Forage Yield, Nutritive Value, and Grazing Tolerance of Dallisgrass Biotypes

B. C. Venuto,* B. L. Burson, M. A. Hussey, D. D. Redfearn, W. E. Wyatt, and L. P. Brown

ABSTRACT

Common dallisgrass (*Paspalum dilatatum* Poir.) is an important forage grass in many subtropical regions including the southeastern USA. The term dallisgrass is synonymous with the common biotype. There are other biotypes of this species but little is known about their forage potential. This study was initiated to evaluate accessions of five dallisgrass biotypes (common, prostrate, Torres, Uruguaiana, and Uruguayan) and 'Pensacola' bahiagrass (*P. notatum* var. *saurae* Parodi) for forage yield, nutritive value, and persistence in southern Louisiana and southeastern Texas, and to determine the response and persistence of the superior biotypes under grazing. Three years of clipping data were collected at Baton Rouge, LA, and College Station, TX. Most of the Uruguayan accessions were equal or superior to common dallisgrass for yield and nutritive value and all had superior stand persistence. The Torres and Uruguaiana biotypes did not survive after the first harvest season. Forage production and persistence of prostrate dallisgrass and Pensacola bahiagrass were better than expected. Six superior accessions of the Uruguayan biotype and common dallisgrass were evaluated under grazing for 3 yr at Jeanerette, LA. After 2 yr of rotational stocking, an average of 90% of the Uruguayan and only 53% of the common dallisgrass plants survived. This was followed by one season of continuous stocking and the average plant survival decreased to 75% for the Uruguayan accessions and 33% for common. Because the yield and persistence of the Uruguayan biotype was consistently superior to that of common, Uruguayan dallisgrass could provide livestock producers in the southeastern USA with a viable alternative to common dallisgrass.

Common dallisgrass is an important forage that was introduced into the USA from South America. It is a natural hybrid that probably originated in Uruguay (Burson, 1991). The exact date of its introduction into this country is unknown but the species was first collected in Louisiana in 1840 (Chase, 1929). The grass is named for A. T. Dallis of La Grange, GA, who promoted it as a pasture grass at the beginning of the 20th century (Holt, 1956).

Common dallisgrass is distributed throughout the southeastern USA and is widely used for permanent pastures (Burson and Watson, 1995). The species is best adapted to areas receiving at least 900 mm of annual rainfall and grows well on clay or loam soils that are moist but not flooded. It initiates spring growth earlier than most warm-season perennial grasses and generally persists later into the fall (Holt, 1956). The species survives well under heavy grazing and has excellent forage nutritive value when properly managed (Holt, 1956). Reported digestibility ranges from 570 to 630 g kg^{-1} and crude protein (CP) can range from 44 to 232 g kg^{-1} (Committee on Animal Nutrition and Feed Composition, 1971).

Several factors limit forage production of dallisgrass. Establishment can be difficult because of poor seed quality and slow germination (Holt, 1956). Germination of commercially available seed is often less than 50%, and seed production is limited by low seed set and ergot (*Claviceps paspali* Stevens & Hall) infection. Ergot produces ergovaline, which causes serious animal health problems (Mayland and Cheeke, 1995).

Common dallisgrass is an obligate apomict with 50 chromosomes that associate as 20 bivalents and 10 univalents during metaphase I of meiosis (Bashaw and Forbes, 1958; Bashaw and Holt, 1958). Attempts to improve the grass through breeding have not been successful because of apomixis and irregular meiosis, which results in low quality pollen.

Besides common dallisgrass, there are four other dallisgrass biotypes [prostrate (*P. dilatatum* var. *pauciciliatum* Parodi), Torres, Uruguaiana, and Uruguayan] that appear to have potential as forage grasses but little is known about them. The prostrate biotype has a more decumbent growth habit than common. It consistently produced more forage than common in Georgia, but poor seed yields prevented its release as a cultivar (Hart and Burton, 1966). However, an accession from Uruguay was released as a germplasm in 1990 (Burton and Wilson, 1991). Prostrate is an obligate apomict (Bashaw and Holt, 1958) and a tetraploid with 40 chromosomes that associate as 10 bivalents and 20 univalents during meiosis (Bashaw et al., 1970). Its irregular meiotic chromosome pairing behavior is the reason for poor seed set. The Torres, Uruguayan, and Uruguaiana biotypes are all apomictic hexaploids with 60 chromosomes, and their genomic compositions and meiotic chromosome pairing behaviors differ (Burson et al., 1991). The Torres biotype has a semiprostrate growth habit somewhat similar to common dallisgrass. In forage evaluation tests in Texas, this biotype produced less forage and was less cold tolerant than common (Burson et al., 1991). It also produced very poor seed. The Uruguayan biotype has a more upright growth habit than the other biotypes. In the same forage tests in Texas, most accessions of the Uruguayan biotype produced more forage and were more winter hardy than common dallisgrass (Burson et al., 1991). The Uruguaiana biotype is intermediate in growth habit between the common and Uruguayan bio-

