PEANUT

No-Till Establishment of Rhizoma Peanut

M. J. Williams,* E. Valencia, and L. E. Sollenberger

ABSTRACT

Planting rhizoma peanut (*Arachis glabrata* Benth.) directly into grass sod may be practical for producers [e.g., cow-calf (*Bos taurus*) production, low maintenance roadside or turf situations, wildlife feed, etc.] who do not need the feed value of pure rhizoma peanut stands. The objective of this study was to determine the effects of planter (no-till vs. conventional sprig planter), ground preparation (undisturbed sod vs. rotovated), planting date (winter vs. summer), and herbicide (glyphosate [*N*-(phosphonomethyl) glycine] vs. none) on the establishment and survival of rhizoma peanut. Planter type had no effect on rhizoma peanut establishment. In 1996 there was a planting date × ground preparation × herbicide interaction due to the winter-planted, rotovated plots without herbicide (0.9 sprouts m^{-2}) having lower sprout counts than any other rotovated treatment at either planting date (>3.4 sprouts m^{-2}). In 1997, only the main effects of planting date and ground preparation and their interaction affected sprout emergence and survival. Final sprout counts were positively correlated with bare ground (r = 0.37). Herbicide suppressed grass in the winter planting only, but did not consistently reduce total ground cover due to increased annual forb cover. There was a ground preparation × herbicide interaction on ground cover of rhizoma peanut (rotovated + herbicide, 22%; rotovated no herbicide, 13%; herbicide not rotovated, 5.9%; and no herbicide not rotovated, 2%). This study indicates that producers can select establishment practices for rhizoma peanut plantings that meet their production goals (clean cultivation establishment for hay production or dairy cattle grazing and sod planting without herbicide for less intensive situations).

Rhizoma peanut is one of the few tropical legumes that combines the desirable characteristics of high nutritive value and long-term persistence under a wide range of grazing management systems (Beltranena et al., 1981; French, 1988; Ocumpaugh, 1990; Ortega-S et al., 1992; Prine et al., 1981). In spite of this, expansion of rhizoma peanut hectarage has been slow since the release of the Florigraze (Prine et al., 1981) and Arbrook cultivars (Prine et al., 1986) by the University of Florida. It is estimated that about 8000 ha of rhizoma peanut have been planted in the Gulf Coast region with most of this area occurring in Florida and Georgia (G.M. Prine, personal communication, 2000).

The cost associated with vegetative establishment is one of the greatest limitations to increased utilization of rhizoma peanut in the Gulf Coast region of the USA. Survival of emerging rhizoma peanut sprouts has proved to be the biggest problem associated with stand establishment. Previous work has indicated that drought stress, particularly in the 3 mo postplanting is one of the main reasons stands fail to establish or establish slowly (Williams, 1993; Williams et al., 1997).

The current recommendation is that rhizoma peanut be established in a clean, prepared plantbed because weedy forbs and grasses compete with establishing rhizoma peanut for moisture (French and Prine, 1991). Additionally, the presence of forbs and grasses reduces the feed value and thus market value of the crop. Several factors suggest that planting rhizoma peanut directly into an established grass sod may be a practical procedure for some uses of rhizoma peanut (e.g., cow-calf production, low maintenance roadside or turf situation, wildlife feed, etc.) that do not need the feed value of pure rhizoma peanut stands (Sollenberger et al., 1989; Williams et al., 1991). The benefits of no-till planting into grass sods include potentially less soil erosion compared with clean-tilled sites; fewer problems with weedy forbs during establishment and throughout the life of the stand (Bennett et al., 1995; Valencia et al., 1999); higher DM yield due to the additive effect of the grass–legume mixture (Valencia et al., 1999; Valentim et al., 1986); and better matching of nutritive value of the pasture or hay to class of livestock (Williams and Chambliss, 1999).

In a plantbed preparation by planting date study (Williams, 1993), no-till planting using conventional sprig planters resulted in fewer sprouts emerging and surviving, which increases the time required to reach adequate levels of rhizoma peanut in the sward. Poor emergence could be largely attributable to failure of sprig planting equipment to adequately cover the rhizomes after planting. Since that time, no-till planters have been developed specifically for use with rhizoma peanut and other vegetatively propagated forage species, but no direct comparison has been made between no-till and conventional planters in sod or clean-tilled sites. The objective of this study was to determine the effect of no-till vs. conventional planters with and without preplant herbicide suppression of existing bermudagrass sod on the establishment and survival of rhizoma peanut planted at two dates.

