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Utilizing Crabgrass and Pearl Millet as Pinpoint Grazing Systems for Yearling Beef Cattle in Mississippi

Abstract

The profitability of beef cattle production in the southern USA relies on ruminants grazing highly nutritive pastures. Traditional perennial warm-season grasses (PWSG) such as bahiagrass (*Paspalum notatum*) and bermudagrass (*Cynodon dactylon*) tend to have limited nutritive value. Warm-season annual grasses (WSAG) such as crabgrass (*Digitaria spp.*) and pearl millet (*Pennisetum typhoides*) can be used as a supplemental forage to improve animal performance during the summer months (pinpoint grazing). The objective of this study was to determine the impact of WSAGs compared to bahiagrass on forage DM yield, nutritive value, and performance of growing beef cattle. The study contained five treatments replicated three times. Treatments included pearl millet ('Prime 380'), three crabgrass cultivars [Mojo Brand (28.4% 'Red River' + 20.0% 'Impact'), 'Red River,' and 'Quick-N-Big Spreader'), and bahiagrass. Pearl millet was planted at 25 lb and crabgrass at 10 PLS ac-1. Treatments were fertilized with 100 lb N ac-1 yr-1 in 50/50 split applications. Pre-grazing forage samples were collected to determine forage biomass and nutritive value. Grazing began when pearl millet reached 18 to 24 inches and crabgrass was 12 to 15 inches. The average stocking rate was 1500 lb BW ac-1. Total biomass production was similar among treatments. Bahiagrass had the lowest nutritive value compared to WSAG during the same grazing duration. Overall, WSAG produced 80% greater ADG compared to bahiagrass. Red River crabgrass produced greater gain per acre (112 lb ac-1) among treatments.

Abbreviations: AWSG, annual warm-season grass; PWSG, perennial warm-season grass; PLS, pure live seed; N, nitrogen; CP, crude protein; NDF, neutral detergent fiber; ADF, acid detergent fiber; ADG, animal daily gain; LSD, least significant difference.

Keywords: crabgrass, biomass yield, nutritive value, gain per acre, animal daily gains

Introduction

Traditional perennial warm-season grasses (PWSG) such as bermudagrass (*Cynodon dactylon*) and bahiagrass (*Paspalum notatum*) are the staple for grazing in the southern USA. Although these perennial forages are well suited for cow-calf operations and can produce high forage yields, they are poorly suited to meet the nutritional requirements of yearling beef cattle (energy and protein) because of their high fiber concentrations and slow ruminal disappearance (Odgen et al., 2006). A pinpoint grazing system is the introduction of forages with higher nutritional value that could help reduce the cost of supplementation when traditional perennial warm-season grasses are lacking the desired nutrition to support the desired animal performance. Annual warm-season grasses (AWSG) such as crabgrass (*Digitaria sanguinalis)*, forage sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*), and sorghum x sudangrass (*Sorghum* bicolor) can be attractive alternatives in terms of live weight gain compared to PWSG across the southern USA. Some disadvantages of AWSGs are their relatively high dependency on timely rainfall events for optimal forage production and their susceptibility to insect damage (armyworms [*Spodoptera frugiperda*] and sugarcane aphids such as *Melanaphis sacchari*).

Crabgrass is an annual warm-season forage crop that has prolific seed production, can reseed very well, and is adapted to a wide range of environmental conditions from drought to field with good water holding capacity (Dalrymple et al., 1999). It grows well at soil pH ranging from 5.5 to 7.5. Crabgrass should be established from mid-April to early June at a seeding rate of 4 to 6 pounds of PLS per acre. Crabgrass is more digestible than other annual-warm season grasses (Teutsch et al., 2005). Once it germinates and proper fertilization is provided, crabgrass can be grazed within 30 to 40 days. Nitrogen application of 50 units of nitrogen per acre is recommended after emergence with a second application after grazing if extra forage is needed. Grazing should begin when the grass is 12 to 15 inches tall and stocking rates ranging from 800 to 1,200 pounds of live weight per acre can be implemented depending on biomass production, fertilization, and rainfall. The length of the grazing season can vary from 60 to 120 days (Blount et al., 2013). Crabgrass can fit well into a rotation with your summer annual following forage crops such as annual ryegrass or small grains.

