Genetic improvement of bermudagrass for hay producers

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Key words: hay; cold tolerance; production; pest tolerance.

Abstract

Bermudagrass (*Cynodon* spp.) is considered the most valuable warm-season perennial grass for hay producers in the Southeastern United States. Bermudagrass genotypes have overall good forage quality, high yields, and store well. However, there are challenges to producing good hay for the market. First, early green-up in the spring is needed to allow for four to five productive clippings during the summer. When first establishing production fields, quick emergence and cover are important for reducing weeds. Forage bermudagrass is somewhat tolerant to drought, however, low rainfall substantially reduces yields. If rainfall is too abundant, it is difficult to have timely curing in the field for baling. This is especially true for the higher quality thick-stemmed cultivars such as Tifton 85. More recently, the bermudagrass stem maggot (BSM, *Atherigona reversura*) has caused yield reductions and reduced net income for hay producers. Plant breeding has attempted to address all these issues. This talk will highlight some areas of research that has been done over the past few decades to improve bermudagrass for hay production.

Introduction

Wild type bermudagrass (known as common bermudagrass) had been used by livestock producers for centuries in the United States before any work was done to genetically improve the forage. In the early 20th century introductions were brought into the US by Cowboy Stevens from which genetic improvement began (Taliaferro et al., 2004). In the 1930’s Dr. Glenn Burton began to make crosses to improve the yield for grazing and for hay production. The first released cultivar was Coastal in 1943 (Burton, 1954). This revolutionized the use of bermudagrass in Southeastern United States. Breeding programs in Georgia and Oklahoma produced a number of new cultivars (Taliaferro et al., 2004). Yield continued to increase through the new releases (Table 1). Besides yield, cold tolerant cultivars (Tifton 44, Midland, Ozark etc.) were bred and released. Later better-quality cultivars (as measured by in vitro or in vivo digestibility and protein content) were developed (Coastcross I, Tifton 85, Coastcross II) (Taliaferro et al., 2004). Of these Tifton 85 is still recommended today due to its high yield and high quality (Burton et al, 1993). Coastcross II (CC II) is a cultivar with high yield, with good hay quality but has less cold tolerance. Generally, bermudagrass is cut for hay about every four to five weeks. Earlier clipping gives higher N and greater digestibility, while yield will continue to increase for another week or two. Curing for hay requires conditioning the stray by crushing the stem and leaves to expose the moisture and speed drying. Hay tedders can be used to increase surface area for drying. Some hay producers prefer not to mechanically condition their hay and allow hot, dry weather to treat the hay. Either way, bermudagrass with thin stems can decrease hay curing times. Some of the best quality cultivars such as Tifton 85 were derived from stargrass (*Cynodon nlemfuënsis*) parents, which have thick stems and broad leaves. Hay producers have difficulty in curing Tifton 85 and other stargrass-type cultivars due to frequent rains and high humidity. Also, preference for thinner stem material must be considered when producing for equine use. In general, bermudagrass has few pests that cause major yield losses. Fall armyworm (*Spodoptera frugiperda*) can quickly devastate yields, but only occurs sporadically and pyrethroid insecticides can control further damage. A new invasive insect (bermudagrass stem maggot (BSM)) has appeared in the United States over the past decade. BSM (Baxter et al., 2016) regularly appears in from May to July each year, moving from south to north. The same chemicals that control fall armyworm also control BSM

(Baxter et al., 2019). If not treated losses can be as high as 50% in late summer clipping if not controlled. Thus, research and development of improved pest-tolerant hay cultivars continues.

Table 1. Dry matter (DM kg/ha) yields from a forage field trial in Tifton, GA 2006-12.

Genotype	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*Mean*
Tifton 85	29376 a	27318 a	26538 a	28232 a	22755 a	24759 a	20458 a	25633 a
Coastcross II	28249 a	26480 a	24508 a	23098 b	21915ab	22891 a	18564 a	23672 a
Russell	22802 b	22682 b	20346 b	23107 b	20051 b	23182 a	19342 a	21645 b
Coastcross I	22223 b	19153 c	19255 b	19092 c	16724 c	17830 c	17891 a	18881 c
Coastal	16317 c	14731 d	17141 b	17502 c	15399 c	19923 b	15030 b	16579 d

Values with the same letter in columns are not significantly different at $P = 0.05$

Methods

To measure the stem thickness a micrometer was used to measure the width of the pseudostem at second node below the terminal end (measurement recorded to an accuracy of ± 0.01 mm). Measurements were taken at the second node for consistency and because damage occurs at the uppermost node in a six replication trial in the greenhouse (Baxter, 2014). A 175 entry core collection was evaluated at three locations (Tifton, GA, Gainesville, FL and Ona, FL) in two randomized block replicates for tolerance to BSM from 2014 to 2016. Visual ratings were done for BSM damage and 15 entries were selected for further evaluation, based on tolerance to BSM and biomass accumulation. In a four replicate randomized complete block test in the field with paired plots (one sprayed to control BSM and other not sprayed) dry matter biomass accumulation was recorded on five clippings. The difference between sprayed and unsprayed plots was used to determine yield loss due to BSM. The rate of establishment was evaluated in Tifton, starting in 2022. In the randomized complete block trial, the rate of establishment of Breeding Line 1 and PI 295114 was evaluated with common cultivar checks Jiggs, Russell, and Tifton 85. Most often used below ground sprigs were compared with above ground stems as a means of establishment. Germination was rated by 15 students and teachers one week after planting and subsequent ratings were taken every 3 weeks afterward.

