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Yield, Quality and Persistence of 13 Accessions of Eastern Gamagrass at Three Southern Locations[1]

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ABSTRACT

Thirteen eastern gamagrass [*Tripsacum dactyloides* (L.) L.] accessions have been identified as potential cultivars but forage production parameters are lacking. Objectives of this study were to determine yield, quality and persistence of these 13 accessions at three southern locations. Accessions were established in 1995 in a randomized complete block with four replications at Americus, GA, Booneville, AR and Coffeeville, MS and forage attributes and persistence determined for three consecutive years. Yields ranged from 7.5 to 19.1 Mg ha^{-1} depending on accession, location and year. When averaged over locations and years, accession 9062680 was the highest yielding accession (17 Mg ha^{-1}). Cutting date and genotype influenced forage quality estimates of CP, ADF and NDF. Average CP ranged from 6 to 11%, ADF from 37 to 42% and NDF from 67 to 73%. Florida accessions winter killed in 1997 at Coffeeville and Booneville but persisted at Americus. A *Rhizoctonia* and *Pythium* complex caused severe damage or death to accessions at Coffeeville except 9062680. Two accessions, 9062680 and 9058495, were identified for future cultivar release.

INTRODUCTION

The Plant Materials Program of the USDA-Natural Resources Conservation Service (NRCS) made extensive field collections of eastern gamagrass within its native range of ecological occurrence (Hitchcock, 1951). Plant Materials Centers (PMC) at Los Lunas, New Mexico; Knox City and Nacogdoches, Texas; Booneville, Arkansas; Coffeeville, Mississippi and Brooksville, Florida identified several accessions with cultivar release potential for livestock forage, wildlife habitat, and conservation buffers. A total of 13 accessions were identified as superior forage types by these PMCs. This study compared yield, quality, and persistence of the 13 accessions at southern locations and identified suitable cultivars for the southeastern U.S.

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MATERIALS AND METHODS

The study was conducted at the USDA-NRCS Jamie L. Whitten PMC, Coffeeville, MS, Booneville PMC, Booneville, AR and Jimmy Carter PMC, Americus, GA from 1996 to1998. Soil type at Coffeeville was an Oaklimeter silt loam, at Booneville, a Taft silt loam, and at Americus, a Lucy fine sandy loam. In 1995, plots (5.5 x 5.5 m) of the 13 accessions were established in a randomized complete block design with four replicates (Table 1). No data was collected in 1995 since it was the establishment year. Soil phosphorus and potassium was maintained at a medium to high level. Nitrogen, as ammonium nitrate (225 kg ha^{-1}), was applied in 75 kg ha^{-1} amounts when the plants began active growth in the spring and after each harvest except for the final harvest.

The initial harvest occurred at the boot stage of growth and subsequent (second and third) harvests were made on 45 day intervals. A 15 cm cutting height was used. Grab samples were collected from each harvest for dry matter (DM) determination and quality estimates of crude protein (CP), acid detergent fiber (ADF),and Neutral Detergent Fiber (NDF). Data was subjected to an analysis of variance for general linear models in SAS (1996). Means were separated using the least significant difference test (LSD; $P<0.05$) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Yield

Season total DM yields by year were obtained by summing three harvests made from May to August in 1996 to 1998 (Tables 2a, 2b, and 2c). An average total DM yield was determined by summing the season total yield by year and dividing by three. Yields of superior accessions (accessions with above average yield) were 12 to 15 Mg ha^{-1} greater than other eastern gamagrass yields reported by researchers in the Midwest and southern U.S. (Faix et al., 1980; Mislevy et al., 1986; Brejda at el., 1994; Edwards et al., 1999). Yields were also equal to or greater than perennial warm season southern forages such as bermudagrass (*Cynodon dactylon*) (11.2 to 17 Mg ha^{-1}), bahiagrass (*Paspalum notatum*) (6.7 to 11.2 Mg ha^{-1}), dallisgrass (*Paspalum dilatatum*) (4.5 to 9.0 Mg ha^{-1}), and Johnsongrass (*Sorghum halepense*) (4.5 to 11.2 Mg ha^{-1})(Ball et al., 1991).