Since the 1980s, there have been several crabgrass cultivars released by R.L. Dalrymple and the Nobel Research Institute which include 'Red River,' 'Quick-N-Big,' 'Impact,' 'Dal's Big River,' and 'Quick-N-Big Spreader.' These cultivars were tested at Mississippi State University in a fertility trial where nitrogen was treated with fertilizer additives. Preliminary results indicated that 'Quick-N-Big Spreader' was the highest yielding and had 24% greater biomass production than Impact, the lowest yielding (Simmons et al., 2020). Comparison of cultivars under Mississippi conditions did not have a significant advantage and culivar selection will depend mostly on seed cost. Trammell and Butler (2018) indicated that 'Impact' crabgrass provided greater animal daily gain and gain per acre over five years when compared to 'Red River' crabgrass.

Pearl millet (*Pennisetum glaucum*) is a tall annual growing grass that can produce several tillers (stems) from the base of the plant and can be used primarily for summer annual forage production for grazing, hay, or baleage across Mississippi. Pearl millet is a hardy AWSG with the ability to tolerate and survive under continuous or intermittent drought, due to its relatively fast root development. Its extensive fibrous root system can grow both laterally and downward into the soil profile. It prefers very well-drained soils, and it is probably the least tolerant of the summer forages to waterlogging and flooding. Although pearl millet can be planted throughout the summer, the best planting dates are from May to June. Seasonal production is generally from June to September with yields in Mississippi ranging from 1,100 to 6,800 lbs DM/ac (White et al., 2014; White et al., 2015). It has a higher energy content than other PWSGs and has the potential to produce higher rates of gain (McCartor and Rouquette, 1977). Hill et al. (2013) have reported nutritive values greater than 19% crude protein, 68% digestibility, and 64% total digestible nutrients. One of the advantages of pearl millet is that it does not produce prussic acid (hydrogen cyanide) and contains no tannins common to other species such as sorghum, sudangrass, and sorghum x sudangrass hybrids. However, pearl millet can accumulate high nitrate levels during drought stress. When grazing pearl millet, animals can be allocated when plants have reached 18 to 24 inches in height. Animals should be removed at a target stubble height of 6 to 8 inches to allow plant recovery and regrowth, but best animal performance might occur when a 10 to 12 inches stubble height is maintained. Rude et al. (2002) indicated that steers grazing pearl millet appeared to have greater grazing efficiency than those grazing mixed grass or kenaf. Schmidt et al. (2019) reported greater gains per acre for pearl millet compared to a sorghum x sudan hybrid or forage sorghum.

Knowledge of the quantitative relationship between forage biomass, nutritive value, and production per animal and per unit land area provides the basis for a successful grazing strategy. Research is needed to evaluate new crabgrass cultivars for forage production that could serve as pinpoint grazing systems during the summer months in the southern USA. The objective of this replicated demonstration was to determine the impact of crabgrass cultivars when compared to pearl millet on forage DM yield, nutritive value, and performance of growing beef cattle.