B.C. Venuto, Louisiana State Univ. Agric. Ctr., Southeast Res. Stn., P.O. Drawer 567, Franklinton, LA 70438; D.D. Redfearn is Plant & Soil Sci. Dep., 366 Ag Hall, Oklahoma State Univ., Stillwater, OK 74078); B.L. Burson USDA-ARS, 430 Heep Center, Texas A&M Univ., College Station, TX 77843-2474; M.A. Hussey Dep of Soil & Crop Sci., Texas A&M Univ., College Station, TX 77843-2474; W.E. Wyatt, and L.P. Brown, Louisiana State Univ. Agric. Ctr., Iberia Res. Stn., Jeanerette, LA 70544. Approved for publication by the Director of the Louisiana Agric. Exp. Stn. as manuscript no. 02-88-0034. Received 18 Feb. 2002. *Corresponding author (bvenuto@agctr.lsu.edu).

Published in Crop Sci. 43:295–301 (2003).

Abbreviations: CP, crude protein; DM, dry matter; IVTD, in vitro true digestibility; LSUAC, Louisiana State University Agricultural Center; NDF, neutral detergent fiber; NIRS, near-infrared reflectance spectroscopy.

types and appears to have forage potential though little is known about its forage characteristics.

The objectives of this study were: (i) to evaluate representative accessions of five dallisgrass biotypes (common, prostrate, Torres, Uruguaiana, and Uruguayan) for yield, persistence, and nutritive value in Louisiana and Texas; and (ii) to evaluate superior genotypes for production and persistence under grazing.

MATERIALS AND METHODS

Clipping Studies

Five dallisgrass biotypes (total of 15 entries; Table 1) and Pensacola bahiagrass were evaluated for dry matter (DM) forage production, nutritive value, and persistence at two locations for 3 yr. Pensacola bahiagrass was used as a standard because it is a commonly grown forage grass in the southeastern USA. The plots were established at the Louisiana State University Agricultural Center (LSUAC) Central Stations Ben Hur Farm at Baton Rouge, LA, on a Sharkey clay (very-fine, smectitic, thermic Chromic Epiaquerts), and at the Texas A&M University Plantation near College Station, TX, on a Norwood silt loam (fine-silty, mixed, superactive, hyperthermic Fluventic Eutrudepts). A third experiment was established at the LSUAC Iberia Research Station near Jeanerette, LA, on a Baldwin silty clay loam (fine, smectitic, hyperthermic chromic Vertic Epiaqualfs). Entries at the latter location were not evaluated for forage yield and nutritive value but were clipped periodically and evaluated for persistence at the termination of the study.

Single-row plots were established by transplanting seedlings into a randomized complete block design with four replications. Twelve transplants, spaced 30 cm within the row, were planted into 3.6-m rows with a 1-m spacing between rows. Plots were established on 23 May 1995 at Baton Rouge, 20 June 1995 at Jeanerette, and 25 May 1995 at College Station. Nitrogen fertilization consisted of 150 kg N ha^{-1} applied in two split applications each year. Plots at Baton Rouge were fertilized with 75 kg N ha^{-1} on 5 Oct. 1995, 1 Apr. 1996, 2 July 1996, 1 Apr. 1997, 3 July 1997, 6 Apr. 1998, and 30 June 1998. Plots at College Station were fertilized with 75 kg N ha^{-1} on 10 Apr. 1996, 22 July 1996, 10 Apr. 1997, 1 July 1997, 20 Apr. 1998, and 22 July 1998. Plots at Jeanerette were fertilized with 75 kg N ha^{-1} on 25 Mar. 1996, 12 Sept. 1996, and 16 Apr. 1997. Phosphorous and potassium were applied with the first N application according to soil test analyses at the beginning of the study and each subsequent year as needed.

Table 1. Sources of dallisgrass and bahiagrass germplasm evaluated for forage potential in Louisiana and Texas.

