the shade, and less time spent grazing. A study conducted by Hoveland et al. (1983) compared steer performance on endophyte- infected and relatively non-infected 'Kentucky 31' tall fescue. Liveweight gain per hectare was 28% greater over the 4-yr period on the relatively non-infected tall fescue (492 kg/ha) than endophyte-infected tall fescue (384 kg/ha). A 66% increase in ADG of steers on non-infected (0.83 kg ha^{-1}) versus endophyte-infected pastures (0.50 kg ha^{-1}) was also reported. Although the endophyte negatively affects animal performance, forage quality does not seem to be as readily impacted. Pederson et al. (1990) reported forage quality parameters of endophyte-infected and endophyte-free 'Kentucky 31'tall fescue that were managed similarly. Endophyte-infected tall fescue had 57% IVDMD, 64% NDF, 32% ADF, and 17% CP, whereas the endophyte-free tall fescue had 57% IVDMD, 65% NDF, 32% ADF, and 16% CP. The forage quality parameters of both were comparable to most cool-season perennial grasses.

Dallisgrass

Dallisgrass (*Paspalum dilatatum*), one of the two main perennial forage species in the region, is a warm-season bunchgrass that grows 25 to 50 centimeters tall. (Anonymous, 2001; Ball et al., 2015; Bungenstab et al., 2011). Indigenous to Uruguay, Argentina, and southern Brazil, dallisgrass is used as a pasture grass in the region because of its nutritive value and the potential to be grazed earlier in the spring and longer into the fall than other warm-season perennial grasses (Venuto et al., 2003). It has an excellent tolerance to poor drainage and is best adapted to clay and loam soils in areas with good summer moisture. Dallisgrass also has good tolerance to drought, substantial carbohydrate reserves in its stem bases, and numerous buds which allow it to have good tolerance to close grazing. Dallisgrass is often grown with red or white clover, which can be planted in the fall after a killing frost occurs. In a study by Bungenstab at al. (2011), Angus × Simmental steers were both continuously and rotationally stocked on dallisgrass pastures to evaluate the influence of stocking density and duration of rest period on forage productivity and beef cattle performance. The mean values for average daily gain across all treatments and periods in 2007 and 2008 were 0.28 kg and 0.36 kg, respectively. A similar response was observed in a study in which steers continuously grazing dallisgrass-white clover in the Lower Coastal Plains of Alabama had average daily gain of 0.34 kg (Brown et al., 1965). Limitations to the use of dallisgrass include forage yield potential, which is often less than that of other warm-season perennial forage grasses (Bungenstab et al., 2011). In addition, seed production is limited by low seed set and ergot infection (Venuto et al., 2003). In the late summer and early fall when seed onset occurs, ergot can cause toxicity in cattle, but seed heads can be clipped to eliminate the ergot problem if it develops. (Ball et al., 2015)

Johnsongrass

Johnsongrass (*Sorghum halepense*) is a warm-season perennial grass that is very well adapted to the heavy clay soils found in the region because of its tolerance to poor drainage. It prefers slightly acidic soils, which are also common in the region. Although it is typically managed for hay production, Johnsongrass can be grazed with proper management. Since Johnsongrass does not tolerate repeated, close defoliation, rotational grazing is recommended to maintain a good stand. (Ball et al., 2015). Johnsongrass is moderately palatable and of medium forage quality, but its nutritive value changes with maturity (Fraps & Fridge, 1940; Newman, 1993). When Johnsongrass is used as a forage crop, there are two significant toxicities that producers need to be aware of, including prussic acid poisoning and nitrate toxicity. Prussic acid can buildup in the leaves of plants that have been stressed by long drought periods, a frost, or application of herbicides like 2,4-D. Johnsongrass can also contain toxic levels of nitrates. Accumulation of nitrates typically occurs following a period of drought or cool, cloudy weather that stunts growth. Unlike prussic acid, nitrates do not degrade over time, so it is important to test heavily fertilized Johnsongrass hay for nitrates (Ball et al., 2015).

Native Warm-Season Grasses

Adaptation and Species Grown in the Southeast

Keyser et. al. (2011b) defines native warm-season grasses (NWSG) as “those that have grown here prior to human settlement”. These bunchgrasses, which are tall-growing and deep-rooted, are naturally well-adapted to the region’s soils, climate, and pests. Typically, these grasses break dormancy in late March and early April, experience rapid growth from mid-May through mid-summer, and then their growth slows in late summer until they become dormant in October. There are numerous species of grasses that are native to the Southeast, but in terms of forage production we tend to focus on the following five species: big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), indiangrass (*Sorghastrum nutans*), eastern gamagrass (*Tripsacum dactyloides*), and switchgrass (*Panicum virgatum*). Their vigorous summer growth and natural adaptability make them good candidates for forage production in the Southeast (Keyser et. al., 2011c).

Establishment

When considering site selection for the establishment of NWSG, recently cleared timberland or land that has been managed for crop production are the two best options. Although recently cleared timberland may need soil amendments (lime, P, and K), there will normally be little weed pressure which can greatly impact establishment success. Modern, clean-cropping methods, especially in non-grass crops like cotton and soybeans, will also greatly reduce potential weed pressure that could hamper establishment efforts. Land that has previously been used for hay production and pasture, especially when bermudagrass makes up even a portion of the forage base, will be more challenging to convert. These sites will often require more planning and management during establishment. Weed pressure can vary greatly among different stands. A study by Temu and Kering (2016) reported 57% and 51% weeds, respectively, in the first year of production for big bluestem and indiangrass grown in Virginia. However, weed pressure was reported by Temu et al. (2018) for big bluestem and indiangrass grown in Virginia at 18% and 19% weeds, respectively, during the second year after planting. Producers should plan to plant NWSG when the soil temperatures reach 15 to 18 °C, which is usually in mid-April to early May. Switchgrass, bluestems, and indiangrass have very small seeds, so seeding depth should be no greater than 0.6 cm. Eastern gamagrass seed is much larger and can be planted 2 to 3 cm deep. A clean, firm seedbed and a smooth soil surface for shallow planting is needed for NWSG because of their small seeds and limited tolerance to weed pressure as seedlings. Advanced control of weeds is key when establishing NWSG. Johnsongrass and dallisgrass, which are common forage systems in the region, and annual grasses such as crabgrass and signalgrass can compete aggressively with NWSG and in some cases cause establishment failure. Approximately 10 to 14 d prior to planting, any emerged weeds should be treated. NWSG can be planted both conventionally or using a no-till seed drill. No-till, which is the preferred method of planting, will offer a firm seedbed, greater retained moisture, and reduced erosion. If planting NWSG conventionally, cultipack the seedbed to ensure that it is firm enough prior to planting. Stands that have 1 or more seedling per 1 ft^2 are ideal and stands with 1 seedling per 2 ft^2 are acceptable but stands that have less than 1 seedling per 4 ft^2 should be reseeded. Once established, NWSG seedlings are small and require only modest fertility levels to perform well. Soil amendments that should be added during establishment include P or K if the soil tests in the low category, and lime when the pH tests below 5.0. Nitrogen should not be added during the establishment period because it will encourage the growth of weeds competing with the small NWSG seedlings. Due to the growth habit of NWSG during the establishment period, it is imperative not to overstress new stands of NWSG. While NWSG continue to mature during their second growing season, you may remove some forage by haying or grazing without any major impacts to the stand, but grazing should be limited to 40 to 70 d and cattle should be removed before August 1st in the mid-South region. A single cutting before June is possible, but a second cutting of hay is not recommended (Keyser et al, 2011a).

