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'Florigraze' and 'Arbrook' Rhizoma Peanut as Pasture for Growing Holstein Heifers

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ABSTRACT

'Florigraze' and 'Arbrook' are the most widely used cultivars of rhizoma peanut (*Arachis glabrata* Benth.), but performance of ruminants grazing these cultivars has not been compared. The objective of this study was to determine sward characteristics and performance of Holstein replacement heifers (*Bos taurus*) on continuously stocked pastures of Florigraze and Arbrook growing on a loamy, siliceous, hyperthermic Grossarenic Paleudult soil. Herbage mass and allowance did not differ between cultivars during 3 yr of grazing and averaged 2840 kg DM ha^{-1} and 2.25 kg of forage kg^{-1} of animal live weight, respectively. Percentage of Arbrook in pasture herbage mass decreased from Year 1 (89%) to Year 3 (66%), while percentage of Florigraze remained relatively constant (90 to 87%). Average herbage crude protein (CP) concentration and in vitro organic matter digestibility (IVOMD) were greater in Florigraze than in Arbrook (177 vs. 161 g kg^{-1} and 705 vs. 661 g kg^{-1}, respectively). Average stocking rate varied little between cultivars, and animal performance was generally similar until Year 3. With a much lower percentage of rhizoma peanut in herbage mass for Arbrook than Florigraze pastures in Year 3, average daily gain (ADG; 701 vs. 516 g) and gain ha^{-1} (575 vs. 418 kg) were greater for heifers grazing Florigraze than for those grazing Arbrook. Florigraze appears better suited for pasture programs with continuous stocking, primarily because of superior persistence, leading to greater animal performance with time.

THROUGHOUT THE MAJORITY of the USA, alfalfa (*Medicago sativa* L.) is the primary forage legume used in the dairy industry. Unfortunately, alfalfa does not persist in many warm-climate regions because of adverse soil or environmental conditions, insect pests, or diseases (Prine et al., 1981; Bouton et al., 1987). Lack of a high-quality forage legume like alfalfa makes it difficult to achieve growth rate targets (0.8 kg live weight gain d^{-1}) for dairy replacement heifers fed forage alone.

Most perennial forages grown in Florida are not capable of supporting weight gains by young, growing animals of 0.8 kg d^{-1}, but rhizoma peanut is an exception (Sollenberger et al., 1989; Williams et al., 1991). Rhizoma peanut is considered an alternative to alfalfa in Florida because of its yield potential (Andrews et al., 1985), high forage quality (Romero et al., 1987; Staples et al., 1987; Sollenberger et al., 1989), persistence (Ortega-S. et al., 1992), and disease and insect resistance. It can be grazed, ensiled, or stored as hay (Andrews et al., 1985; Staples et al., 1987) and yields up to 10 Mg ha^{-1} yr^{-1} under natural rainfall conditions (Lopez et al., 1986).

Florigraze and Arbrook are the two most widely used cultivars of rhizoma peanut. Arbrook is favored over Florigraze on excessively drained soils and under drought conditions and appears to be better adapted to and higher yielding on deep, sandy soils (Prine et al., 1986). Florigraze grows less upright, achieves ground cover faster following establishment, and is more cold-tolerant than Arbrook. Compared under clipping management during 4 yr, yield was similar but Arbrook was more productive early in the season and in autumn of dry years (Prine et al., 1986). Nutritive value of the two cultivars did not vary greatly in clipping studies; however, averaged across a 3-yr study, Florigraze CP concentration was 11 g kg^{-1} greater than Arbrook, and Florigraze IVOMD was at least 25 g kg^{-1} greater than that of Arbrook in 2 of 3 yr (Prine et al., 1986). Williams et al. (1991) evaluated steer performance on continuously stocked pastures of either bahiagrass (*Paspalum notatum* Flügge) or rhizoma peanut-mixed grass [primarily *Cynodon dactylon* (L.) Pers.] with a stocking rate of 0.6 steers ha^{-1}. Average daily gain of steers (initial weight of 260 kg) grazing the legume-grass mixture was 0.8 kg d^{-1}, compared with 0.5 kg d^{-1} for steers that grazed bahiagrass. Seasonally, ADG was improved as steers grazing the rhizoma peanut-grass mixture consumed proportionally more rhizoma peanut and less grass. Animal performance trials conducted by Sollenberger et al. (1989) during 3 yr demonstrated good productivity of Florigraze rhizoma peanut under rotational stocking (5-wk rest period, 1-wk grazing period), and yearling steer ADG was 0.93 kg d^{-1}.