Entry	Biotype or cultivar	2*n*	Country of origin
PI 404439	Torres	60	Brazil
PI 404444	Uruguaiana	60	Brazil
PI 404445	Uruguaiana	60	Brazil
PI 404808	Uruguayan	60	Uruguay
PI 404812	Uruguayan	60	Uruguay
PI 404815	Uruguayan	60	Uruguay
PI 404818	Uruguayan	60	Uruguay
PI 404819	Uruguayan	60	Uruguay
PI 404820	Uruguayan	60	Uruguay
PI 404821	Uruguayan	60	Uruguay
PI 404831	Uruguayan	60	Uruguay
554	Uruguayan	60	Uruguay
PI 548066†	Prostrate	40	Uruguay
PI 404841	Common	50	Uruguay
Commercial Dallisgrass‡	Common	50	Commercial Seed
Bahiagrass‡	Pensacola	20	Commercial Seed

† This entry was released by the USDA-ARS and the University of Georgia as Prostrate Dallisgrass Germplasm #1 (Burton and Wilson, 1991).
‡ Commercial seed obtained from Kaufman Seed Co., Ashdown, AR. The dallisgrass seed was produced in Australia.

Plots were mechanically harvested three to five times per year at a stubble height of 8 cm. Plots at Baton Rouge were harvested four times in 1996 (5 May, 1 July, 16 August, and 1 October), four times in 1997 (15 May, 2 July, 15 August, and 3 October) and three times in 1998 (20 May, 7 July, and 19 August). Plots at College Station were harvested four times in 1996 (3 June, 3 July, 7 August, and 5 September), four times in 1997 (12 May, 19 June, 29 July, and 26 August), and five times in 1998 (7 May, 11 June, 21 July, 29 August, and 15 October). The harvested material was weighed in the field and sub-samples from each plot were collected and oven dried for 3 d at 60°C to determine percent DM. Samples were subsequently ground with a Wiley mill equipped with a 1-mm screen and analyzed for CP, neutral detergent fiber (NDF), and in vitro true digestibility (IVTD). Plant counts were taken at the end of the establishment year (1995) and again 3 yr later to determine relative persistence.

Nutritive Value

Near-infrared reflectance spectroscopy (NIRS) spectra were collected for each sample with a Model 6500 near-infrared reflectance spectrophotometer (NIRSystems, Silver Spring, MD[1]). A library data set was developed from samples analyzed previously at the LSUAC Forage Quality Laboratory at the Southeast Research Station. The library file consists of approximately 625 samples analyzed for CP, NDF, and IVTD from previous research experiments.

Samples from this experiment were centered and selected using the CENTER and SELECT programs in the NIRS2 (version 3.0) system software (Infrasoft International, 1992). Selected samples were compared with the library using the MATCH program to determine if the spectra of the selected samples from this experiment matched the spectra of any samples in the library. Two matched samples from the library for each selected sample were used if available. If selected samples from this experiment were not matched by at least two samples in the library file, then wet chemistry values were used for those samples. Matched samples from the library file and wet chemistry values for dallisgrass samples not matched to the library were used to make the calibration data set. Reflectance data were related to the calibration data by using a modified partial least squares regression procedure to develop the prediction equation (Shenk and Westerhaus, 1991). Samples identified as outliers from the calibration data set were analyzed by traditional wet chemistry methods.

Prediction equations had standard errors of calibration of 0.73, 1.86, and 2.94 g kg^{-1} for CP, NDF, and IVTD, respectively. Prediction equations had standard errors of cross validation of 1.01, 2.22, and 3.41 g kg^{-1} for CP, NDF, and IVTD, respectively. The $1 - V/R$ value (where V/R is the ratio of unexplained variance to total variance) had a value of 0.98 for CP, 0.97 for NDF, and 0.91 for IVTD. Samples in the library file and from this experiment were analyzed for CP colorimetrically (AOAC, 1990), and NDF was measured using methods described by Goering and Van Soest (1970), which were modified by excluding decalin. Additionally, 2 mL of a 2% (w/v) α-amylase solution was added at the beginning of

[1] Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the US Department of Agriculture and does not imply its approval to the exclusion of other products that may also be available.

the NDF procedure (Van Soest and Robertson, 1980). In vitro true digestibility was measured by means of the methods described by Goering and Van Soest (1970).

Pasture Study

To evaluate persistence and performance of selected dallisgrass biotypes under grazing, a study was established on 27 Mar. 1998, at the LSUAC Iberia Research Station, Jeanerette, LA, on a Baldwin silty clay loam (fine, smectitic, hyperthermic chromic Vertic Epiaqualfs). Six of the higher yielding Uruguayan accessions and a commercial source of common dallisgrass were used for the study.