MATERIALS AND METHODS

The study site was a former bermudagrass hay field at the USDA-ARS Subtropical Agricultural Research Station (STARS), Brooksville, FL (28°37′ N, 82°22′ W) that contained a mixture of 'Callie Giant' and common bermudagrass [*Cynodon dactylon* (L.) Persoon] and bahiagrass (*Paspalum notatum* Flugge). The field had been grazed the previous growing season, but received no N fertilization. The soil type at this site

M.J. Williams, USDA-ARS, Subtropical Agricultural Research Station, Brooksville, FL 34601-4672; E. Valencia, Univ. of Virgin Islands, St. Croix, U.S. Virgin Islands; and L.E. Sollenberger, Dep. of Agronomy, Univ. of Florida, Gainesville. Joint contribution of the USDA-ARS and Florida Agric. Exp. Stn. Journal Series no. R-07956. Received 7 Sept. 2001. *Corresponding author (mjwi@mail.ifas.ufl.edu).

Published in Agron. J. 94:1350–1354 (2002).

was an Arredondo fine sand (loamy, siliceous, hyperthermic Grossarenic Paleudults). In October 1996, split-split plot design with four replicates was used with planting date (winter vs. summer) as the main plot and with preplant herbicide application (herbicide vs. none) as the subplot. Within this split-split plot arrangement, planter type (no-till vs. conventional sprig planter) and ground preparation (undisturbed sod vs. rotovated) were imposed in a factorial arrangement. The whole test was repeated on a separate adjacent area of the field starting in October 1997.

Glyphosate was broadcast-applied at the rate of 2.24 kg a.i. ha^{-1} in 290 L ha^{-1} water in October and July of each year. Designated plots were rotovated 2 wk before the winter (24 Jan. 1996 and 27 Jan. 1997) and summer (15 Aug. 1996 and 1997) planting dates and cultipacked. Individual plot size was 3 by 15 m with 15-m alleys between blocks. Planting material came from a Florigraze rhizoma peanut nursery area (not hayed or grazed for at least 2 yr before digging) at STARS. At planting, rhizoma peanut top growth was removed, if necessary, and rhizomes were dug with a grass-sprig digger the day of planting. A rate of 1260 kg rhizomes ha^{-1} was used for both planters (conventional, Bermuda King, Ardmore, OK; no-till, Spigger's Choice 2000, Grimsley Sprigger Service, Parrot, GA[1]). All plots were cultipacked after planting. After planting, two 1-m^2 plots were permanently marked and emergence based on the number of sprouts per square meter (based on the visual presence of emerging or expanded leaflets not associated with previously emerged leaves) was determined at 2, 4, 6, 8, 10, and 12 wk post planting. Additionally, at 12-wk postplanting, a visual estimate of percent ground cover of grass or grass-like plants, forbs, dead material, and bare ground was estimated for the permanently marked areas. Final percent ground cover of rhizoma peanut based on a visual estimate for the whole plot area for both planting dates was determined in August (18 and 12 mo post planting for winter and summer planting dates, respectively) of the year after planting.

Emergence was analyzed using a split-split-split plot model with repeated measurements (SAS Inst., 1989) with year as the main plot, planting date as the subplot, and herbicide as the sub-subplot. In the initial analysis, the year × rep error term was used to test year effects, planting date and its interaction with year was tested with planting date × year × rep error term, and herbicide and its interaction with year and planting date were tested with herbicide × year × planting date × rep error term. The effect of planter and ground preparation and all appropriate interactions were tested with the residual error term. Final sprout count (number of sprouts at 12 wk after planting); percent grass, forb, dead, total cover (grass + forb + dead), and bare ground; and rhizoma peanut ground cover at 12 to 18 mo after planting was analyzed as a split-split-split model without repeated measures. Appropriate error terms, as outlined for emergence analysis, were used. Pearson's correlation coefficients (PROC CORR; SAS Inst., 1989) were determined for final sprout count and grass or grass-like plants, forbs, dead material, and bare ground. Due to year × planting date × herbicide interactions, data were further analyzed separately by year. In that analysis as appropriate, data were combined if main effects and their interaction terms were not significant ($P > 0.05$).

RESULTS

There were numerous interactions between establishment variables and year ($P < 0.05$) for sprout emergence and final sprout count and data was reanalyzed separately for each year. Differences between years were probably due to differences in moisture and temperature at the winter planting date (Table 1). As seen in previous studies (Williams, 1993; Williams et al., 1997), planting date affected sprout emergence (Fig. 1 and 2), but rhizoma peanut sprouts consistently emerged more quickly after planting ($P = 0.01$) in the summer than winter regardless of year. As in previous studies, variability in final sprout count also was probably due to environmental differences, particularly soil moisture. Drier conditions in the spring of 1997 account for lower final counts than in 1996.