Yield and Quality

A study conducted by Faix et al. (1980) evaluated yield and survival of Asiatic bluestems (*Bothriochloa* spp.) and eastern gamagrass in southern Illinois. Forage was harvested at a 15-cm stubble height in 1975 and 3 to 4 cm in 1976 and 1977. Over the three-year period, the Asiatic bluestems averaged 11,650 kg ha^{-1} to 13,230 kg ha^{-1} and were not significantly different. The average yield for eastern gamagrass was significantly greater over the 3-yr period at 17,670 kg ha^{-1}. Cuomo and Anderson (1996) compared the effects of N fertilization and burning on CP concentration of switchgrass, big bluestem, and indiangrass in Nebraska. Monocultures of each NWSG species were either burned in mid-April or left unburned, and one-half of each of those treatments was either fertilized or not fertilized. Plots were then harvested in mid-June and mid-July of 1990 and 1991, respectively. Crude protein concentration for big bluestem across all treatments was 75.0 g kg^{-1} DM and 59.2 g kg^{-1} DM for 1990 and 1991, respectively. Indiangrass crude protein was 72.5 g kg^{-1} DM and 64.1 g kg^{-1} DM, respectively. Waramit et al. (2012) evaluated the effect of N levels and plant maturity on the nutritive value of four NWSG species in Iowa. Indiangrass, big bluestem, switchgrass, and Eastern gamagrass were treated with three N levels (0, 65, and 140 kg ha^{-1}) and harvested on ten dates at approximately two-week intervals for the first seven dates and three-week intervals for the last three harvests. The interaction of species × harvest date for IVDMD and CP concentration suggested that the value of IVDMD and CP decreased with each successive harvest, although the level of decrease differed among species. The decreases in IVDMD throughout the growing season for bluestem and indiangrass ranged from 70% to 28% and 70% to 36% in 2006, respectively, and 65% to 24% and 67% to 36% in 2007, respectively. The greatest CP concentration for all species occurred at the first harvest date, then rapidly decreased between the first 4 harvest dates, and then gradually decreased throughout the rest of the growing season. The decreases in forage CP concentration for big bluestem and indiangrass ranged from 231 to 37 g kg^{-1} DM, respectively, in 2006 and 166 to 28 and 169 to 32 g kg^{-1} DM, respectively, in 2007. Backus et al. (2017) conducted a trial to evaluate management options for switchgrass, Eastern gamagrass, and a mixture of big bluestem and indiangrass under 2 grazing strategies to produce beef cattle and biomass at 2 different Tennessee locations. For both locations, the big bluestem and indiangrass mixture had the greatest overall nutritive values. Keyser at al. (2016) also reported greater CP concentration in a big bluestem and indiangrass mixture compared to that of switchgrass.

Grazing Management of NWSG

Native warm-season grass pastures must be managed properly to maintain both forage nutritive value and stand density. They can be grazed when the average canopy height reaches 38 cm. At the beginning of the growing season, NWSG grows rapidly and heavy stocking rates should be used to prevent it from growing too tall. Understocking NWSG will result in overly mature forage that is less palatable and of a lesser nutritive quality. Monitoring the canopy height of NWSG throughout the grazing season is important for stand management. Unlike most other forages that are common to the Mid-South, the tall growth habit of NWSG prevents it from having very many growth points that are near to the ground. Grazing pressure should be adjusted to maintain the canopy height between 38 and 50 cm. NWSG should not be grazed any closer than 30-cm stubble height. If overgrazing occurs, root reserves will be reduced, and stand density can suffer as a result. As forage growth slows, it is important to monitor NWSG closely from late June into August, since factors such as precipitation can greatly impact their performance in mid-to-late summer. Stocking rates typically need to be decreased during this time period, and grazing should conclude sometime around the first of September. Forage NWSG need about six weeks rest from defoliation to restore root reserves before the first frost. These forages respond well to prescribed burns during the dormant season. Both palatability and nutritive value of NWSG can be increased through prescribed burning (Keyser et al., 2011b).

Limitations to the Use of NWSG in the Southeast

There are certain limitations to utilizing NWSG for forage production in the Southeast. Establishment can be challenging because NWSG develop more root growth than top growth in the first 2 yr after planting. As previously discussed, advanced weed prevention, well-prepared seedbeds, and shallow seeding are essential to successfully establishing NWSG. In addition, specialized equipment might need to be used for planting certain NWSG (Keyser et al., 2011c). Despite their advantages, since NWSG can present such a challenge in establishment and often require close management, their adoption as a forage has been very minor in the Southeast, and many producers are unaware of the potential of using NWSG as a forage base.

Big bluestem

Big bluestem is a highly palatable forage and is often considered the best of the native grasses (Keyser et al., 2011b). It can grow to 1 to 2 m in height. Big bluestem plants often grow in clumps, although some have short rhizomes. The root system is very extensive and can be as deep as 2 to 2.5 m. Driving machinery over an old stand can be quite difficult, because the crowns become very dense and tough. Turkey foot is a common name for big bluestem, as its purplish inflorescence resembles a turkey's foot (Moser & Vogel, 2005).