The plots were planted into an unimproved 1.62-ha pasture consisting of a mixture of annual ryegrass (*Lolium multiflorum* Lam.), common bermudagrass [*Cynodon dactylon* (L.) Pers.], common dallisgrass, bahiagrass, carpetgrass (*Axonopus affinis* Chase), smutgrass [*Sporobolus poiretii* (Roem. & Schult.) Hitchc.], and some miscellaneous species. The experiment was designed as a randomized complete block with six replications. Each entry was planted into a plot consisting of 50 transplants in five rows of 10 plants per row, spaced 45 cm within and between rows. The area where the plots were to be planted was sprayed on 9 Mar. 1998 with 0.91 kg a.i. ha^{-1} glyphosate [*N*-(phosphonomethyl) glycine] to temporarily suppress growth of species in the unimproved pasture. Prior to planting, 3.3- by 5.5-m sections of DeWitt Pro 5 weed barrier (DeWitt Co., Sikeston, MO) were placed over each plot area to minimize plant competition during the establishment year. The plots were established by hand transplanting small plants, approximately 12 cm tall, that were started from seedlings. Ten- to 15-cm-long openings were cut into the weed barrier at the point where each seedling was to be transplanted and a small hole about 7 cm deep was dug into the soil at each opening. Except for digging these small holes, the soil in the plot area was not disturbed. A 1.8-m border of unimproved pasture was left between plots within each replication and a 2.8-m border was left between replications. The weed barrier was removed from the plots on 23 Oct. 1998. The plots were fertilized on 25 Mar. 1999, and 27 Mar. 2000, with 84 kg ha^{-1} of N, 30 kg ha^{-1} P, and 100 kg ha^{-1} K. An additional 84 kg N ha^{-1} was applied on 6 Aug. 1999 and 14 Sept. 2000.

Grazing was initiated on 5 May 1999. Because of the unusually dry conditions in 1999 and 2000, plots and surrounding unimproved pasture were only grazed four times in 1999 (5 May, 17 June, 30 July, and 9 September) and four times in 2000 (2 June, 24 July, 3 September, and 20 October). Duration of grazing was 4 d for each grazing period. Stocking density was an average of 13.6, 500-kg Angus-cross cows ha $^{-1}$ and was adjusted throughout the grazing season based upon forage availability. Before grazing, one dallisgrass plant in each plot and a 30- by 30-cm pasture area adjacent to each plot were cut to a height of 10 cm and forage mass was determined. Grazing was initiated when inflorescences were observed on the Uruguayan biotypes and terminated when plots were grazed to a height of 10 to 15 cm. Immediately after grazing, all plots were mowed to a uniform height of 10 cm to minimize differential residual effects of grazing, particularly those that might be associated with palatability. Surviving plants were counted for each plot at the end of the establishment year (12 Nov. 1998) and each grazing season (8 Dec. 1999 and 28 Nov. 2000).

During the 2001 season, the plots were stocked continuously at an average of 2.5 500-kg Angus-cross cows ha^{-1}. Grazing was initiated in May and the animals were removed in October. On 14 November, three individuals independently observed and rated each plot for percent dallisgrass ground cover.

All data were analyzed by the General Linear Models Procedure of SAS (SAS Institute, 1989). For the clipping study, entry was considered a fixed effect. Year, location, and block within location were considered random effects. For comparisons made among biotypes, biotype was considered a fixed effect. For the grazing study, entry was considered a fixed effect and year and block were considered random effects. All tests of significance were made at the 0.05 probability level unless otherwise stated. When differences were detected, means were separated using the *F*-protected least significant difference (LSD) test.

RESULTS AND DISCUSSION

Clipping Studies

Yield

Dry matter yield differences were observed for location, year, location × year, entry, and entry × location. Analysis by location and year are presented in Table 2. During 1996, the DM production among most entries was not different between Baton Rouge and College Station but there were exceptions. At Baton Rouge, the Torres biotype did not survive the establishment year and Pensacola bahiagrass produced more forage in Louisiana than Texas ($P < 0.01$). Both common dallisgrass entries produced more forage ($P < 0.01$) at College Station than Baton Rouge (Table 2). Both accessions of the Uruguaiana biotype produced little forage the first year and did not persist at either location.

During the second and third years, large differences in forage yields were apparent between locations. At Baton Rouge, the forage produced by the prostrate and Uruguayan biotypes during 1997 decreased more than 50% from that produced in 1996. Yields of all Uruguayan accessions continued to decrease in 1998. Both common dallisgrass entries exhibited a drastic reduction in yield during 1997 and 1998 (Table 2). Pensacola bahiagrass had a more gradual decline over the 3 yr (Table 2).

At College Station, common, prostrate, and Uruguayan entries tended to produce more forage in 1997 than 1996, and the same was true for Pensacola bahiagrass. However, DM production of all entries was less in 1998 than the previous year (Table 2). This was probably due to less rainfall and higher temperatures from May to July 1998 than during the same period in 1997.