Knowledge of Arbrook rhizoma peanut responses to grazing management is limited and no studies have been published comparing animal performance on the two cultivars. This information is needed by producers as they consider which cultivar to establish for future grazing programs. The objective of this study was to evaluate herbage mass, allowance, and nutritive value of Florigraze and Arbrook pastures under continuous stocking management and to compare animal performance of Holstein replacement heifers grazing the two cultivars in North Florida.

MATERIALS AND METHODS

Site Characteristics and Experimental Design

The experiment was conducted from 1994 to 1996 at the Forage Evaluation Field Laboratory of the Beef Research Unit, University of Florida, Gainesville (29°38′ N, 82°22′ W). Well-established pastures of Florigraze and Arbrook rhizoma peanut were evaluated on a Sparr fine sand soil with a pH of

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Abbreviations: ADG, average daily gain; CP, crude protein; IVOMD, in vitro organic matter digestibility.

Table 1. Monthly rainfall measured at the Beef Research Unit, University of Florida, Gainesville, and the 30-yr average for Gainesville, FL.

Month	1994	1995	1996	30-yr average
			mm	
January	226	92	46	83
February	16	33	24	99
March	88	116	265	93
April	33	133	71	75
May	90	51	70	106
June	165	151	172	168
July	134	42	216	180
August	99	150	196	203
September	111	59	43	142
October	142	90	154	59
November	34	82	20	52
December	41	23	80	81
Total	1179	1022	1357	1341

5.9. Average nutrient concentrations were 22, 26, 52, and 518 mg kg^{-1} of Mehlich-I extractable P, K, Mg, and Ca, respectively. Rainfall during the 3 yr of the experiment was 1179 (1994), 1022 (1995), and 1357 (1996) mm (Table 1).

Pastures of both cultivars were continuously stocked and there were two replications per treatment arranged in a completely randomized design. Grazing was initiated in June 1994 and in May 1995 and 1996, and continued until October each year. The experimental period was 133, 168, and 140 d in 1994, 1995, and 1996, respectively. Experimental units were 0.5-ha paddocks, and animals had free access to water and a commercial salt and mineral mix. A variable stocking rate was used and sward canopy height was maintained between 15 and 20 cm based on the results of Ortega-S. et al. (1992). Testers were Holstein heifers with an initial weight of 180 kg, and two were assigned per pasture.

Plant Measurements

Pastures were sampled every 14 d with a double sampling technique to determine herbage mass (Frame, 1981). Settling height of a 0.25-m^2 aluminum disk was the indirect measure of herbage mass, and the direct measure involved clipping herbage to a 5-cm stubble. At each sampling, indirect measures were taken at 30 sites per pasture by a stratified randomization procedure to ensure that all areas of the pasture were represented. Three double samples (both the disk measure and clipping done at the same sites) were taken in each experimental unit every 28 d. Sites for double sampling were selected to represent the range of herbage mass in the pasture (one low, medium, and high herbage mass site). Samples from these sites were dried at 60°C to obtain actual herbage mass. To calibrate the disk meter, disk meter readings were used as the independent variable in a regression equation relating forage mass to disk height. The equation used to predict herbage mass (in kg ha^{-1}) was $Y = -1562 + 633\ HT - 15.4\ HT^2$ ($R^2 = 0.60$; where HT is average disk height).

To estimate diet nutritive value, hand-plucked forage samples were collected from each pasture every 14 d. At approximately 20 locations per pasture, a sample was clipped from the top 5 cm of the sward canopy with hand shears. The composite sample was dried to a constant weight at 60°C and ground to pass a 1-mm screen. This herbage was analyzed for CP by a macro-Kjeldahl technique and for IVOMD by a modified two-stage procedure (Moore and Mott, 1974).