Little bluestem

Little bluestem is much smaller than big bluestem, but it thrives on poor sites and also provides good quality forage (Keyser et al., 2011a). Little bluestem is adapted to soils ranging from sandy to clay-loam in texture. It begins growth in late spring after cool-season species have already developed (USDA, 2016).

Indiangrass

Indiangrass is another tall warm-season grass that has a bunch-type growth habit as a result of short rhizomes (< 30 mm). It generally grows from 0.5 to 2.0 m in height and has a yellowish brown to black panicle that ranges from 10 to 30 cm in length. Roots can grow down to about 1.6 m, and it will grow in soils that have a pH ranging from 5.6 to 7.1. Indiangrass begins to grow at about the same time as big bluestem, but its shoot apices begin to elongate earlier than those of big bluestem, and plants can become very stemmy quickly (Moser & Vogel, 2005).

Blends

Big bluestem, little bluestem, and indiangrass are later maturing species that are all very palatable. These traits allow for the species to complement each other well when used in blends for hay production or pasture. Often times, blends are generally preferred over single-species plantings of these grasses. Contrarily, switchgrass and eastern gamagrass should not be planted in mixtures with other NWSG. Bluestems and indiangrass mature later than switchgrass and eastern gamagrass, and when grazed, cattle will preferentially graze the bluestems and indiangrass, causing their eventual loss from the stand (Keyser, 2011a).

Fertility Responses

Perry and Baltensperger (1979) conducted a 2-yr evaluation of yield and forage quality in established pure stands of switchgrass, indiangrass, and big bluestem under differing N fertilization rates. The stands were fertilized with 0, 45, and 90 kg N ha^{-1} and harvested at 6 biweekly dates beginning in the summers of 1973 and 1974. The leaf CP percentages were increased with N fertilization at the first 3 harvests, whereas leaf IVDMD percentages were increased with N fertilization during the first 5 harvests. Leaf yields increased nearly 2-fold at the 45 kg N ha^{-1} rate compared with the 0 N rate in 1973, a year with relatively abundant rainfall. In a study by Berg (1995), differing levels of N fertilization were applied to a mixed stand of blue grama (*Bouteloua gracilis*), sideoats grama (*B. curtipendula*), little bluestem, sand bluestem (*Andropogon hallii*), switchgrass, and indiangrass. In the first year of the study, the herbage yield increased linearly with 26 kg herbage produced kg $^{-1}$ N applied. With increasing N rates, the residual N effect increased the proportion of blue grama and decreased the proportion of taller perennial grasses. This study suggests that N fertilization of mixed NWSG stands established on marginal farmland can result in substantial herbage yield increases, but some of the yield increases may be from weedy species.

Animal Performance

Stocker cattle can perform well when grazing NWSG in the summer months. In several grazing trials performed at the University of Tennessee AgResearch and Education Centers from 2010 to 2012, stocker cattle had ADG ranging from 0.48 kg to 1.08 kg while grazing eastern gamagrass, switchgrass, and big bluestem and indiangrass mixtures. These studies also reported that cattle had the greatest ADG on the big bluestem and indiangrass mixture. In addition, there were greater gains within the first 30 d of the grazing season across all of the NWSG species (Keyser et al., 2011c). Another study conducted in Tennessee (Keyser et al., 2016) evaluated forage mass, nutritive attributes, and animal performance in switchgrass and a big bluestem and indiangrass mixture with or without inter-seeded crimson clover. Over the course of the 3-yr study, dairy heifers had an ADG of 1.25 kg for the big bluestem and indiangrass mixture across all treatments during the early season and 0.54 kg later in the season. A study conducted by Backus et al. (2017) evaluated management options for switchgrass, eastern gamagrass, and a mixture of big bluestem and indiangrass under two grazing strategies to produce beef cattle and biomass at 2 different Tennessee locations. Steers had an ADG of 1.03 kg grazing the big bluestem and indiangrass mixture at both of the locations across all experimental yr and treatments, which illustrates that NWSG may support animal gains during the summer months that are similar to or greater than those of other warm-season perennial forage systems in the Southeast (Ball et al., 2015)

Summary

The Black Belt physiographic region in Alabama is characterized by its heavy clay soils with a high shrink-swell capacity and varying pH extremes. This unique set of challenges influences forage production system dynamics and livestock production in this region. Currently, tall fescue and dallisgrass are the two most common perennial pasture forage systems used in the region. However, the majority of this acreage is endophyte-infected tall fescue. Tall fescue toxicosis can cause a decrease in animal production in grazing beef cattle, especially in the summer months. Native warm-season grasses offer an alternative to grazing endophyte-infected tall fescue in the summer months. Forage NWSG are adapted to the region, and offer drought tolerance, good summer growth, and reduced fertility inputs. Mixtures of big bluestem, little bluestem, and indiangrass are complementary in their growth habits and offer good palatability and nutritive value, which may provide a warm-season forage option for beef producers in the summer months.

II. FORAGE PRODUCTION CHARACTERISTICS AND ANIMAL PERFORMANCE OF GROWING BEEF HEIFERS GRAZING NATIVE WARM-SEASON GRASS MIXTURES

INTRODUCTION

The Alabama Black Belt soil region is characterized by its uncommon heavy clay soils and assorted pH extremes, which cause distinct challenges for beef-forage systems in the area. Currently, tall fescue and dallisgrass pastures are the two most common perennial pasture forage systems, and most of the tall fescue in this region is endophyte-infected. Grazing endophyte-infected tall fescue in the summer months causes a decrease in beef cattle performance. The endophyte produces the ergot alkaloid ergovaline that causes a variety of serious symptoms in grazing livestock that are referred to collectively as fescue toxicosis. Cattle that experience fescue toxicosis will have decreased weight gain, milk production, conception rate, and serum prolactin levels, and they are unable to dissipate body heat due to vasoconstriction. Alternative forage systems are needed to help producers avoid the potential issues that arise with the use of endophyte-infected tall fescue in beef-forage systems. Native warm-season grasses (NWSG) are one alternative that producers may consider as a grazing option during the summer months. Forage NWSG are adapted to the region and offer drought tolerance, good summer growth, and the potential for reduced fertility inputs while still maintaining production potential. Mixtures of big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and indiangrass (*Sorghastrum nutans*) are complementary in their growth habits and offer good palatability and nutritive value, which may provide a warm-season forage option for beef producers in the summer months.