The difference in the yields of common and Uruguayan entries between the two locations in 1997 and 1998 was large (Table 2). When the mean amount of forage produced over all 3 yr is considered, all Uruguayan and common entries produced more DM ($P < 0.01$) at College Station than Baton Rouge. At Baton Rouge, the combined 3-yr means for all Uruguayan entries (except PI 404831) and both common entries were 7.9 Mg ha^{-1} and 3.5 Mg ha^{-1}, respectively, whereas at College Station, the means were 14.8 Mg ha^{-1} and 13.6 Mg ha^{-1}, respectively. The Uruguayan accession PI 404831 did not produce as much forage as the other Uruguayan accessions (Table 2). It is less vigorous and is morphologically different from the other accessions

Table 2. Dry matter yield of five dallisgrass biotypes and Pensacola bahiagrass at Baton Rouge, LA and College Station, TX from 1996 to 1998.

	Louisiana				Texas			
Entry	1996	1997	1998	3-yr mean†	1996	1997	1998	3-yr mean†
	Mg ha^{-1}							
Torres								
PI404439‡	–	–	–	–	3.4	–	–	–
Uruguaiana								
PI 404444§	5.7	–	–	–	5.0	–	–	–
PI 404445§	4.5	–	–	–	4.6	–	–	–
Uruguayan								
PI 404808	12.6	5.4	4.1	7.4	14.2	14.5	13.2	14.0
PI 404812	11.4	5.1	4.4	7.0	15.6	14.8	12.8	14.4
PI 404815	12.1	6.3	5.0	7.8	16.5	18.5	14.1	16.4
PI 404818	13.3	7.0	4.9	8.4	14.0	16.0	13.2	14.4
PI 404819	12.7	6.0	4.5	7.7	15.4	17.7	14.3	15.8
PI 404820	13.9	7.6	4.8	8.8	14.5	15.5	12.2	14.0
PI 404821	13.1	6.4	3.3	7.6	15.0	16.8	11.9	14.6
PI 404831	7.6	–	–	–	9.5	13.2	8.9	10.5
554	14.5	7.0	4.6	8.7	15.0	17.0	13.3	15.1
Prostrate								
PI 548066	11.3	7.0	7.0	8.4	11.2	13.2	7.4	10.6
Common								
PI 404841	7.2	1.9	2.4	3.8	13.3	13.6	10.3	12.4
Commercial	6.6	1.9	1.3	3.3	15.9	16.3	12.2	14.8
Bahiagrass								
Pensacola	8.5	7.3	6.9	7.6	6.5	7.3	7.1	7.0
Mean	10.3	5.7	4.4	7.2	11.8	15.0	11.6	13.4
CV	17	28	36	23	22	17	25	21
LSD	2.5	2.3	2.3	1.3	3.8	3.6	4.1	2.2

† For entries tested for 3 yr.
‡ The Torres biotype did not establish in Louisiana and failed to survive after the first harvest season in Texas.
§ The Uruguaiana biotypes failed to survive in Louisiana or Texas after the first harvest season.

in that it has lax leaves and is not as upright. This accession also produced less DM in earlier studies (Burson et al., 1991). The 3-yr means of prostrate dallisgrass and Pensacola bahiagrass were more consistent across locations and differences were not detected between locations (Table 2). The similar performance of bahiagrass at both locations was not expected because it is better adapted to lighter textured soils, and the soil at the test site at Baton Rouge was a heavy clay and at College Station a silt loam.

Table 3. Percentage plant survival of five dallisgrass biotypes† and Pensacola bahiagrass after 3 yr clipping (1996–1998) at Baton Rouge and Jeanerette, LA and College Station, TX.

Entry	Baton Rouge	Jeanerette‡	College Station
	% survival		
Uruguayan			
PI 404808	81	77	88
PI 404812	81	81	79
PI 404815	94	71	85
PI 404818	98	75	88
PI 404819	90	77	83
PI 404820	94	58	88
PI 404821	90	77	83
PI 404831	21	29	65
554	88	79	90
Prostrate			
PI 548066	100	75	73
Common			
PI 404841	29	25	73
Commercial	25	19	77
Bahiagrass			
Pensacola	88	73	67
Mean	62	51	65
CV	22.7	32.6	11.5
LSD0.05	20	24	11

† The Torres biotype did not establish in Louisiana and failed to survive after the first harvest season in Texas. The Uruguaiana biotypes failed to survive in Louisiana or Texas after the first harvest season.
‡ Entries at Jeanerette were clipped only twice a year.