Florida accessions (9059213, 9059215, 9055975) produced significantly lower yields than the other accessions in 1996 at Coffeeville and Booneville (Table 2a and 2c) and these accessions did not persist after 1996 at Coffeeville and Booneville. Persistence was better at Americus but yields declined sharply in 1998. This lack of persistence at Booneville and Coffeeville compared to Americus is probably related to climate. Americus is located in southwest Georgia where winter temperatures are milder (Plant Hardiness Zone 8a) than those of North Mississippi and Northwest Arkansas (Plant Hardiness Zone 7a). It is anticipated that cutting height may have been too low for Florida accessions at Americus due to their higher growing points on the stem. Removal of herbage below the growing points after two years of defoliation may have contributed to a decline in yield in 1998.

After the plots were burned in 1998 at Coffeeville, it was evident that all accessions (except accession 9062680) were either severely damaged or killed by disease (*Rhizoctonia* and *Pythium* complex (Table 2c). This accession exhibited resistance to this disease complex and continued to produce acceptable yields despite limited rainfall in 1998. It is anticipated that this disease complex destroyed accession 9043762 in late 1996 and later severely damaged accessions 434493, 9043740, 9058465, 9043708, and 9066165 following the second harvest in 1997. These accessions did not recover after the second harvest. These diseases were probably environmentally induced, with climate and moisture being key elements for their occurrence.

Combining data over three years and locations did not produce an accession (genotype) by location interaction (Table 3). Accession 9062680 was the highest yielding accession over locations but yields did not differ significantly from accessions 9066165, 9043740 or 9058495.

Quality

Estimates for CP, ADF, and NDF were conducted on forage for each harvest from accessions that produced above average yield for each location by harvest combination. Crude protein, ADF and NDF for these accessions were similar at each location but varied between harvests and years (Tables 4a, 4b, 5a, 5b, and 5c). Typically the first harvest was the highest quality because the plants were harvested at the boot stage. In subsequent harvests, particularly at Coffeeville, high yields may have diluted N concentration and due to the age of forage (6-7 wks), ADF and NDF concentrations were higher; thus lowering quality. Acid detergent fiber and NDF percentages are similar to those reported by Bredja et al. (1994) and Edwards et al. (1999) for eastern gamagrass. Fiber analyses were 10 to 12 percentage units higher than those reported for 'Coastal' bermudagrass harvested on 4-wk intervals (Ball et al., 1991).

CONCLUSIONS

The Jamie L. Whitten Plant Materials Center plans to release accession 9062680, as 'Highlander' in 2003 for the upper and lower southeastern states with potential for use in northern Florida. The Booneville Plant Materials Center plans to release accession 9058495 for Arkansas, eastern Oklahoma and southern Missouri.

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Table 1. Eastern gamagrass accessions and Plant Materials Center origin.

Accession	PMC Origin
9058465	Booneville, AR
9058495	Booneville, AR
9058569	Booneville, AR
9059213	Brooksville, FL
9059215	Brooksville, FL
9055975	Brooksville, FL
9062680	Coffeeville, MS
9062708	Coffeeville, MS
434493	Knox City, TX
9066165	Los Lunas, NM
9043629	Nacogdoches, TX
9043740	Nacogdoches, TX
9043762	Nacogdoches, TX

Table 2a. Total dry matter yield of eastern gamagrass accessions by year and 3 year average at Booneville, Arkansas.

	DM yield			
Accession	1996	1997	1998	Avg.
	---------- Mg ha^{-1}----------			
9062680	17.0	13.3	14.2	14.4
9058495	15.7	11.1	12.7	13.7
9066165	18.0	10.1	9.3	13.7
9043762	15.2	12.3	11.1	13.3
434493	17.4	9.9	10.0	12.8
9058465	14.6	8.7	9.8	11.4
9062708	13.6	9.4	9.1	11.6
9058569	13.8	6.0	7.0	9.2
9043629	13.5	5.5	7.2	9.0
9043740	10.2	5.7	6.9	7.9
9055975	4.5	*	*	*
9059213	5.6	*	*	*
9059215	4.7	*	*	*
Mean	13.7	8.3	11.3	11.7
LSD (0.05)	4.7	1.6	2.5	2.9

* Winter killed.

Table 2b. Total dry matter yield of eastern gamagrass accessions by year and 3 year average at Americus, Georgia.