In July of each year, samples were taken to determine botanical composition of the herbage mass. From five representative 0.25-m^2 quadrats per experimental unit, herbage was clipped to a 5-cm stubble. Fresh herbage from each quadrat was hand separated into rhizoma peanut, grass (common bermudagrass and bahiagrass), and broadleaf weed fractions. Fractions were dried at 60°C and weighed to determine proportion of each fraction in the herbage mass.

Animal Measurements

Animals were weighed at the beginning and end of the trial and every 28 d during the experiment following a 16-h period without food and water. Heifer ADG was calculated with tester animals only. Total heifer grazing days per hectare was determined by both testers and put-and-take animals, and data are expressed on the basis of a 225-kg animal. Average stocking rate was calculated by dividing total animal days per hectare by the number of days of grazing in the experimental period each year. Gain per hectare was determined by multiplying tester ADG by the number of total heifer grazing days per hectare.

Statistical Analysis

All animal responses and pasture herbage mass, allowance, CP, and IVOMD data are presented as yearly averages across sampling dates. Pasture data are also presented as monthly averages to assess seasonal trends. Yearly averages were compared by the mixed procedure of SAS, and year was a random effect and cultivar a fixed effect (SAS Institute, 1999). Presence or absence of year × cultivar interaction is noted in the text and tables. The monthly pattern of pasture responses was compared across years by the repeated function of the mixed procedure of SAS (SAS Institute, 1999). Year and month were random effects and cultivar a fixed effect. Treatments were considered different if $P \leq 0.10$, and trends were noted when $P < 0.20$. All means reported in the text are least squares means.

RESULTS AND DISCUSSION

Data of annual averages or totals are reported by year because there were cultivar × year interactions for percentage peanut and grass in herbage mass and interactions or trends toward interactions for all of the animal responses. Data of monthly averages for pasture responses are reported across years because there were no cultivar × year × month interactions for any of the responses.

Herbage Mass and Herbage Allowance

There was no cultivar × year interaction ($P = 0.49$) or cultivar effect ($P = 0.20$) for annual average herbage mass. Across years, herbage mass averaged 2890 kg ha^{-1} for Arbrook and 2760 kg ha^{-1} for Florigraze (Table 2). Averaged across years, there were no monthly differences in herbage mass between cultivars with the exception of May, when Arbrook had 29% more herbage mass than Florigraze ($P < 0.01$; Fig. 1). This supports the observation made by others that Arbrook grows more rapidly than Florigraze during spring (Prine et al., 1990). Herbage mass tended to decrease across time during the season, averaging approximately 3600 kg ha^{-1} when grazing began, remaining relatively stable between 2500 and 3000 kg ha^{-1} during summer through early fall, and then decreasing to approximately 2400 kg ha^{-1} by October. Average herbage mass for 3 yr

Table 2. Annual average herbage mass (HM), allowance (HA), crude protein (CP) concentration, and in vitro organic matter digestibility (IVOMD) of continuously stocked pastures of Florigraze (FL) and Arbrook (AR) rhizoma peanut.†

	1994			1995			1996			Average		
Response	AR	FL	SE	AR	FL	SE	AR	FL	SE	AR	FL	SE
HM, kg ha^{-1}	2840	2740	124	3200	2920	118	2630	2630	118	2890	2760	70
HA, kg of forage kg^{-1} of animal live weight	2.4	2.1	0.19	2.5	2.3	0.04	2.2	2.1	0.04	2.3	2.2	0.07
CP, g kg^{-1}	172b‡	184a	4.4	146b	165a	4.2	166b	183a	4.2	161b	177a	2.5
IVOMD, g kg^{-1}	684b	732a	9.3	669b	711a	8.9	628b	672a	8.9	661b	705a	5.2

† There was no cultivar × year interaction for HM ($P = 0.49$), HA ($P = 0.71$), CP ($P = 0.74$), or IVOMD ($P = 0.94$).
‡ Means within a row and year followed by different letters are different ($P < 0.05$).

across cultivars was 2830 kg ha^{-1}, suggesting that herbage mass was unlikely to be limiting animal performance (Black and Kenney, 1984).