Whereas published work has demonstrated the potential for using monocultures of NWSG in the Alabama Black Belt (Mason et al., 2019), no research has evaluated forage production characteristics of NWSG blends in this region. Additionally, in the Southeast, there is limited research regarding the performance of developing beef heifers on NWSG mixtures. Keeping heifer development costs low is consequential to producers, so it is important to establish the impact of a relatively expensive direct cost such as nitrogen (N) fertilization in this forage production system. The objective of this study was to evaluate the effect of N fertilizer on forage production characteristics and animal performance of beef heifers grazing a NWSG mixture in the Black Belt region of Alabama.

MATERIALS AND METHODS

Research Site

A summer grazing trial was conducted at the Black Belt Research and Extension Center (BBREC) in Marion Junction, AL (32º28’50.29”N latitude, 87º15’26.61”W longitude) during the 2018 and 2019 growing seasons to evaluate forage production, persistence, and nutritive value of NWSG with or without N fertilization under continuous stocking. Six plots (2-ha each) comprised of Houston clay were demarcated in early 2018 for the project. Big bluestem (‘KY ecotype’), little bluestem (‘Cimarron’), and indiangrass (‘Boone’) comprised the tertiary mixture of established NWSG used for this study. Plots were established in April 2016 using a seeding rate of 11 kg PLS ha^{-1} for the tertiary blend, consisting of 6 kg ha^{-1} big bluestem, 4 kg ha^{-1} Indiangrass, and 1 kg ha^{-1} of little bluestem, respectively. Paddocks were sampled on a 2-ha grid basis in mid-April 2016 during the establishment year and amended with variable rates of P and K in July 2017 according to soil test recommendations of the Auburn University Soil Testing Laboratory (Auburn, AL). At the time of testing, the mean pH for the test plots was 7.1, the CEC was 58.5 meq, the OM was 6.4%, and P and K were 32 and 230 lbs/ac, respectively. No N fertilizer was applied during the 2-yr establishment phase following planting. During the 2016 and 2017 growing seasons, both mowing and mob grazing were utilized to manage the forage to a target residual height of 25 cm. A prescribed burn was performed in late February 2018 and 2019 to reduce the amount of thatch present before the coming growing season during the years of the grazing trial.

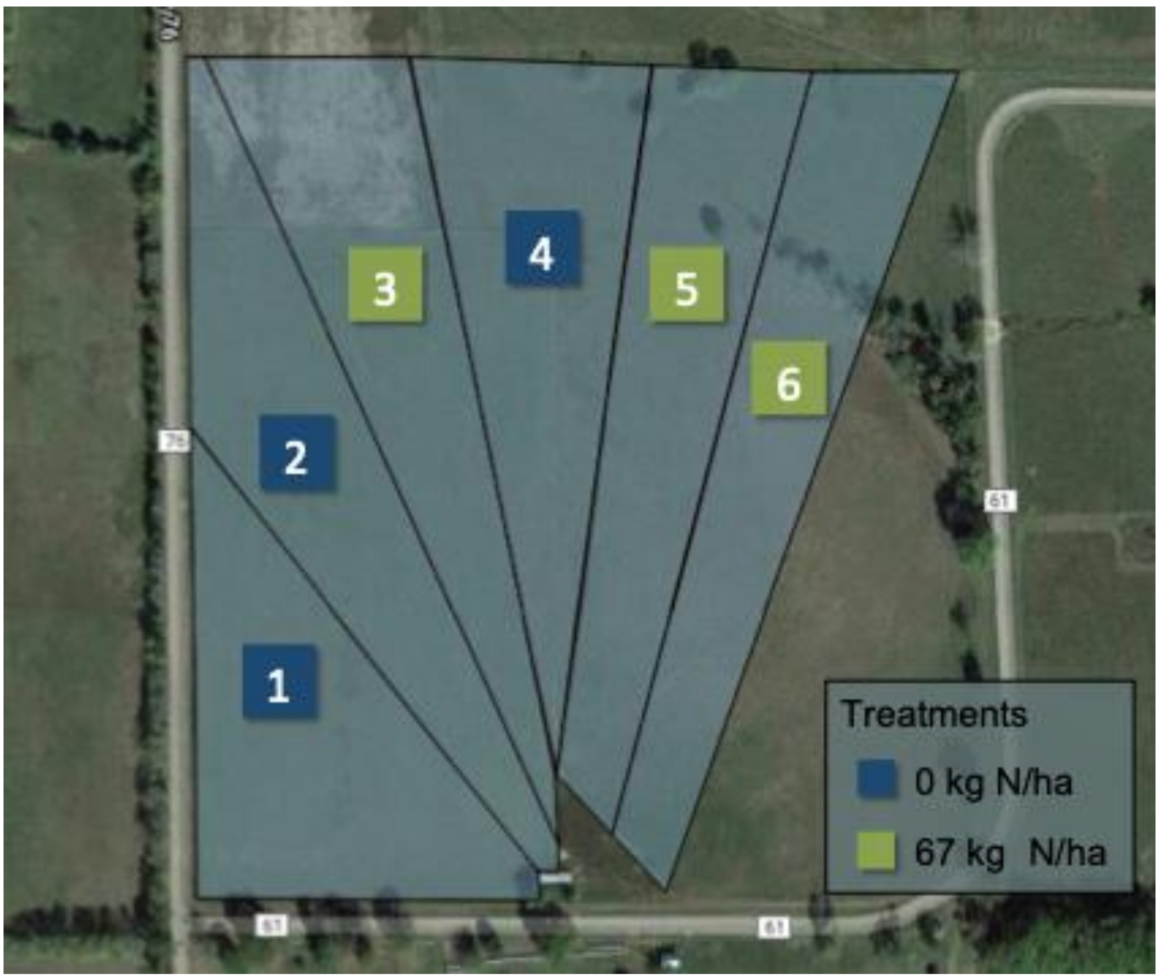

Figure 1. Layout of experimental plots

Experimental Design

Six, 2-ha plots of NWSG were randomly assigned to one of two fertilization regimes: 0 kg N ha^{-1} or 67 kg N ha^{-1} (n = 3 plots per treatment). These treatments were selected to evaluate forage production and persistence responses of these forage mixtures under a low-input fertility system. Paddocks were continuously stocked with 4 Angus × Simmental beef heifers (initial BW, 288 kg) each. Heifers were born between September 11, 2017 and October 18, 2017 and September 3, 2018 and October 11, 2018 and were weaned according to the BBREC SOP (PRN 2016-2990) in mid-May 2018 and early-May 2019, respectively. From weaning until the start of the study, heifers were placed in a dry lot setting with annual ryegrass hay (*Lolium multiflorum*) and supplemented with 50:50 pelleted corn gluten feed and soybean hulls at approximately 1% of their body weight. Initial test weights for beef heifers were collected on June 4, 2018, and May 29, 2019, respectively, and 4 test heifers were randomly assigned to one of the two N fertilization treatments.