	DM yield			
Accession	1996	1997	1998	Avg.
	----------Mg ha^{-1}----------			
9062680	22.0	18.4	15.9	19.1
9043740	19.5	25.1	12.5	19.0
434493	19.1	19.8	16.9	18.6
9062708	19.4	16.4	16.2	18.0
9043762	16.4	18.4	15.5	16.8
9059215	17.2	20.1	3.0	16.6
9058495	18.1	14.3	11.1	16.1
9059213	15.2	18.1	11.0	14.8
9058465	17.2	18.0	13.1	14.4
9066165	21.6	19.0	15.8	18.8
9043629	*	12.6	13.1	12.8
9055975	7.3	8.6	6.4	7.4
9058569	12.0	6.6	3.0	7.2
Mean	17.1	16.8	12.5	15.7
LSD (0.05)	2.4	3.3	4.8	2.9

* Not harvested in 1996.

Table 2c. Total dry matter yield of eastern gamagrass accessions by year and 3 year average at Coffeeville, Mississippi.

	DM yield			
Accession	1996	1997	1998	Avg.
	----------Mg ha^{-1}----------			
9062680	14.3	26.4	13.4	18.1
434493	14.0	14.0	†	
9043629	10.6	13.6	†	†
9043740	9.8	15.0	†	†
9043762	12.7	†		
9055975	2.3	*		
9059213	5.6	*		
9059215	6.7	*		
9058465	16.3	15.0	†	†
9058495	14.4	22.4	†	†
9058569	7.7	13.6	†	†
9062708	13.5	17.2	†	†
9066165	15.8	13.6	†	†
Mean	11.0	11.2		
LSD (0.05)	4.2	5.1		

* Winter killed in 1996-1997.
† Plants killed by soil disease.

Table 3. Three year average dry matter yield by accession averaged over the three locations.

Accession	DM Yield (Mg ha^{-1})
9062680	16.4
9066165	15.5
9043740	14.3
9058495	14.1
9062708	13.9
9043762	13.9
9058465	13.7
434493	13.3
9043629	12.0
9059213	10.7
9059215	10.5
9059569	7.9
9055975	4.7
LSD (0.05)	2.4

Table 4a. Forage quality estimates of eastern gamagrass accessions by harvest date and seasonal mean, Coffeeville, MS 1996.

	Forage quality estimates											
	Harvest dates											
Accession	05/20			07/03			08/19			Average		
	CP[1]	ADF[2]	NDF[3]	CP	ADF	NDF	CP	ADF	NDF	CP	ADF	NDF
	---------- % ----------			--------- % ----------			--------- % ----------			-------- % ----------		
434493	12	34	66	7	43	72	9	39	68	9	39	69
9043762	12	31	66	7	38	69	8	38	65	9	36	67
9058465	11	31	59	7	39	70	7	39	67	8	36	65
9058495	12	32	65	7	38	71	7	39	68	9	36	68
9062708	13	33	60	5	42	72	7	39	68	8	38	67
9062680	11	33	66	7	39	71	7	39	67	8	37	68
9066165	14	33	67	7	39	71	7	40	69	9	37	69
Mean	12	32	64	7	40	71	7	39	67			
LSD (0.05)[4]	2	NS[5]	6	1	3	NS	NS	NS	1.3			

1 – crude protein; 2 – acid detergent fiber; 3 – neutral detergent fiber; 4 – least significant difference; 5 – not significant.

Table 4b. Forage quality estimates of eastern gamagrass accessions by harvest dates and seasonal mean, Coffeeville, MS 1997.

	Forage quality estimates											
	Harvest dates											
Accession	05/16			07/01			08/20			Average		
	CP[1]	ADF[2]	NDF[3]	CP	ADF	NDF	CP	ADF	NDF	CP	ADF	NDF
	----------% ----------			----------% ---------			---------- %- ---------			---------- % --------		
434493	15	35	66	11	38	67	---[6]	---	---			
9043629	14	34	65	12	39	70	10	37	68	12	37	68
9043740	14	34	66	10	40	69	---	---	---			
9058465	13	35	66	10	42	71	---	---	---			
9058495	15	35	67	10	40	71	10	37	68	12	37	69
9058569	15	34	66	10	43	72	10	39	70	12	39	69
9062708	14	34	66	9	42	72	---	---	---			
9062680	14	36	67	10	42	71	9	40	68	11	39	69
9066165	15	35	66	9	39	69	---	---	---			
Mean	14	35	66	10	41	70	10	38	69			
LSD (0.05)[4]	1.4	NS[5]	NS	1.4	3	2	NS	2.4	NS			

1 – crude protein; 2 – acid detergent fiber; 3 – neutral detergent fiber; 4 – least significant difference; 5 – not significant; 6 – Plants did not recovery after July harvest.