Materials and Methods

All animal procedures were conducted by following the recommendations and guidelines approved by the Mississippi State University Institutional Animal Care and Use Committee (Protocol # IACUC-20-221). The study was conducted at the Hendry H. Leveck Animal Research Farm at Mississippi State University during the summer of 2020. The soil type is a Savannah Fine Sandy loam (Fine-loamy, siliceous, semiactive, thermic Typic Fragiudults) with a 2 to 5% slope. All plots were adjusted for pH, P, and K based on soil testing recommendations. Glyphosate was applied 3 weeks before planting to all treatments for weed control. The experimental design was a randomized complete block replicated three times. Treatments were four AWSGs and a PWSG. The AWSGs include dwarf BMR pearl millet [‘Prime 360,’ PM360)] and three crabgrass varieties (Mojo Brand [28.4% ‘Red River’ + 20.0% “Impact’, RRI], ‘Red River [RRC],’ and ‘Quick-N-Big Spreader [QBS]).’ The PWSG treatment was a three-year-old bahiagrass (BHG) pasture. Pearl millet was planted at 25 lb PLS ac^{-1} and crabgrass at 10 lb PLS ac^{-1} in a prepared seedbed by broadcasting the seed and cultipacking. Annual grasses were established on June 1, 2020. Treatments were fertilized with 50 lb N ac^{-1} on June 23, 2020, using urea ammonium sulfate (33-0-0-18S). Bahiagrass pastures were fertilized similarly to the annual grass pastures.

Herbage Estimation and Nutritive Value

Before each grazing cycle, five random forage samples were collected in a zig-zag pattern in each paddock using a 2-ft^2 quadrat to determine dry matter biomass yields. Biomass samples were dried at 140°F in a forced-air oven for 72 h and ground to pass a 1-mm screen using a Wiley Mill (Thomas Scientific, Swedesboro, NJ, USA). Biomass samples were analyzed for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), in vitro dry matter digestibility at 48-h (IVTDMD), and water-soluble carbohydrates (WSC) in a Foss 2500 Near Infra-red Reflectance Spectroscopy (NIRS) instrument (Foss North America, Eden Prairie, MN) using the 2021 grass hay equation developed by the NIRS Forage and Feed Testing Consortium (Hillsboro, WI).

Grazing Management

Grazing in each treatment was done by using a put and take system. The initial stocking rate was 1231 ± 12 lb of beef ac^{-1} and varied within each grazing cycle. Thirty-six English crossbred steers (560 ± 67) were obtained from the Beef Research Unit at the Henry H. Leveck Animal Research Farm at Mississippi State University. Animals were weighed and stratified by BW and randomly assigned to each treatment. Before beginning the grazing trial, all animals were treated by internal and external parasites and vaccinated against respiratory and clostridial pathogens per MSU veterinarian recommendations (Safegard [deworming]), two doses of Pyramid 5 [respiratory] and

Ultrabac 8 [clostridial], and Permethrin [fly control]). Grazing began when pearl millet treatment has reached 18 to 24 inches in height and crabgrass was 12 to 15 inches. Animals were weighed at each pre-and post-grazing period in each treatment to estimate daily gain and gain per acre. Pastures were allowed to recover to their respective heights before resuming grazing. Between grazing periods, animals were removed from the experimental pastures and placed on warm-season perennial mixed (bahiagrass/bermudagrass) pastures. Animals had access to minerals ad libitum during the duration of the demonstration.

Statistical Analysis

All data were analyzed in SAS 9.4. Forage productivity and nutritive value data were analyzed using General Linear Mixed Models (GLIMMIX) procedure with replication as a random. Repeated measures analysis by grazing period was used with a compound symmetry covariance structure for the analysis of animal daily gain (ADG) and gain per acre (GPA). Repeated measures by sampling date will be used with a standard covariance structure for the analysis of forage mass and nutritive value. The GLIMMIX Procedure with the Multivariate Analysis of Variance (MANOVA) was used to analyze total animal performance. Mean differences were assessed at the $\alpha = 0.05$.

Results and Discussion

Weather Conditions

During the duration of the demonstration, precipitation was 3 inches below normal (Table 1). Lack of precipitation could have affected the seasonal distribution of biomass production and the number of possible grazing days and animal performance. The temperature distribution was very similar to the long-term normal except in May when the mean temperature was cooler. Cooler temperatures also created a decline in growing degree days (GDD) and therefore affecting germination and establishment.

Table 1. Weather conditions during the preliminary evaluation of crabgrass and pearl millet culitvars in 2021 at Starkville, MS along with the 30-yr normal for each parameter.