Forage Management

Nitrogen fertilization was applied on April 19, 2018 and April 15, 2019 in yr 1 and 2, respectively. Weed control was applied on June 29, 2018. No herbicide was applied in 2019. Weed control decisions were made when visual canopy contributions of undesirable species exceeded 30% to reflect best management practices for NWSG stands. Grazing was initiated on June 4, 2018 and May 29, 2019 when the plots reached an average height of 50 cm. Stocking rates were adjusted using put-and-take heifers and cows to maintain forages in a vegetative state to a target height of 30 to 38 cm, or 2,800 kg DM ha^{-1}. Grazing was discontinued when forage canopy height decreased to ≤ 22 cm, or 1,960 kg DM ha^{-1} for the test heifers. This study was conducted according to a protocol approved by the Institutional Animal Care and Use Committee of Auburn University (PRN # 2018-3273).

Forages were continuously stocked throughout the growing season and managed to maintain a target forage DM availability of 2,800 kg DM ha^{-1}. Stocking rate adjustments were made using put-and-take heifers and cows based on the calculation of forage availability and animal utilization at the time of sampling. Animal utilization since the previous sampling date was estimated using an assumed dry matter intake of 2% of mean BW plus an additional 40% waste due to trampling. Stocking rate adjustments were determined based on amount of predicted consumption by cattle within a plot over a 2-week period. If the amount of projected available forage was estimated to be over 2,800 kg DM ha^{-1}, stocking rate adjustments were made using put-and-take heifers or mature cows. During the early months of the grazing season and stocking densities required to maintain forage to the target canopy height, mature cows were used in addition to put-and-take heifers due to limited animal availability.

Response Variables

Forage Mass and Nutritive Value

Forage mass and nutritive value was determined by clipping 0.10-m^2 quadrats (10 per paddock) at the initiation of the trial and every 2 weeks during the trial. Forage within quadrats was clipped to leave an aboveground stubble height of approximately 5 cm for forage mass and 25 cm for nutritive value samples. Fresh-cut forage was then placed into cloth bags for transportation back to the Auburn University Ruminant Nutrition Laboratory. Samples from each paddock were oven-dried at 60°C for 72 hr, air-equilibrated, and weighed. Forage DM availability was calculated for each paddock based on dry-weight data multiplied by the area of the paddock.

Canopy Height

Aboveground canopy heights were estimated at 30 locations in each of the paddocks every 2 wk during the grazing trial. Canopy heights were collected using a grazing stick.

Ground Cover

A visual assessment of canopy composition was conducted at the beginning, middle, and end of the grazing season. A quadrat with four 50-cm × 50-cm sections was used at 20 different locations in the paddock. Species composition as a percentage of the stand was estimated as: NWSG, weeds, and bare ground.

Botanical Composition

Botanical composition samples were taken at the beginning, mid-point, and end of the grazing season. Three 0.10-m^2 quadrats were clipped in each paddock. Fresh-cut forage was then placed into cloth bags for transportation back to the Auburn University Ruminant Nutrition Laboratory and hand separated into the following categories: bluestems, indiangrass, or weeds. Separated samples were oven dried at 60°C for 72 hours and then weighed. Stand composition was calculated as the mass of each component divided by the total sample weight to determine % contribution from each species, which provided an estimate of changes in stand persistence during the growing season.

Canopy Light Interception

Canopy light interception data was collected at the beginning, middle, and end of the grazing season at 20 locations per paddock. In each paddock, one A reading was taken above the canopy in a representative area, followed by 20 B readings collected below the canopy using a Li-Cor 2200-C Plant Canopy Analyzer. The plant canopy analyzer is a non-destructive method for estimating leaf area index and light interception.

Animal Performance

Twenty-four beef heifers were weaned for two weeks prior to the start of the grazing trial. When paddocks reached the target grazing height, heifers were weighed, body condition scored, and randomly assigned to paddocks. Heifer weights and BCS were taken again every 28 days until the completion of the study. Following the first weigh period in each year of the study, heifers had less than 0.22 kg d^{-1} gain. Heifers were supplemented with 50:50 soyhulls and corn gluten feed at 1% of their BW to target 0.5 kg d^{-1} gain based on forage quality to keep heifers growing at a rate to achieve a projected early winter breeding window.

Laboratory Analysis

Dried, air-equilibrated forage samples were ground in a Wiley mill to pass a 1-mm screen. Concentration of DM was determined by drying samples to constant weight at 100°C according to procedures of AOAC (1995). Forage concentration of N was determined by the Kjeldahl procedure (AOAC, 1995), from which crude protein (CP) was calculated. Forage *in vitro* true digestibility (IVTD) was determined according to the Van Soest (1991) modification of the Tilley and Terry procedure (1963) using the DaisyII incubator system (Ankom Technology™, Macedon, NY). Ruminal fluid was collected from a cannulated Holstein cow at the Auburn University College of Veterinary Medicine. The cow was fed 2.7 kg of 15% CP beef stocker pellets, 10.9 kg of soybean hull pellets, 0.9 kg of cotton seed, and 0.2 kg of Megalac (Arm and Hammer Animal Nutrition, Princeton, NJ) twice daily and had access to free-choice bermudagrass hay. The collected rumen fluid was stored in thermos containers to maintain a temperature supportive of the microbial population and transported to the Auburn University Ruminant Nutrition laboratory.

Statistical Analysis

Data were analyzed using the MIXED procedure in SAS 9.4 (SAS Inst. Inc., Cary, NC) for a completely randomized design. Independent variables included harvest date, treatment, and harvest date × treatment interaction. Year was treated as a random effect in the model. Treatment means were separated using the PDIFF option of the LSMEANS procedure (SAS Inst. Inc., Cary, NC) when significant at $\alpha = 0.05$.