Annual average herbage allowance was not affected by year, cultivar, or their interaction and ranged between 2.1 and 2.5 kg forage kg^{-1} of animal live weight (Table 2). There were no monthly differences between cultivars (Fig. 2). Herbage allowance was greatest at initiation of grazing in May, decreased as stocking rate was increased and pasture herbage mass decreased in June, and remained relatively constant at ≈2 kg of forage kg^{-1} of animal live weight from June through October, with the exception of July when allowance was ≈1.6 kg of forage kg^{-1} of animal live weight (Fig. 2). Parkin and Boultwood (1981) pointed out that the amount of herbage on offer per animal is a major factor determining animal performance. Provided that herbage allowance was >1.0 kg of forage kg^{-1} of animal live weight, gains of yearling beef heifers on continuously stocked 'Tifton 85' bermudagrass pastures were at or near maximum levels (>0.6 kg d^{-1}) observed in that experiment (Pedreira, 1995), so it seems unlikely that the allowances in the present study limited gain.

Botanical Composition

There were year × cultivar interactions ($P < 0.01$) for percentages of rhizoma peanut and grass (Table 3). Florigraze rhizoma peanut percentage remained relatively constant across the 3 yr, ranging only from 90 in Year 1 to 87 in Year 3. In contrast, Arbrook percentage decreased from 89 to 82 from Year 1 to 2 and from 82 to 66 from Year 2 to 3. Grass percentage in Arbrook pastures increased concomitantly from 10% in Year 1 to 31% in Year 3. Differences in percentage peanut and grass between cultivars occurred in Years 2 and 3 (Table 3). Weeds made a minor contribution (3% or less) to pastures of both cultivars in all years.

These data suggest that the more upright growth habit of Arbook (Prine et al., 1986) makes it less well suited to continuous stocking than Florigraze. Mathews et al. (1994) reported an increase in common bermudagrass proportion each year during a 2-yr study when 'Callie' bermudagrass was continuously stocked. In the same experiment, rotationally stocked Callie pastures experienced little change in botanical composition. They suggested that rotational stocking allowed the taller-growing Callie to shade common bermudagrass during parts of the regrowth period, keeping common bermudagrass in check. In contrast, continuous stocking, even at the same stocking rate as the rotational pastures, resulted in greater light penetration to the lower-growing common bermudagrass and increased its competitiveness with Callie. The decrease in Arbrook and the associated increase in common bermudagrass in the current study are likely from causes similar to those cited by Mathews et al. (1994). Previous studies have documented the

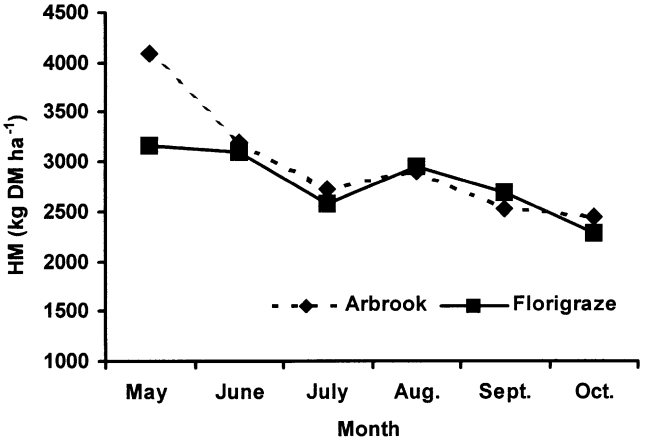

Fig. 1. Average herbage mass (HM) on continuously stocked pastures of Florigraze and Arbrook rhizoma peanut across 3 yr of grazing. Arbrook HM was greater than Florigraze in May ($P < 0.01$; SE = 240), but there were no cultivar differences in HM in June ($P = 0.45$; SE = 130), July ($P = 0.76$; SE = 140), August ($P = 0.81$; SE = 150), September ($P = 0.71$; SE = 160), or October ($P = 0.45$; SE = 150). DM = dry matter.