	Month				
Weather Variable	***May***	***Jun***	***Jul***	***Aug***	***Sep***
Precipitation (in)	1.8	5.4	4.2	3.1	4.4
30-yr Normal (in)	4.3	4.6	4.5	4.1	3.9
Deviation (in)	-2.5	0.7	-0.2	-1.0	0.5
Max Temp (°F)	92.0	95.0	97.0	100.0	95.0
Min Temp (°F)	37.0	59.0	70.0	65.0	51.0
Mean Temp (°F)	69.0	78.2	82.7	81.2	75.6
30-yr Normal (°F)	71.3	78.4	81.6	80.9	75.1
Deviation (°F)	-2.3	-0.2	1.1	0.3	0.5
GDD_{50}*	578	850	1021	977	776
30-yr Normal	667	855	981	961	768
Deviation	-89	-5	40	16	8

*Growing degree days (GDD) base 50.

Biomass

No significant differences were observed among cultivars on biomass for the duration of the grazing period (Figure 1). Despite no significant differences, ‘Red River’ crabgrass (RCC) and ‘Prime 360’ (PM360) pearl millet had greater biomass production while ‘Quick-N-Big Spreader’ (QNBS) production was lower than bahiagrass (BHG). Average biomass production was 3576 lb DM ac^{-1} (ranging from 3343 to 3798 lb DM ac^{-1}). Pearl millet and two of the crabgrass cultivars (‘Mojo’ [RRI and ‘Red River’]) had a 3, 9, and 10% yield increase in forage biomass production, respectively, when compared to bahiagrass under the same growing season length and fertility conditions. On the other hand, QNBS had a 3% lower yield than bahiagrass. Most of the crabgrass production yields are very similar to those reported by Simmons et al. (2020).

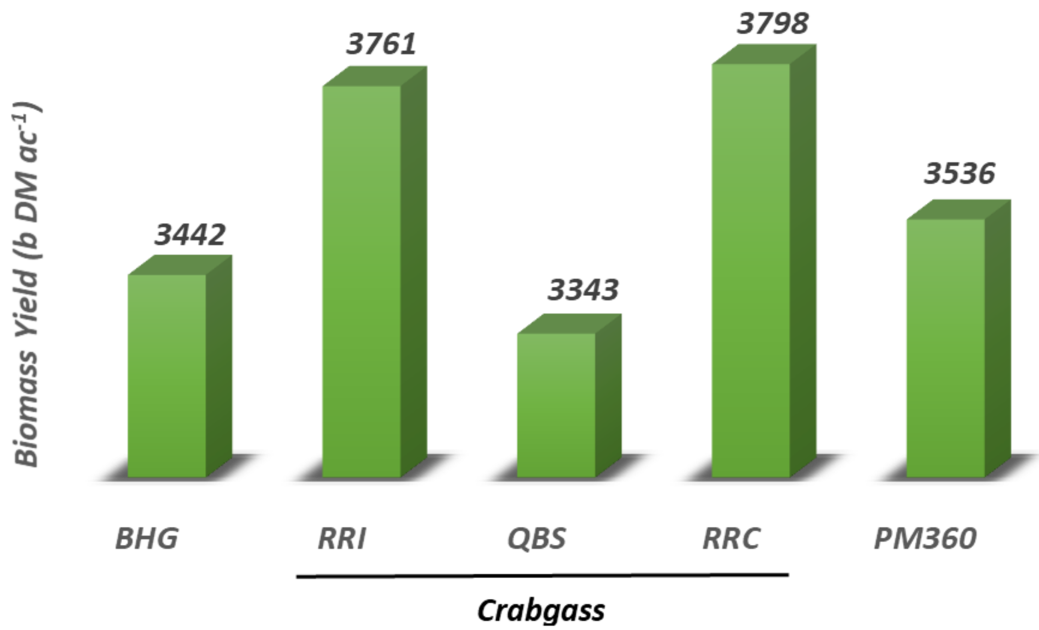

Figure 1. Seasonal biomass production of four annual warm-season grasses when compared to bahiagrass for the same period of growth under the same fertility conditions.