Weather Data

Weather instruments operated by AWIS Weather Services, Inc. collected daily minimum and maximum ambient temperatures and daily total precipitation data throughout the experimental period. Weather instruments were located in Marion Junction, AL. Temperature data and total precipitation are reported in Tables 1 and 2.

RESULTS AND DISCUSSION

Temperature and precipitation

In Yr 1, mean temperatures (Table 1) for May and August were 4 and 9% greater than the 10-yr average, respectively, and mean temperatures for June and July were 2 and 4% less, respectively. In Yr 2, mean temperatures for May and August were 5 and 17% greater than the 10-yr average, respectively, and mean temperatures for June and July were 3 and 1% less,

respectively. In Yr 1, monthly total precipitation (Table 2) was 75, 20, and 3% greater than the 10-yr average in May, July, and August, respectively, and 31% less in July. In Yr 2, monthly

total precipitation was 9 and 78% less than the 10-yr average in May and July, respectively, and 45 and 34% greater than 10-yr average in June and August, respectively.

Table 1. Monthly mean air temperatures (˚C) for Yr 1, Yr 2, and 10-yr averages for Marion Junction, AL.

Month	Year 1†			Year 2†			10-yr Avg., ˚C
	Avg. High, ˚C†	Avg. Low, ˚C	Mean, ˚C	Avg. High, ˚C†	Avg. Low, ˚C	Mean, ˚C	
May	30.1	17.8	23.5	30.3	17.6	23.9	22.7
June	32.4	21.4	26.3	31.9	20.3	26.1	26.8
July	32.5	22.3	26.6	33.2	21.4	27.3	27.7
August	31.7	21.7	25.7	33.8	21.7	27.7	23.6

† Data was collected from AWIS Weather Services, Inc.

† Year 1 = 2018 and Year 2 = 2019 growing seasons.

Table 2. Monthly total precipitation for Yr 1, Yr 2, and 30-yr averages and differences from 10-yr averages for Marion Junction, AL.

Month	Total Precipitation, mm†			Differences, mm	
	Yr 1†	Yr 2	10-yr Avg.	Yr 1†	Yr 2
May	175	91	100	+75	-9
June	61	128	88	-27	+40
July	120	22	100	+20	-78
August	105	137	102	+3	+35

† Data was collected from AWIS Weather Services, Inc.

† Year 1 = 2018 and Year 2 = 2019 growing seasons.

Forage Mass and Canopy Height

There were no differences ($P > 0.05$) among N-fertility treatments for mean forage mass (mean 4,489 kg DM ha $^{-1}$) across the 2-yr study (Table 3). However, differences ($P < 0.05$) were observed in mean forage mass across sampling dates. Forage mass peaked in June, then decreased through mid-to-late summer. These observations agree with the expected growth distribution of these NWSG in the Southeast. The greatest expected production window of NWSG is from mid-May through mid-summer, and then their growth slows in late summer until they become dormant in October (Keyser et al., 2011c). Forage mass in the present study was greater than that reported by Mason et al. (2019) for total herbage mass of Eastern gamagrass grown in the Black Belt region of Alabama for May through September (mean 2,954 kg DM ha $^{-}$

^{1}). Backus et al. (2017) evaluated management options for switchgrass, Eastern gamagrass, and a mixture of big bluestem and indiangrass under two grazing strategies to produce beef cattle and biomass at two different Tennessee locations. During the first 30 d of the grazing season that occurred in May, mixtures of big bluestem and indiangrass at the two locations had a mean yield of 3,655 kg DM ha^{-1}, which is similar to the observed early-season NWSG forage mass in May and June in this study. A date × treatment interaction (P =0.0003) was observed for canopy heights during the NWSG growing season (Table 4) where canopy heights decreased with each successive sampling date, although the pattern of decline differed between N fertilization treatments. The N-fertilized NWSG mixtures had a greater canopy height at the beginning of the grazing trial, but rapidly declined in early July, and then leveled off from late July into August. The unfertilized NWSG mixtures maintained similar canopy heights from May through June, and rapidly decreased from mid-July into August. According to Keyser et al (2011b), grazing pressure should be adjusted to maintain the canopy height between 38 and 50 cm and should not be grazed any closer than 30-cm stubble height. The N fertilized plots were above the ideal height range for grazing at the first three harvest dates of the trial. Although there were no differences in forage mass among N-fertilization strategies, when fertilized with 67 kg N ha^{-1}, NWSG had taller canopy heights early in the growing season than unfertilized plots. Stocking densities were adjusted to increase grazing pressure to manage NWSG closer to the target grazing height. By mid-summer, N-fertilized NWSG were maintained closer to the target height for grazing for the remainder of the season. Unfertilized NWSG plots remained in the ideal grazing range for the first four harvest dates, and then fell up to 8 cm below this threshold at the fifth and sixth harvest dates, respectively.

Table 3. Date effects on herbage mass (kg DM ha^{-1}) in grazed native-warm season grass mixtures in Marion Junction, AL.

Date†	Herbage mass (kg DM ha^{-1})
1	3868^{b}
2	4798^{ab}
3	5538^{a}
4	3875^{b}
5	4383^{b}
6	4473^{ab}

$^{a-b}$ Within a column, least squares means with differing superscripts differ ($P < 0.05$).
†Harvest date 1= Jun 4, 2018 and May 28, 2019; 2= Jun 20, 2018 and Jun 13, 2019; 3= Jul 2, 2018 and Jun 25, 2019; 4= Jul 18, 2018 and Jul 9, 2019; 5= Jul 30, 2018 and Jul 22, 2019; 6 = Aug 13 and 16, 2018 and Aug 5, 2019.

Table 4. Nitrogen fertilization rate and harvest date effects on above ground canopy sward height (cm).