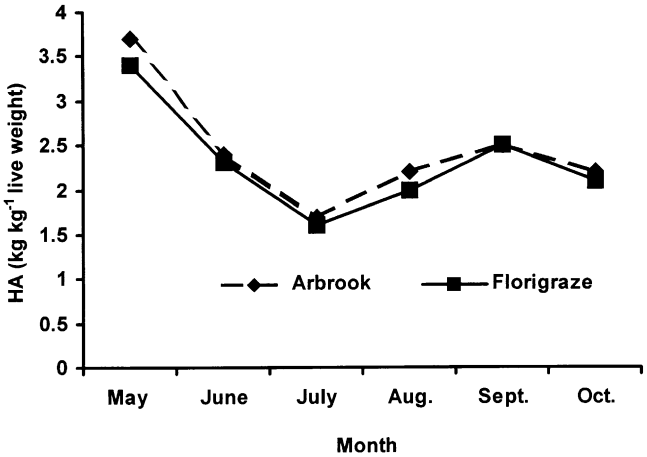

Fig. 2. Average herbage allowance (HA; kg of forage kg^{-1} of animal live weight) on continuously stocked pastures of Florigraze and Arbrook rhizoma peanut across 3 yr of grazing. There were no differences between cultivars in any month ($P > 0.23$; SE = 0.11–0.23).

Table 3. Rhizoma peanut and grass percentages in the herbage mass during July in each of 3 yr for continuously stocked pastures of Florigraze (FL) and Arbrook (AR) rhizoma peanut.†

	1994			1995			1996		
	AR	FL	SE	AR	FL	SE	AR	FL	SE
	%								
Rhizoma peanut	89	90	1.1	82b‡	89a	1.1	66b	87a	1.9
Grass	10	8	1.0	16a	10b	1.1	31a	10b	2.1

† There was cultivar × year interaction for rhizoma peanut ($P < 0.01$) and grass ($P < 0.01$) percentages.
‡ Means within a row and year followed by different letters are different ($P < 0.05$).

persistence of Florigraze under continuous stocking (Williams et al., 1991; Ortega-S. et al., 1992) if herbage mass and stubble height were sufficiently great. Ortega-S. et al. (1992) found that Florigraze percentage remained at 80% or greater when growing with common bermudagrass if residual dry matter was maintained above ≈1700 kg ha^{-1} (≈16-cm stubble).

Herbage Nutritive Value

There were effects of year and cultivar on hand-plucked herbage CP (Table 2), but there was no year × cultivar interaction ($P = 0.74$). Average herbage CP across years was 16 g kg^{-1} higher in Florigraze than Arbrook (177 vs. 161 g kg^{-1}). This follows general trends reported under clipping by Prine et al. (1986), but it also reflects the greater proportion of grass in Arbrook pastures. There was a general decline in Arbrook CP during the growing season (average across years of 194 in May to 144 g kg^{-1} in October), while Florigraze maintained a relatively constant CP concentration throughout (Fig. 3).

Herbage IVOMD was affected ($P < 0.01$) by cultivar in all years, and was consistently greater for Florigraze than for Arbrook (705 vs. 661 g kg^{-1}). The lower IVOMD may be associated with the higher proportion of bermudagrass observed in Arbrook pastures (Table 3); however, the response was present in Year 1 and remained relatively consistent across years. From May to October, IVOMD of both cultivars decreased ($P < 0.05$) (Fig. 4). The decrease in IVOMD and CP from midsummer to early autumn may be associated with an increasing proportion of senescing or dead herbage that often occurs under continuous stocking (not quantified in the current study). In this study, mean IVOMD of both cultivars (683 g kg^{-1}) was greater than that reported by Terrill et al. (1996) for Florigraze (651 g kg^{-1}); however, Sollenberger et al. (1989) reported values above 700 g kg^{-1} for hand-plucked samples from Florigraze pastures.