Persistence

The Torres and Uruguaiana biotypes did not persist at Baton Rouge or College Station (Table 3). Both biotypes were not harvested after the first year because of stand reduction. At Baton Rouge, there was a clear separation of all remaining entries. The Uruguayan entries (except for PI 404831), prostrate dallisgrass, and Pensacola bahiagrass persisted better than both common dallisgrass entries (Table 3); however, there were differences between College Station and Baton Rouge. The Uruguayan accessions (except for PI 404831) persisted about the same at both locations, but prostrate dallisgrass and Pensacola bahiagrass did not persist as well at College Station. The most striking difference between locations was common dallisgrass. Both entries persisted much better at College Station (75%) than Baton Rouge (27%; Table 3).

The plots at Jeanerette were harvested twice in 1996 (data not shown) and were last fertilized on 16 Apr. 1997. Thereafter, they were essentially abandoned except for occasionally being mowed for maintenance purposes. By 11 Mar. 1999, the Torres and Uruguaiana biotypes had died (Table 3). Both common dallisgrass entries did not persist well (22%). The more persistent entries were the prostrate and Uruguayan biotypes and Pensacola bahiagrass (Table 3). Because plants in these plots competed with weeds and received minimal fertilization, these conditions are similar to those encountered in most unimproved pastures. The most interesting finding was the poor persistence of both common dallisgrass entries. It was similar to what occurred in the plots at Baton Rouge.

The primary reason forage yields of the common dallisgrass entries were higher at College Station than Baton Rouge (Table 2) was their superior persistence in Texas (Table 3). Their lack of persistence at Baton Rouge and Jeanerette was not anticipated because common dallisgrass is reported to be well adapted to the heavy, poorly drained soils of the Gulf Coast region (Burson and Watson, 1995). Soils at both Louisiana locations fit that description (Soil Survey Division, USDA-NRCS, 2002). A possible explanation for their failure to persist at Baton Rouge is because the plots were located only about 1 km from the Mississippi River and the water table was routinely very high. Apparently common dallisgrass could not tolerate the wet soil for extended periods and died. Although the plots at Jeanerette were not close to a river, this area of south Louisiana is at a low elevation (4.5–6.1 m) and consequently often has a high water table. Because of these conditions, the soils are poorly drained and are frequently saturated. These findings suggest that common dallisgrass is not as well adapted to wet, heavy soils for extended periods, and when grown under these conditions, it will not perennate readily but behaves more as a weak perennial persisting through seedling recruitment. In an earlier study, wet soil conditions reduced the growth of the Uruguayan accessions, which decreased the amount of forage produced (Burson et al., 1991). These findings suggest that the Uruguayan biotype tolerates wet soils better than common dallisgrass. Although productivity is reduced under these conditions, the Uruguayan accessions produce more DM than common.

Nutritive Value

Analysis of CP, NDF, and IVTD revealed effects of location, year, and year × location for all variables. Entry × location and entry × year differences also were observed for NDF. Three-year means from analyses by location for CP, NDF, and IVTD are presented in Table 4. Crude protein differed at Baton Rouge during 1997 and at College Station during 1996 (data not shown). At Baton Rouge during 1997, the common accessions had higher CP levels than the prostrate biotype and were similar to all of the Uruguayan accessions, except for PI 404815 and PI 404820, but were not different from the Uruguayan or prostrate biotypes at College Station during 1996. Crude protein levels for both common accessions at College Station during 1996 were lower than those of the Uruguaiana accessions.

Differences in NDF were observed at Baton Rouge during 1996 and 1997 and at College Station during 1997 and 1998. A comparison of NDF among the common and Uruguayan accessions did not reveal a consistent separation, although some Uruguayan accessions had greater mean NDF. Except for College Station during 1998, the two common accessions did not differ from one another. The two common accessions also did not differ from the Torres, prostrate, or Uruguaiana biotypes.

Table 4. Three-year means for crude protein (CP), neutral detergent fiber (NDF), and in vitro true digestibility (IVTD) of five dallisgrass biotypes† and Pensacola bahiagrass at Baton Rouge, LA, and College Station, TX, from 1996 to 1998.

	Louisiana			Texas		
Entry	CP	NDF	IVTD	CP	NDF	IVTD
	g kg^{-1}					
Uruguayan						
PI 404808	113	691	642	98	711	717
PI 404812	114	689	652	98	710	720
PI 404815	109	703	627	98	713	708
PI 404818	109	703	632	95	715	706
PI 404819	111	695	638	100	707	711
PI 404820	106	707	631	100	707	718
PI 404821	112	694	644	96	716	711
PI 404831	–	–	–	93	712	716
554	109	706	628	100	711	715
Prostrate						
PI 548066	105	682	636	102	685	709
Common						
PI 404841	120	681	643	98	705	716
Commercial	119	680	635	103	699	716
Bahiagrass						
Pensacola	105	696	644	98	707	686
Mean	110	695	638	98	707	712
CV	21	4.4	7.4	21.8	2.7	5.4
LSD	NS	14	NS	NS	7.4	15

† For entries tested for 3 yr. The Torres biotype did not establish in Louisiana and failed to survive after the first harvest season in Texas. The Uruguaiana biotypes failed to survive in Louisiana or Texas after the first harvest season.