Date†	No fertility	67 kg N ha^{-1}	*P*-value
	---------------------- cm	----------------------	--------------
1	48^{a}	60^{a}	0.0054
2	47^{a}	63^{a}	0.0001
3	47^{a}	57^{a}	0.0103
4	39^{b}	41^{b}	0.5948
5	37^{bc}	37^{b}	0.9430
6	30^{c}	37^{b}	0.1075
Mean	41^{e}	48^{d}	0.0003

$^{a-c}$ Within a column, least squares means with differing superscripts differ ($P < 0.05$), SEM =2.85.
$^{d-e}$ Within a row, least squares means with differing superscripts differ ($P < 0.05$), SEM =2.80.
†Harvest date 1= Jun 4, 2018 and May 28, 2019; 2= Jun 20, 2018 and Jun 13, 2019; 3= Jul 2, 2018 and Jun 25, 2019; 4= Jul 18, 2018 and Jul 9, 2019; 5= Jul 30, 2018 and Jul 22, 2019; 6 = Aug 13 and 16, 2018 and Aug 5, 2019.

Nutritive Value

A date × N fertilization treatment effect (P = 0.0023) was observed for forage CP concentration (Table 5). Forage CP concentration was greater for the N-fertilized NWSG mixtures than those that did not receive fertilizer at the first, second, and fifth sampling date, respectively. No differences were observed among N fertilization strategies at the third, fourth, and sixth sampling dates. Nitrogen fertility rate (P <0.0001) and harvest date (P = 0.0004) had an effect on forage IVTD. Mean percentage IVTD was greater (P = 0.0004) for the unfertilized NWSG mixture than when fertilized at 60 kg N ha^{-1} across the 2-yr study (Table 6). Forage IVTD percentage gradually decreased from 74% at the beginning of the grazing trial in late-May and early-June to 60% at the conclusion of the study in mid-August. Percentage CP for NWSG mixtures in the present study was low compared with data reported by Rushing et al. (2019) for big bluestem, little bluestem, and indiangrass grown in Mississippi and managed under clipping having a two-year mean of 9.7% for each species, respectively. Percentage CP was also low compared with data reported for other commonly used warm-season perennials under similar management in the region. Venuto et al. (2003) reported a mean CP value of 12% (DM basis) under continuous stocking for common dallisgrass grown in southern Louisiana and southeastern Texas in a three-year evaluation. Percentage IVTD was greater than that reported by Rushing et al. (2019). The authors reported a two-year mean of 58.1%, 57.9%, and 57.9% for big bluestem, little bluestem, and indiangrass grown in Mississippi, respectively. Percentage IVTD values reported at the beginning of the NWSG growing season could meet requirements for growing beef heifers (NRC 2016), but would likely not meet the target requirements of 0.5 kg d^{-1} gain by the end of the season. Percentage CP values reported throughout the season would not meet requirements for growing beef heifers for these gain targets.

Table 5. Effect of N fertilization rate and harvest date on forage concentrations of CP (% DM basis) in native warm-season grass mixtures.

Date†	No fertility	67 kg N ha^{-1}	*P*-value
	---------------------%, DM basis-------------------		-----------
1	7.0[a]	9.3[a]	<0.0001
2	6.5[a]	8.2[b]	0.0002
3	6.5[a]	7.1[c]	0.1860
4	6.4[a]	6.5[c]	0.7909
5	5.3[b]	6.7[c]	0.0030
6	5.0[b]	5.2[d]	0.2338
Mean	6.1	7.2	<0.0001

[a-d] Within a column, least squares means with differing superscripts differ ($P < 0.05$), SEM=0.40.

†Harvest date 1= Jun 4, 2018 and May 28, 2019; 2= Jun 20, 2018 and Jun 13, 2019; 3= Jul 2, 2018 and Jun 25, 2019; 4= Jul 18, 2018 and Jul 9, 2019; 5= Jul 30, 2018 and Jul 22, 2019; 6 = Aug 13 and 16, 2018 and Aug 5, 2019.

Table 6. Effect of N fertilization rate on forage concentrations of *in vitro* true digestibility (% DM basis) in native warm-season grass mixtures.

Fertilization rate	IVTD†
	-----------------------%----------------------
No fertility	69.2[a]
67 kg N ha^{-1}	67.0[b]

[a-b] Within a column, least squares means with differing superscripts differ ($P < 0.05$).

†IVTD = in vitro true digestibility.

Ground Cover

A visual assessment of changes in canopy composition was conducted at the beginning, middle, and end of the summer growing season. Visual assessments of perennial pastures are a rapid, practical, and inexpensive method that allows producers to estimate weed pressure, bare ground, and the overall strength of a stand. This measurement can help producers make decisions on stocking density and develop an end-of-the grazing season management strategy, which is key to the persistence of NWSG. There were no observed differences ($P > 0.05$) among N fertilization strategy (Table 7) or sampling date (Table 8) for the percentage of NWSG in the stand throughout the growing season. However, percentage of bare ground (Table 8) was greater in August ($P = 0.0030$) than in late May and early June, which is likely due to decreased canopy heights observed under continuous stocking as the grazing season progressed. Visual percentage of weeds (Table 8) was greater ($P = 0.0271$) in late May and early June than in August. Overall, weed pressure was low compared with data reported by Temu and Kering (2016) for big bluestem and indiangrass grown in Virginia that reported 57% and 51% weeds, respectively in the first year of production. However, weed pressure was similar to data reported by Temu et al. (2018) for big bluestem and indiangrass grown in Virginia that reported 18% and 19% weeds, respectively, during the second year after planting. In the first year of the present study, because of heavy weed pressure (greater than 30% visual weed contribution in the stand), all plots were treated with an herbicide application in June to reflect industry practice and best management practices for stand maintenance. This, coupled with the increase in percentage of bare ground, could account for the decrease in visual percentage of weeds in the canopy.

Table 7. Effect of N fertilizer rate on visual percentage (%) of above ground canopy sward components.

Item	No fertility	67 kg N ha^{-1}	*P*-value
	---------------------------%------------------------		---------------
NWSG†	66	65	0.7872
Bare ground	25	20	0.1205
Weeds	9	15	0.0502

†NWSG = Native warm-season grasses.

Table 8. Date effects on visual percentage (%) of above ground canopy sward components at the beginning and end of the native warm-season grass grazing season.

Item	May/June	August	*P*-value
	---------------------------%------------------------		---------------
NWSG†	68	63	0.1466
Bare ground	17^{b}	29^{a}	0.0030
Weeds	16^{a}	9^{b}	0.0271

$^{a-b}$ Within a row, least squares means with differing superscripts differ ($P < 0.05$), SEM=3.18.
†NWSG = Native warm-season grasses.