Average Daily Gain

There was no cultivar effect ($P = 0.24$) on heifer ADG, but the interaction of cultivar and year approached significance ($P = 0.16$). As a result, data were analyzed by year. During 1994 and 1995, mean ADG was similar between treatments (611 vs. 598 g head^{-1} d^{-1} for Arbrook and Florigraze); however, in 1996, heifers grazing Florigraze pastures gained 185 g head^{-1} d^{-1} more than those in Arbrook pastures ($P < 0.05$; 701 vs. 516 g head^{-1} d^{-1}). These differences in ADG may be because of the greater proportion of rhizoma peanut in Florigraze than in Arbrook pastures in Year 3 (Table 3), although the advantage of Florigraze over Arbrook pas-

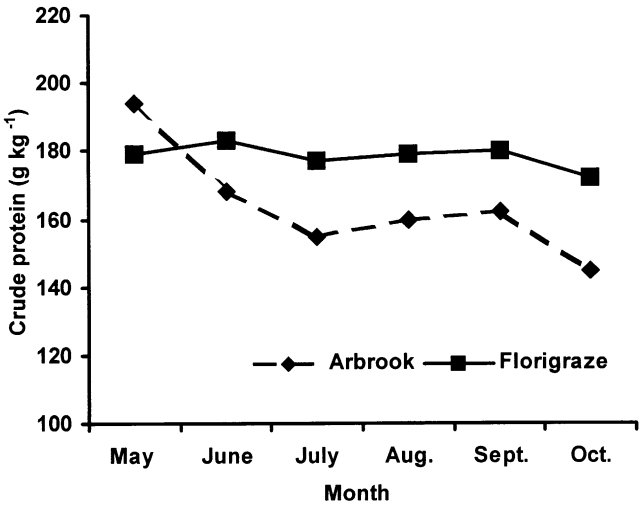

Fig. 3. Average crude protein of hand-plucked herbage from continuously stocked pastures of Florigraze and Arbrook rhizoma peanut across 3 yr of grazing. There was no cultivar effect in May ($P = 0.34$; SE = 11), but Florigraze crude protein was greater than Arbrook in June ($P = 0.10$; SE = 6), July ($P = 0.04$; SE = 5), August ($P = 0.03$; SE = 6), September ($P = 0.04$; SE = 6), and October ($P = 0.01$; SE = 7).

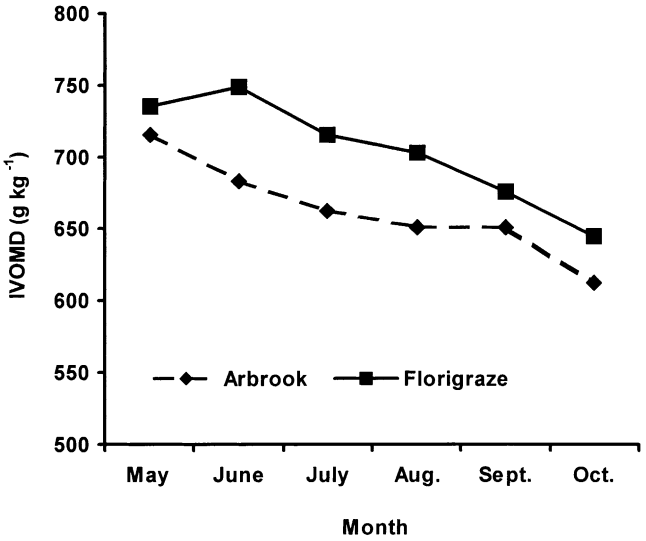

Fig. 4. Average in vitro organic matter digestibility (IVOMD) of hand-plucked herbage from continuously stocked pastures of Florigraze and Arbrook rhizoma peanut across 3 yr of grazing. There was no cultivar effect in May ($P = 0.48$; SE = 20), but Florigraze IVOMD was greater than Arbrook in June ($P < 0.01$; SE = 11), July ($P < 0.01$; SE = 12), August ($P < 0.01$; SE = 10), and October ($P = 0.09$; SE = 13), and tended to be greater in September ($P = 0.14$; SE = 12).