Results for IVTD indicated differences among entries in Baton Rouge during 1997 and in College Station during 1998. At Baton Rouge, both common dallisgrass entries were superior to Uruguayan accessions PI 404815, PI 404820, and 554, but did not differ from prostrate dallisgrass or Pensacola bahiagrass. There were no IVTD differences among any of the dallisgrass biotypes at College Station in 1998, but all were superior to Pensacola bahiagrass.

These results indicate that the Uruguayan biotype was equal to or better than the common entries for yield and nutritive value at both Baton Rouge and College Station. The enhanced persistence of the Uruguayan entries at Baton Rouge relative to the common dallisgrass, indicates that this biotype has the potential to provide a significant production advantage in the southern coastal region for livestock producers.

Pasture Study

Forage Production and Nutritive Value

Forage biomass production, as estimated from clipped samples before grazing, was different for entry, year, and grazing period. All Uruguayan accessions were superior to common with DM yield per plant averaging 156 g for common dallisgrass compared with a mean of 232 g for the Uruguayan accessions. Overall yields were less in 2000 (140 g plant^{-1}) than in 1999 (300 g plant^{-1}). This decline was the result of reduced rainfall and loss of plants. Yields declined with each grazing period, but there was no grazing period × entry interaction. Common dallisgrass had lower NDF values than any Uruguayan accessions, but there were no differences in CP or IVTD.

Persistence

Although this study was not designed to evaluate relative palatability, field observations indicated there were no gross animal preferences among entries during the grazing periods and all plots were grazed at about the same intensity. Survival at the end of the establishment year was not different among entries and the percentage of surviving plants ranged from 96 to 100% (Table 5) with a mean of 99% for the six Uruguayan entries and 96% for common. After the first grazing season, stand densities of all entries numerically decreased. The greatest reduction was in the common dallisgrass plots. Mean stand density (94%) of the six Uruguayan accessions was higher ($P < 0.01$) than that of common dallisgrass (64%). Following the second grazing season, stand density of the Uruguayan accessions declined to a mean of 90% while common decreased to 53%. Of the six Uruguayan accessions, PI 404812 had the lowest persistence, but it persisted much better ($P < 0.01$) than common.

The plants were subjected to continuous stocking during the 2001 growing season. By ranking the plots for plant coverage and density at the end of the grazing season, it was determined that plant density continued to decrease. The relative rankings of the entries continued to follow the same trends observed during the previous 2 yr (Table 5). The survival of common dallisgrass was lower than five of the six Uruguayan accessions and the mean survival percentage for the Uruguayan entries was 75% compared with 33% for common. All plots in two replications were over grown with common bermudagrass and this contributed to the overall decrease in the dallisgrass stand. This occurred because the cattle selectively grazed the dallisgrass which reduced its competitiveness and allowed common bermudagrass to invade the plots. Because of their more upright growth habit, the Uruguayan entries competed better with bermudagrass than did common dallisgrass. The persistence of these entries under grazing is consistent with that observed in the clipped plots at Baton Rouge and the unattended plots at Jeanerette. The Uruguayan accessions have a definite persistence and forage production advantage over common dallisgrass. Although recovery from grazing, as measured by percent of previous yield, was not different among entries (data not shown), the combination of lower yield and poorer persistence of the common biotype under grazing resulted in a significant overall advantage for the Uruguayan accessions.

Table 5. Percent plant survival of Uruguayan and common dallisgrass biotypes under grazing at Jeanerette, LA.

Entry	1998†	1999‡	2000§	2001¶
	% survival			
Uruguayan				
PI 404812	96	89	80	59
PI 404818	99	90	85	77
PI 404819	98	92	86	68
PI 404820	99	96	94	79
PI 404821	100	98	96	79
PI 404831	100	99	97	88
Common				
Commercial	96	64	53	33
Mean	98	90	84	69
CV	2.7	9.1	13.3	39.5
LSD	NS	10	13	32

† End of the establishment year.
‡ End of one season of rotational grazing.
§ End of second season of rotational grazing.
¶ End of a season of continuous grazing.

CONCLUSIONS

An unexpected finding was the overall performance of Pensacola bahiagrass. This grass has the reputation of producing relatively small quantities of low quality forage. However, in this study, its DM production, forage nutritive value, and persistence were much better than expected in heavy clay soils. Thus, with improved soil fertility and better management, the species may be a better forage grass than previously perceived.