Nutritive Value

Table 2. Influence of sampling date and warm-season annual cultivars on nutritive value for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), and *in vitro* dry matter digestibility (IVTDMD) when compared to bahiagrass during the same grazing period at Starkville, MS during the summer of 2020.

	Sampling Date					
	14-Jul	***14-Aug***	***$LSD_{0.05}$***	***14-Jul***	***14-Aug***	***$LSD_{0.05}$***
Cultivar	-------------- ***CP (% DM)*** --------------			---------- ***ADF (%DM)*** ----------		
BHG	11.4	8.8	1.2	40.4	44.1	1.9
PM360	17.3	11.6	1.3	30.2	38.8	1.5
RRI	18.0	11.9	1.3	31.1	40.8	1.4
QBS	17.9	12.6	1.7	31.9	40.1	1.6
RRC	16.5	11.8	1.6	33.0	41.0	1.7
$LSD_{0.05}$	1.9	0.9	--	2.0	1.2	--
	-------------- ***NDF (%DM)*** --------------			-------- ***IVTDMD (%DM)*** --------		
BHG	67.0	71.4	2.3	71.4	66.4	2.0
PM360	54.7	67.8	1.7	82.5	70.4	2.0
RRI	52.9	67.2	2.2	82.3	70.0	1.5
QBS	53.3	66.1	2.2	81.1	68.3	1.9
RRC	53.9	66.7	3.1	79.7	67.8	2.7
$LSD_{0.05}$	3.0	1.8	--	2.1	1.9	--

There was a significant sampling date x cultivar interaction for crude protein (CP;P = 0.0001), acid detergent fiber (ADF; P <0.0001), neutral detergent fiber (NDF; P < 0.0001), and *in vitro* true digestible dry matter (IVTDMD; P < 0.0001). The nutritive value of all cultivars declined during the grazing season (Table 2). 'Quick-N-Big Spreader' crabgrass maintained a greater CP than the rest of the cultivars. Bahiagrass

(BHG) CP declined by 23% while the mean CP decline was 31%. Acid detergent fiber increased 9% and 27% for BHG and among warm-season annual grasses (WSAGs), respectively. ‘Prime 360’ pearl millet had lower ADF compared to all other treatments. Bahiagrass had a greater NDF concentration than the WSAGs, but NDF concentrations increased by 25% from July to August for WSAGs and 7% for BH, respectively. Mojo brand (RRI) crabgrass and PM360 had a greater IVTDMD concentration than the rest of the treatments at both sampling dates. Bahiagrass had a 7% decline in IVTDMD while the mean decline for WSAGs was 15%. Nutritive values in this study were very similar to those reported by Bouton et al. (2018).

Animal Performance

Pearl millet provided more grazing days (65 d) than the rest of the treatments (Figure 2). Grazing days were similar between RRC and BHG (56 d). In Oklahoma, Bouton et al. (2018) reported a mean of 52 grazing days across four years and four cultivars. Warm-season annual cultivars provided greater animal daily gain (ADG) compared to BHG for the same grazing period (Figure 3). Average daily gain ranged from 0.63 (BHG) to 1.36 lb hd^{-1} d^{-1} (RRC). Red River crabgrass ADG was not significantly different than QBS. Bahiagrass had 53% lower ADG than RRC. The average daily gain was lower than those reported by Bouton et al. (2018; 1.72 lb hd^{-1} d^{-1}). Animal gain per acre (pounds of live weight) ranged from 34 (BHG) to 122 lb ac^{-1} (RRC; Figure 4). Cultivars RRC and PM360 provided greater gain per acre (Figure 4). Bahiagrass and RRI had 72 and 38% lower gain per acre compared to RRC. Bouton et al. (2018) reported a four-year mean of 205 lb of live weight per acre. When taking into consideration the cost of seed and fertilization, the estimated cost of gain was $2.53, $0.73, $2.19, $1.61, and $0.90 for BHG, PM360, RRI, QBS, and RRC, respectively. Assuming that the average price per beef is $1.10 per pound, the utilization of these warm-season annual grasses could provide an economic advantage as pinpoint grazing systems. The crabgrass cultivars (RRI, QBS, and RRC) and PM360 can provide increased returns of $48, $59, $97, and $65 per acre compared to BHG, respectively.