Table 4. Average daily gain (ADG), animal grazing days per hectare, average stocking rate (SR), and gain per hectare (GHA) of replacement dairy heifers grazing continuously stocked pastures of Florigraze (FL) and Arbrook (AR) rhizoma peanut.†

	1994			1995			1996		
Response	**AR**	**FL**	**SE**	**AR**	**FL**	**SE**	**AR**	**FL**	**SE**
ADG, g	620	600	63	600	590	15	520b‡	700a	31
Animal days§, d ha^{-1}	758b	845a	16	1030	998	27	810	820	7
SR§, head ha^{-1}	5.7b	6.3a	0.11	6.1	5.9	0.16	5.8	5.9	0.05
GHA, kg	471	510	62	616a	592b	3.7	418b	575a	29

† There was cultivar × year interaction for animal days ($P = 0.08$) and average SR ($P = 0.06$) and a trend toward interaction for ADG ($P = 0.16$) and GHA ($P = 0.12$).
‡ Means within a row and year followed by different letters are different ($P < 0.05$).
§ Animal days and stocking rate are expressed based on a heifer of 225-kg live weight.

tures in nutritive value was not greater in Year 3 than in the other years. Heifer ADG on both cultivars was lower than that reported for yearling beef steers on rotationally stocked Florigraze pastures in Florida (Sollenberger et al., 1989); however, those animals were 16 to 18 mo old at initiation of the trial compared with 6 to 8 mo old in the current study.

Average Stocking Rate and Gain per Hectare

Animal days on pasture were affected by year ($P < 0.01$) and year × cultivar interaction ($P = 0.08$). Greater animal days on pasture were achieved when heifers were grazing Florigraze pastures during 1994 ($P < 0.06$; 845 vs. 758), but no differences were observed in 1995 and 1996 (Table 4). Average stocking rate was calculated as animal days per hectare divided by number of days of grazing during that year. Within a year, number of days of grazing was the same for all experimental units, so this response is similar to that of animal days per hectare. Average stocking rate of 225-kg live weight heifers was affected by a year × cultivar interaction ($P = 0.06$). Stocking rate was greater on Florigraze pastures compared with Arbrook (6.3 vs. 5.7 head ha^{-1}) in Year 1, but there were no differences in Years 2 and 3 (Table 4).

There was a trend ($P = 0.12$) toward year × cultivar interaction for gain per hectare, so data were analyzed and are presented by year. This trend occurred because gain per hectare on Arbrook pastures was higher ($P < 0.05$) in Year 2 than on Florigraze swards (616 vs. 592), while in 1996 the opposite was observed (Table 4). The relatively large differences that occurred in Year 3 may be expected into the future if the proportion of rhizoma peanut in Arbrook pastures continues to be lower than for Florigraze.

CONCLUSIONS

On the basis of these results, it is likely that neither herbage mass nor herbage allowance limited animal performance on pastures of either cultivar. Arbrook had more rapid early spring growth, leading to greater herbage mass in the first month of grazing each year. Florigraze had greater CP concentration and IVOMD than Arbrook throughout the 3 yr of the experiment. The proportion of rhizoma peanut in herbage mass decreased by 23% units across the 3 yr for Arbrook pastures compared with three units for Florigraze, suggesting that Arbrook is less tolerant of continuous stocking than Florigraze. Although ADG was not different between cultivars during Years 1 and 2, the large decrease in Arbrook proportion in Year 3 was associated with lower ADG on Arbrook pastures that year. Average stocking rate varied little between cultivars, and gain per hectare was slightly greater (24 kg) for Arbrook than Florigraze in Year 2 but markedly greater for Florigraze than Arbrook (157 kg) in Year 3. On the basis of these data, Florigraze rhizoma peanut appears better suited than Arbrook for pasture programs with continuous stocking. Under this management, it had greater nutritive value, and more importantly, superior persistence. The latter was associated with greater animal gains in Year 3 of the current study. This trend is expected to continue into the future as long as the advantage in percentage rhizoma peanut of Florigraze over Arbrook swards is maintained.

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