Within years, neither planter type nor its interaction with any of the other establishment parameters tested affected emergence of rhizoma peanut sprouts or final sprout count either year so planter was pooled for further analysis. In 1996, although planting date did not affect final emergence (Fig. 1), there was a planting date × ground preparation × herbicide interaction ($P = 0.01$). The final sprout count in winter-planted, rotovated plots without herbicide treatment was lower than any other rotovated treatment at either planting date in 1996. In contrast in 1997, herbicide did not affect emergence, and there was no planting date × ground preparation × herbicide interaction. Only the main effects of planting date ($P = 0.02$) and ground preparation ($P = 0.001$) and their interaction ($P = 0.005$) affected sprout emergence and survival (Fig. 2).

[1] Names are necessary to report factually on available data; however, the USDA neither guarantees nor warrants the standard of the product, and the use of the name by USDA implies not approval of the product to the exclusion of others that are suitable.

Table 1. Monthly minimum and maximum temperature and precipitation at USDA-ARS-STARS, Brooksville, FL, in 1996 to 1998.

	Min. temp.			Max. temp.			Precipitation		
Month	1996	1997	1998	1996	1997	1998	1996	1997	1998
	°C						mm		
January	8.3	5.4	10.0	20.7	22.3	21.9	123.9	52.1	65.5
February	9.1	7.6	9.3	22.0	26.5	20.6	68.6	25.4	257.8
March	10.0	10.0	10.4	22.0	29.5	22.9	190.5	71.1	147.3
April	14.1	12.7	13.6	27.0	31.8	27.4	89.7	111.8	1.3
May	19.3	17.6	17.8	31.8	30.6	31.5	96.5	59.7	47.0
June	20.5	20.3	22.0	31.4	31.7	35.5	135.8	100.3	22.9
July	22.3	21.4	21.9	32.9	32.8	33.0	52.3	125.7	172.7
August	21.5	21.7	21.5	32.5	33.1	32.0	91.9	105.4	130.8
September	19.3	20.6	22.0	30.8	32.9	29.2	86.9	154.9	214.1
October	17.3	16.0	18.7	29.9	29.4	28.5	67.3	71.4	114.3
November	10.8	10.3	16.3	25.4	23.9	26.1	11.4	85.1	19.0
December	8.7	8.4	13.1	25.6	19.8	25.1	34.3	256.5	24.5

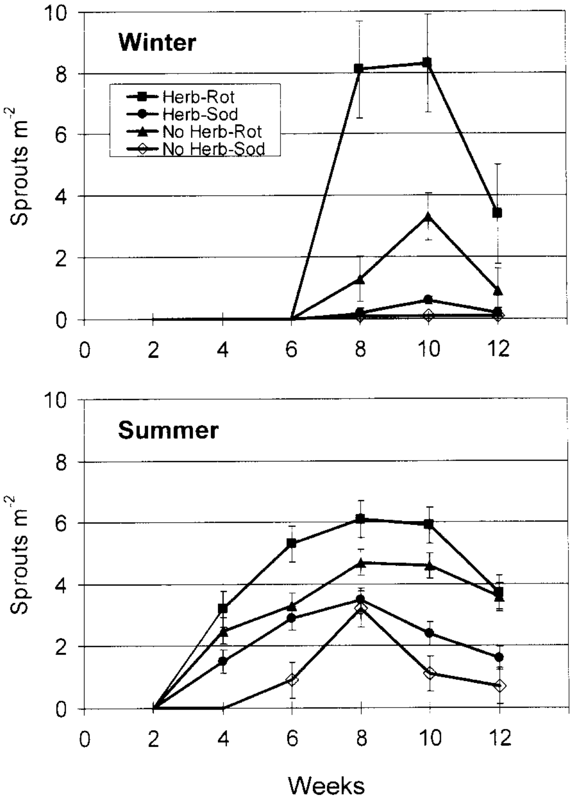

Fig. 1. Effect of planting date, herbicide (Herb), and ground preparation (rotovated [Rot] vs. sod [Sod]) on emergence and final stand count (at 12 wk postplanting) of 'Florigraze' rhizoma peanut in 1996. Winter and summer planting dates were 24 Jan. and 15 Aug. 1996, respectively. Herbicide treatment consisted of glyphosate broadcast at the rate of 2.24 kg a.i. ha^{-1} in 290 L ha^{-1} in October and July of each year. Vertical bars are standard errors.