Botanical Composition

There were no differences ($P \geq 0.05$) observed between N fertilization treatments or sampling dates for the percentage of bluestems in the NWSG stand (Table 9). However, the indiangrass contribution (Table 9) was greater ($P = 0.0022$) in the beginning of the grazing season compared with the end. Although indiangrass has a later heading date than most other NWSG, shoot apices begin to elongate earlier than those of big bluestem, which could account for the increased contribution at the beginning of the grazing season (Moser and Vogel, 1995). Weed presence (Table 9) was greater ($P = 0.0064$) at the end of the season in August than at the initiation of the trial in late May and early June. The increase in percentage of bare ground could account for the decrease in visual percentage of weeds in the canopy, while there was an increase in weed presence according to our botanical composition data.

Table 9. Date effects on change in above ground sward botanical composition (%) during the warm-season months.

Item	May/June	August	*P*-value
	------------------------------%	-----------------------------	--------
Indiangrass	63.9	60.8	0.0022
Bluestems†	24.9	24.3	0.1678
Weeds	11.3	14.9	0.0064

†Big bluestem and little bluestem were reported as a combined measure.

Light Interception

A date × treatment interaction ($P < 0.0001$) was observed for canopy light interception. Canopy light interception of NWSG decreased across sampling dates, although differently among N-fertilization treatments. Light interception (Table 10) in the N-fertilized treatment decreased by 51% from late May and early June to August, while the non-fertilized treatment decreased by 26% throughout the grazing season. Canopy heights in N-fertilized NWSG were greater from early June through July of each year of the trial. A taller sward height may have greater spatial distribution in the canopy, which would influence early season light interception measures, although there were no differences in forage mass among fertility treatments. Under continuous stocking and as the grazing season progressed, there were no differences in canopy height or forage mass between N-fertilization treatments during the mid-to-late grazing season. The decrease in light interception at the end of the grazing season is presumably related to the increase in the visual percentage of bare ground, shorter canopy heights, and reduced leaf area in residual forage remaining in late August of each year of the study.

Table 10. Effect of nitrogen fertilization rate and harvest date on canopy light interception (%) at the beginning and end of the native warm-season grass grazing season.

Date	No fertility	67 kg N ha^{-1}	P-value
	----------------------------%-----------------------------		--------
May/June	43.9^{a}	61.5^{a}	0.0049
August	32.3^{b}	29.9^{b}	0.6597

$^{a\text{-}b}$ Within a column, least squares means with differing superscripts differ ($P < 0.05$).

Animal Performance and Stocking Density

No differences ($P \geq 0.05$) were observed among N fertilization treatments for initial BW, final BW, ADG, or BCS (Table 11) for beef heifers grazing the NWSG blend in this study. Overall, mean heifer ADG was low across both N fertilization treatments in the 2-yr study with less than 0.5 kg heifer^{-1} d^{-1} gain. Whereas heifer gains were low in this study, beef heifers maintained a BCS of 5 or greater during the summer grazing season. Several grazing trials have been conducted with NWSG monocultures in the Midwest to Western US with reported stocker gains of 0.7 kg d^{-1} or greater (Anderson et al., 1988; Karges et al., 1992; Mitchell et al., 2005).

Few studies have evaluated animal performance on NWSG mixtures in the Southeast US. A study by Keyser (2011c) in Tennessee reported gains of 0.96 kg d^{-1} for stocker steers weighing 272 kg that were grazing a big bluestem and indiangrass mixture. Differences between these data and the ADG reported in the present study could be due in part to a lack of an extended preconditioning period. There were no differences in stocking density (mean: 1009 kg BW ha^{-1}) between N fertilization treatments.

Table 11. Beef heifer initial BW, final BW, ADG, and BCS† grazing native warm-season grasses across differing nitrogen fertilization rates.

Item	No fertility	67 kg N ha^{-1}	*P*-value
Initial BW (kg)	290	286	0.1311
Final BW (kg)	310	315	0.6492
ADG (kg d^{-1})	0.29	0.38	0.3959
BCS	5.7	5.7	1.0000

†BW = body weight, ADG = average daily gain, and BCS = body condition score.

Table 12. Effect of date on stocking rate of beef cows and heifers grazing native warm-season grass mixtures.

Date†	Yr 1	Yr 2
	-------------------Kg ha^{-1}---------------------	
1	1112	829
2	790	692
3	1138	788
4	1093	1405
5	1055	1342
Mean	1038	1011

†Date 1= Jun 22, 2018 and Jun 6, 2019; 2= Jul 9, 2018 and Jun 20, 2019; 3= Jul 23, 2018 and Jul 1, 2019; 4= Aug 1, 2018 and Jul 10, 2019; 5= Aug 13, 2018 and Jul 23, 2019.

Summary and Conclusions

Results of this study indicate that NWSG blends can provide a viable grazing system for the Alabama Black Belt Soil region in the summer under reduced N inputs. Nitrogen fertilized NWSG had greater CP concentration through the mid-summer during the grazing season; however, unfertilized NWSG had greater digestibility than those fertilized with N. Canopy heights were greater in the N-fertilized NWSG during the early summer months, but N fertilization did not impact mean forage mass during the trial. Canopy light interception was greater at the beginning of the season for N-fertilized NWSG, but light interception decreased by late in the growing season. This decrease in canopy light interception was supported by an increase in bare ground percentage and decreased canopy heights at the end of the grazing season across N fertilization treatments. Additionally, there were no differences in heifer ADG or BCS across the 2-yr study when NWSG mixtures were fertilized with 0 or 67 kg N ha^{-1}. Data from this trial indicate that N fertilization effects on forage mass and stand persistence measures were not different from the mid-summer to the end of the grazing season. End-of-season NWSG stand management is important for sward recovery prior to fall dormancy and may influence stand persistence in low-N input systems like those described in this trial.

Future grazing and animal performance studies may be beneficial in demonstrating and evaluating the intensive management practices required by native grasses, such as rotational stocking and prescribed burning. Other alternative summer grazing systems for the region should also be evaluated in comparison to NWSG blends. Evaluating this alternative grazing system is beneficial for producers who are trying to reduce input costs and alleviate the reproductive effects of fescue toxicosis in their heifer development programs during the summer months. This study provides information on an alternative system that would perform well in the Black Belt region, alleviate issues surrounding grazing tall fescue in the summer, and potentially reduce input costs in heifer development.

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