Results and Discussion

Stem thickness of some of the common cultivars is presented in Table 2. Recently, CC II has been released which has thinner stems, high quality and yields similar to Tifton 85. From the evaluation of BSM tolerant lines, two have been selected for increase and release (Breeding Line and PI 295114). The biomass accumulation of the Breeding Line and PI 295114 was better than for other cultivars including the fine-stemmed cultivars Jiggs and Alicia over two years without insecticide sprays to control the BSM adult flies (Figure 1). The stem diameter of these two lines are finer than Tifton 85 but comparable to CC II. The Breeding Line and PI 295114 above ground stem cuttings established faster than for the other cultivars and overall stem cuttings established faster than below ground sprigs. This will allow for easier and faster establishment and greater acceptance among ranchers and hay producers when these two lines are released.

Conclusions

There have been some major improvements to bermudagrass biomass accumulation since the 1930s. Forage quality has been improved since the 1960s, primarily from *C. nlumefuenis* and are also more tolerant to BSM but have much less cold tolerance. Since stem cuttings do well for propagation of the new forage bermudagrass cultivars, the increase in acreage will make them available to hay producers much faster and efficiently. Future breeding and production improvements will attempt to combine more cold tolerance and better-quality genotypes.

Table 2. Leaf and stem diameter of forage bermudagrass cultivars grown in the greenhouse (Baxter, 2014).

Cultivar	*Leaf width (mm)*		*Stem diameter (mm)*	
Alicia	2.08	c	0.84	d
Coastal	2.09	c	0.81	d
Coastcross-II	3.35	b	1.17	c
Common	1.86	c	0.74	d
Russell	2.21	c	1.04	c
Tifton 68	4.11	a	1.62	a
Tifton 85	3.67	b	1.34	b
SE	0.127		0.061	

Values with the same letter are not significantly different at $P = 0.05$

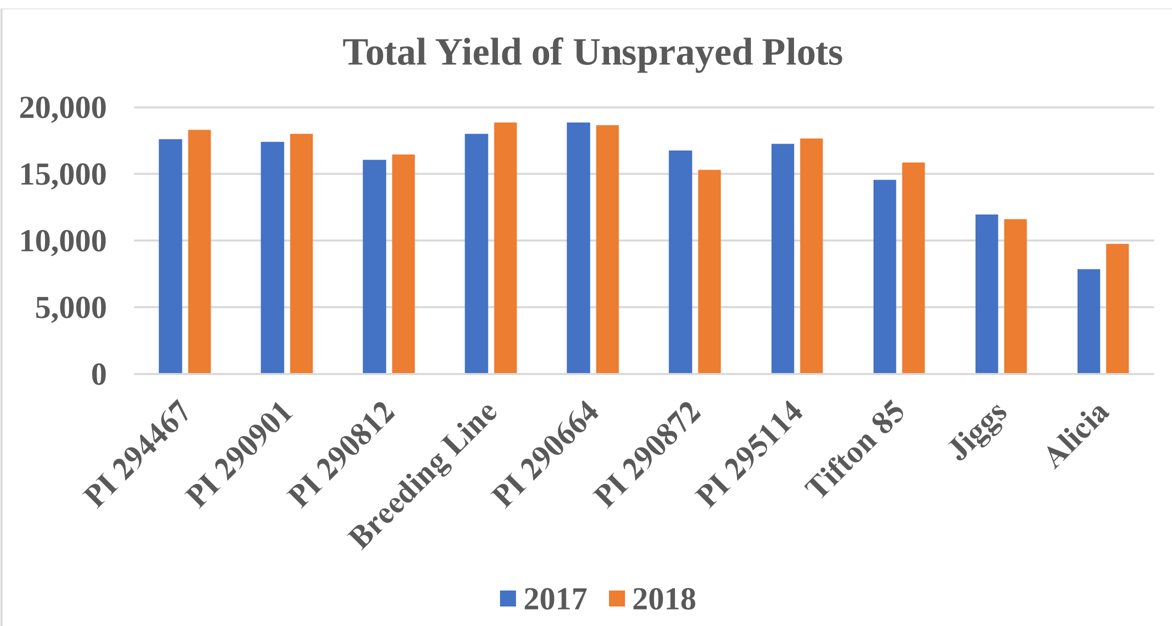

Figure 1: Dry Matter yields of lines evaluated for BSM tolerance under with no control sprays for BSM at Tifton, GA in years 2017 and 2018.

Acknowledgements
We acknowledge the Georgia Beef Commission and Georgia Seed Development for financial support for this research.

References:

Anderson, W.F. 2005. Development of a forage bermudagrass (*Cynodon* sp.) core collection. Grassland Sci. 51:305-308.

Baxter, L.L. 2014. The bermudagrass stem maggot: An exotic pest in the southeastern United States. M.S. thesis, Univ. of Georgia, Athens.

Baxter, L.L., Anderson, W.F., Hudson, W.G., Hancock, D.W., Prevatt, G.G., Moore, Z. 2019. Quantifying the damage potential of the bermudagrass stem maggot. Crop Sci., 59:2280-2286

Burton, G.W. 1954. Coastal bermudagrass. Cir. 10. Ga Agric. Exp. Stn., Athens

Burton, G.W., R.N. Gates, and G.M. Hill. 1993. Registration of 'Tifton 85' bermudagrass. Crop Sci. 33(3): 644. doi: 10.2135/cropsci1993.0011183X003300030045x.

Taliaferro, C.M.; Rouquette, F.M.; Mislevy, P. (2004) Bermudagrass and Stargrass. In Agronomy Monographs; Wiley:Hoboken, NJ, USA, 2016; pp. 417–475.