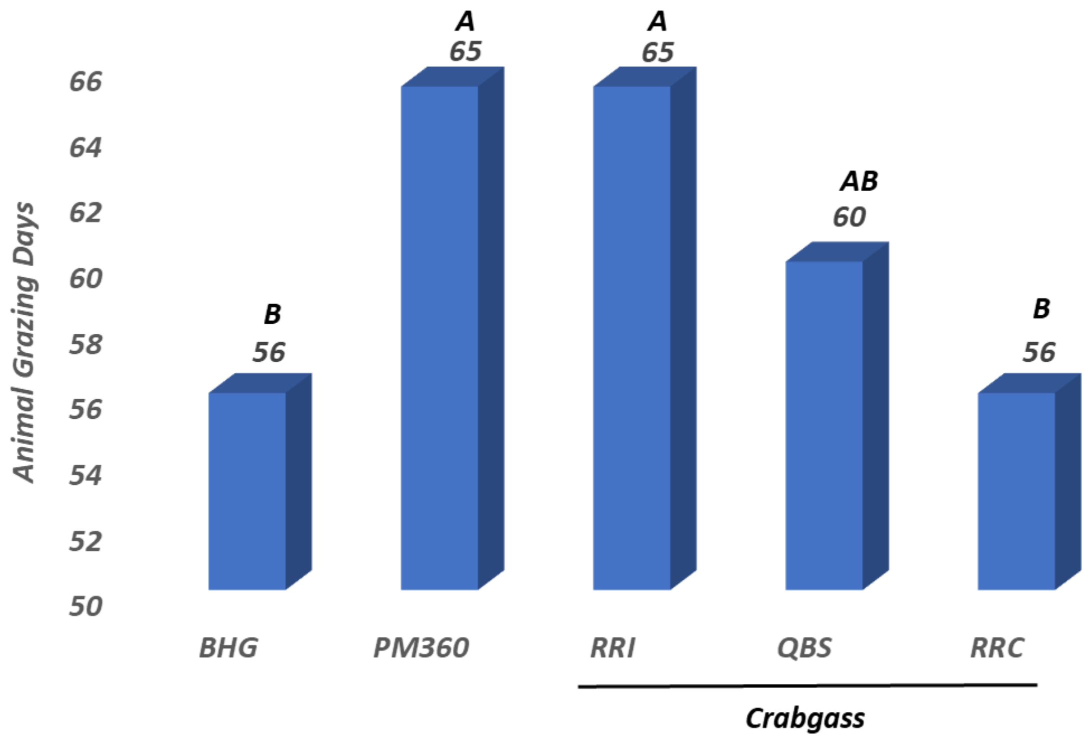

Figure 2. Animal grazing days for four warm-season annual grasses when compared to bahiagrass for the same period of growth under the same fertility conditions at Starkville, MS during the summer of 2020. Treatments with similar letters are not significant α = 0.05.