Stand persistence and forage production of prostrate dallisgrass was satisfactory, but as previously reported (Hart and Burton, 1966), its major limitation is poor seed set. Both the Torres and Uruguaiana biotypes lack the persistence to be potential forage grasses. Findings from this study demonstrate that Uruguayan dallisgrass persists much better and produces more forage on poorly drained clay soils than common dallisgrass. Equally important, the nutritive value of the Uruguayan forage was equivalent to common dallisgrass. Because of these attributes, the Uruguayan biotype should provide livestock producers in the southeastern USA with a viable alternative to common dallisgrass. The large difference in yield performance between Louisiana and Texas may lead to a reevaluation of previously held assumptions concerning the ability of dallisgrass to survive and attain maximum productivity on poorly drained soils. More research is needed in this area.

ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance received from the LSUAC Forage Quality Laboratory, especially to Randy Walz, Laura Zeringue, and Jerry Simmons.

REFERENCES

AOAC. 1990. Official methods of analysis. 15th ed. Association of Official and Analytical Chemists, Washington, DC.

Bashaw, E.C., and I. Forbes, Jr. 1958. Chromosome numbers and microsporogenesis in dallisgrass, *Paspalum dilatatum* Poir. Agron. J. 50:441–445.

Bashaw, E.C., and E.C. Holt. 1958. Megasporogenesis, embryo sac development and embryogenesis in dallisgrass, *Paspalum dilatatum* Poir. Agron. J. 50:753–756.

Bashaw, E.C., A.W. Hovin, and E.C. Holt. 1970. Apomixis, its evolutionary significance and utilization in plant breeding. p. 245–248. *In* M.J.T. Norman (ed.) Proc. Int. Grassl. Cong., 11th, Surfers Paradice, Queensland. 13–23 Apr. 1970. Univ. Queensland Press, St. Lucia, Queensland.

Burson, B.L. 1991. Genome relationships between tetraploid and hexaploid biotypes of dallisgrass, *Paspalum dilatatum.* Bot. Gaz. (Chicago) 152:219–223.

Burson, B.L., P.W. Voigt, and G.W. Evers. 1991. Cytology, reproductive behavior, and forage potential of hexaploid dallisgrass biotypes. Crop Sci. 31:636–640.

Burson, B.L., and V.H. Watson. 1995. Bahiagrass, dallisgrass and other *Paspalum* species. p. 431–440. *In* R.F Barnes et al. (ed.) Forages: An introduction to grassland agriculture. Iowa State Univ. Press, Ames, IA.

Burton, G.W., and J.P. Wilson. 1991. Registration of prostrate dallisgrass germplasm #1. Crop Sci. 31:1392.

Chase, A. 1929. The North American species of *Paspalum.* Contrib. U.S. Natl. Herb. 28(1):310.

Committee on Animal Nutrition and Feed Composition. 1971. Atlas of nutrition data on US and Canadian feeds. National Academy of Science, Washington, DC.

Goering, H.K., and P.J. Van Soest. 1970. Forage fiber analysis (apparatus, reagents, procedures, and some applications). Agric. Handb. 379. USDA-ARS, U.S. Gov. Print. Office, Washington, DC.

Hart, R., and G.W. Burton. 1966. Prostrate vs common dallisgrass under different clipping frequencies and fertility levels. Agron. J. 58:521–522.

Holt, E.C. 1956. Dallisgrass. Tex. Agric. Exp. Stn. MP 662. College Station, TX.

Infrasoft International. 1992. NIRS 2 Version 3.0: Routine operation and calibration software for near infrared instruments, Infrasoft International, Silver Springs, MD.

Mayland, H.F., and P.R. Cheeke. 1995. Forage-induced animal disorders. p. 121–135. *In* R.F Barnes et al. (ed.) Forages: The science of grassland agriculture. Iowa State Univ. Press, Ames, IA.

SAS Institute. 1989. SAS/STAT user's guide, Version 6. 4th ed. Vol. 2. SAS Institute, Inc., Cary, NC.

Shenk, J.S., and M.O. Westerhaus. 1991. Population structuring of near-infrared spectra and modified partial least squares regression. Crop Sci. 31:1548–1555.

Soil Survey Division, U.S.D.A.-N.R.C.S. 2002. [online]. Available at http://www.statlab.iastate.edu/cgi-bin/osd/osdnamequery.cgi; verified 15 Aug. 2002.

Van Soest, P.J., and J.B. Robertson. 1980. Systems of analysis for evaluating fibrous feeds. p. 49–60. *In* W.J. Pigden et al. (ed.) Proc. Int. Workshop on Standardization Anal. Meth. Feeds. Ottawa, Canada. 12–14 Mar. 1979. Unipub, New York.