Table 5a. Forage quality estimates of eastern gamagrass accessions by harvest dates and seasonal mean, Americus, GA 1996.

	Forage quality estimates											
	Harvest dates											
Accession	05/22			07/09			08/27			Average		
	CP[1]	ADF[2]	NDF[3]	CP	ADF	NDF	CP	ADF	NDF	CP	ADF	NDF
	----------% ----------			----------%----------			---------- % ---------			----------% --------		
434493	11	38.	70	6	43	74	9	42	70	8	41	71
9059215	11	36	70	6	45	76	7	44	72	8	42	72
9043740	10	36	66	6	40	71	7	39	70	7	39	69
9058465	9	36	68	6	41	70	8	41	68	8	39	69
9058495	11	37	71	6	42	74	7	42	72	8	40	72
9062708	12	36	69	6	43	73	7	44	70	8	41	70
9062680	8	39	70	6	42	72	8	40	68	8	40	70
9066165	10	39	74	7	42	73	7	43	70	8	42	72
Mean	10	37	70	6	42	73	7	42	70			
LSD (0.05)[4]	NS[5]	2	NS	NS	3	2	1	NS	2			

1 – crude protein; 2 – acid detergent fiber; 3 – neutral detergent fiber; 4 – least significant difference; 5 – not significant

Table 5b. Forage quality estimates of eastern gamagrass accessions by harvest dates and seasonal mean, Americus, GA 1997.

	Forage quality estimates											
	Harvest dates											
Accession	05/20			07/15			09/04			Average		
	CP[1]	ADF[2]	NDF[3]	CP	ADF	NDF	CP	ADF	NDF	CP	ADF	NDF
	---------- % ----------			----------% ----------			----------% ----------			---------- % --------		
434493	8	40	71	8	42	72	8	41	70	8	41	71
9059215	7	40	72	7	43	74	6	43	74	7	42	73
9043740	7	40	72	6	42	73	7	41	71	7	41	72
9058465	7	39	70	7	41	71	8	39	69	7	40	70
9043762	7	38	71	6	41	71	6	41	70	6	40	71
9062708	9	35	70	7	42	74	7	40	71	8	39	72
9062680	7	40	71	8	40	71	8	39	71	8	40	71
9066165	6	41	72	7	43	73	7	41	72	7	42	72
9059213	7	39	71	6	42	74	6	43	72	6	42	72
Mean	7	39	71	7	42	72	7	41	71			
LSD (0.05)[4]	1	2	2	1	2	1	1	2	2			

1 – crude protein; 2 – acid detergent fiber; 3 – neutral detergent fiber; 4 – least significant difference; 5 – not significant.

Table 5c. Forage quality estimates of eastern gamagrass accessions by harvest dates and average Americus, GA 1998.

	Forage quality estimates											
	Harvest dates											
Accession	06/17			07/29			09/10			10/20		
	CP[1]	ADF[2]	NDF[3]	CP	ADF	NDF	CP	ADF	NDF	CP	ADF	NDF
	----------%----------			--------- %----------			----------%----------			----------%--------		
434493	5	43	75	9	37	70	10	37	67	11	39	70
9043740	5	41	74	8	38	72	11	34	65	10	38	69
9058465	5	40	71	9	37	70	10	35	66	11	38	68
9043762	4	41	73	8	38	71	11	34	65	10	39	69
9062708	5	39	72	10	36	70	11	36	68	11	37	69
9062680	4	42	71	11	36	69	10	38	69	11	38	67
9066165	5	41	74	10	37	70	11	36	68	11	39	70
9043629	5	41	74	10	36	69	11	34	65	11	38	68
Mean	5	41	73	9	37	70	11	35	66	11	38	69
LSD (0.05)[4]	NS[5]	NS	3	2	2	2	NS	3	2	NS	NS	NS

1 – crude protein; 2 – acid detergent fiber; 3 – neutral detergent fiber; 4 – least significant difference; 5 – not significant

Table 5c (Con't). Average forage quality estimates of eastern gamagrass accessions, Americus, GA 1998

Accession	Average		
	CP[1]	ADF[2]	NDF[3]
	---------- % ----------		
434493	9	39	71
9043740	9	38	70
9058465	9	37	69
9043762	8	38	70
9062708	9	37	70
9062680	9	38	69
9066165	10	38	70
9043629	9	37	69

1 – crude protein; 2 – acid detergent fiber; 3 – neutral detergent fiber.