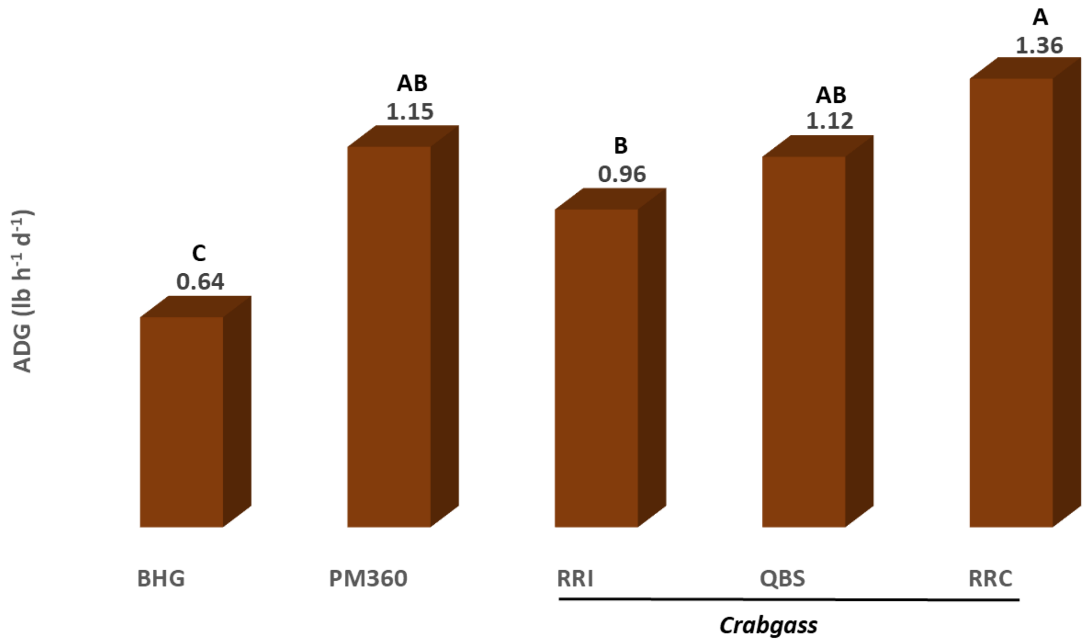

Figure 3. Animal daily gain (ADG) for four warm-season annual grasses when compared to bahiagrass for the same period of growth under the same fertility conditions at Starkville, MS in the summer of 2020. Treatments with similar letters are not significant $\alpha = 0.05$.

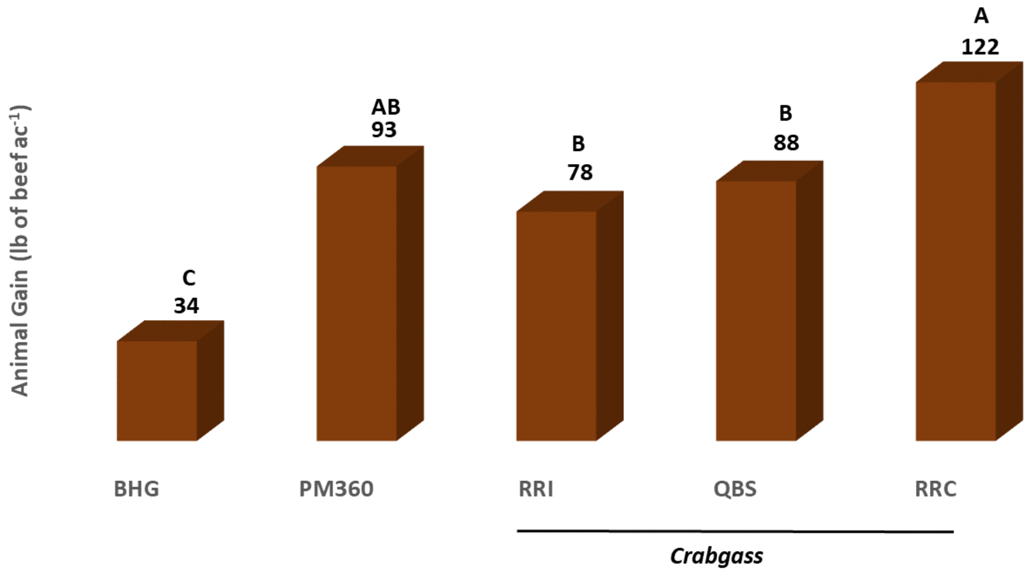

Figure 4. Gain per acre for four warm-season annual grasses when compared to bahiagrass for the same period of growth under the same fertility conditions at Starkville, MS during the summer of 2020. Treatments with similar letters are not significant α = 0.05.

Conclusions

Warm-season annual grasses can be used as pinpoint seasonal feed supplementation systems to aid with increasing animal daily gains and beef production per acre in the southern USA. These WSAGs can complement a cool-season annual grass rotation and supplement greater nutritive value when compared to perennial warm-season grasses such as bahiagrass. Animals grazing crabgrass or pearl millet did not show any apparent issues indicating that these pinpoint grazing systems can be used to complement the animal performance of animals grazing bahiagrass or could be utilized as a summer stocker grazing system to complement summer productivity while transitioning from cool-season annual grazing such as annual ryegrass.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Literature Cited

Blount, A.R., Ball, D.M., Sprenkel, R.K., Myer, R.O., & Hewitt, T.D. (2013). Crabgrass as a Forage and Hay Crop. IFAS Extension. Pub. SS-AGR-193.

Bouton, J.H., Motes, B., Trammell, M.A., & Butler, T.J. (2018). Registration of 'Impact' Crabgrass. J. of Plant Reg. 13:19–23. doi:10.3198/jpr2018 .0 4.0 019crc.

Dalrymple, R. L., Mitchell, R., Flatt, B., Dobbs, W., Ingram, S., & Coleman, S.W. (1999). Crabgrass for Forage: Management from the1990s. #NF-FO-99-18. The Samuel Roberts Noble Found. Agric. Div., Ardmore, OK.

Hill, G.M., Hanna, W.W. & Gates, R.N. (2013). Pearl millet cultivars and seeding method effects on forage quality and performance of grazing beef heifers. J. Produc. Ag. 12(4): 578-580.

McCartor, M.M. & Rouquette., M.F. (1977). Grazing pressures and animal performance form pearl millet. Agron, J. 69(6): 983-987.

Ogden, R.K., Coblentz, W.K., Coffey, K.P., Turner, J.E., Scarbrough, D.A., Jennings, J.A., & Richardson, M.D. (2006). Ruminal in situ disappearance kinetics of nitrogen and neutral detergent insoluble nitrogen from common crabgrass forages sampled on seven dates in northern Arkansas. J. Anim. Sci. 84:669–677.

Rude, B.J., Baldwin, B.S., & Hanson, K.C. (2002). Performance and Nutrient Utilization by Steers Consuming Kenaf, Pearl Millet, or Mixed Grass. Prof. Anim. Sci. 18(1): 74-78.

Schmidt, C., Lemus, R., & Rudds, L. (2019). Evaluation of BMR Forage Systems for Beef Cattle Performance in Mississippi. *In:* Proceedings of the Southern Branch of the American Society of Agronomy. Birmingham, AL. February 3-5. *Volunteered.*

Simmons, C., Lemus, R., & Rushing, B. (2020). Crabgrass (*Digitaria sanguinalis*) Cultivar Response to Nitrogen Fertilizer Additives. *In:* Proceedings of the American Society of Agronomy Southern Branch. Louisville, KY. February 1-3. *Volunteered*

Teutsch, C.D., Fike, J.H., & Tilson, W.M. (2005). Yield, Digestibility, and Nutritive Value of Crabgrass as Impacted by Nitrogen Fertilization Rate and Source. Agron. J. 97:1640–1646.

Trammel, M. & Butler, T. (2018). Noble Releases New Forage Crabgrass Cultivar Called Impact.

White, J.A., Lemus, R., & Rivera, D. (2014). Mississippi Warm-Season Forage Crop Variety Trials, 2013. Mississippi Ag. and Forest. Ex. Stn. Bull 483.

White, J.A., Lemus, R., & Rivera, D. (2015). Mississippi Warm-Season Forage Crop Variety Trials, 2014. Mississippi Ag. and Forest. Ex. Stn. Bull 493.