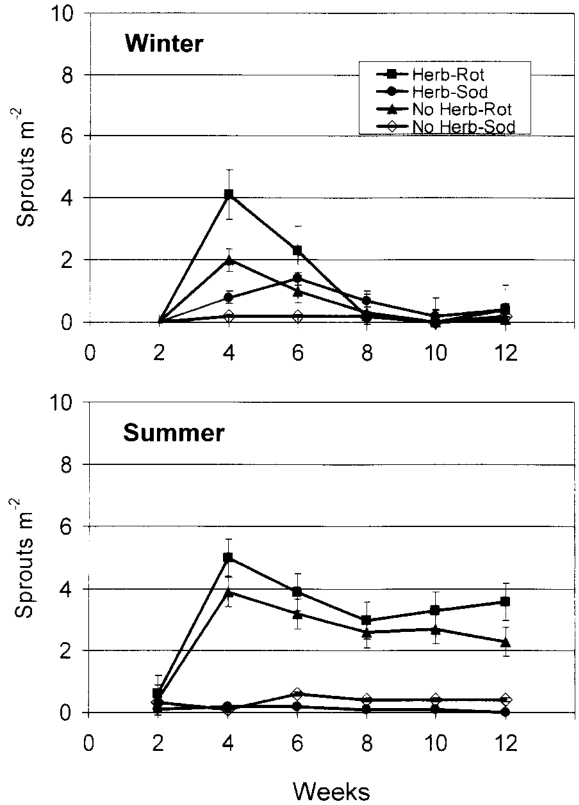

Fig. 2. Effect of plating date, herbicide (Herb), and ground preparation (rotovated [Rot] vs. sod [Sod]) on emergence and final stand count (at 12 wk postplanting) of 'Florigraze' rhizoma peanut in 1997. Winter and summer planting dates were 27 Jan. and 15 Aug. 1997, respectively. Herbicide treatment consisted of glyphosate broadcast at the rate of 2.24 kg a.i. ha^{-1} in 290 L ha^{-1} in October and July of each year. Vertical bars are standard errors.

Ground cover estimates were made to determine the effect planting treatments had on the different types of vegetative cover and their relationship to final sprout counts. There was a year × planting date × ground preparation × herbicide interaction ($P < 0.05$), mainly due to the higher percent ground cover of forbs in the rotovated plots at the winter planting date in 1997 compared with 1996 (Table 2). Warmer temperatures in the spring of 1997 (Table 1) possibly favored germination of winter annual forbs that year, particularly in rotovated plots. Higher amounts of forbs in 1997 account for the higher total cover for that treatment date combination that year. In contrast to 1996, the amount of forbs at the summer planting also was higher in rotovated plots in 1997.

Although both years grass and forb coverages were negatively correlated ($r = -0.64$, $P = 0.0001$, 2 yr avg.), final sprout count was either not correlated or was correlated at low levels with any of the individual vegetative cover estimates (grass, $r = -0.09$, $P = 0.16$; forb, $r = -0.10$, $P = 0.11$; dead, $r = -0.19$, $P = 0.002$, 2 yr avg.). This indicated that grass or forb cover alone did not affect rhizoma peanut emergence. Final sprout count was correlated negatively ($r = -0.37$, $P < 0.0001$, 2 yr avg.) with total ground cover, which included all vegetative fractions.

Due to the relatively consistent final sprout numbers, there were no year or planting date effects on rhizoma peanut cover estimates (2–22%) made 18 mo after winter planting and 12 mo after the summer planting. There was a ground preparation × herbicide treatment interaction ($P < 0.05$). The highest rhizoma peanut ground cover estimate was 22% for the combination of rotovated with herbicide, 13% for rotovated with no herbicide, 5.9% for herbicide not rotovated, and 2% no herbicide not rotovated. Even at the low initial sprout numbers found in this study, the final sprout count at 12 wk postplanting was positively correlated with final percent rhizoma peanut ground cover estimate ($r = 0.53$, $P < 0.0001$) taken by at least 12 mo after planting.

DISCUSSION

Equipment designed for no-till operation did not enhance the establishment of rhizoma peanut in sod. Both planters were equally effective for establishing rhizoma peanut in prepared ground or directly into grass sod. Previous work with conventional sprig planters in no-till situations had shown poorer rhizome placement and variable coverage (Williams, 1993), but such problems were not apparent in this study. This may have been related to the different grass sods used. In the previous work, the sod had been bahiagrass, which forms a stolon mat not present in most bermudagrass stands.

As with previous studies (Williams, 1993), ground prep-

Table 2. Effect of planting date, herbicide, and ground preparation (rotovated vs. sod) on grass, forb, dead, total cover, and bare ground at 12 wk postplanting.

	1996					1997				
Treatment	Grass	Forb	Dead	Total cover†	Bare ground	Grass	Forb	Dead	Total cover	Bare ground
					Winter‡					
Herbicide§										
Rotovated	5.9 a¶	18.1 ns	6.6 a	30.6 a	69.4 b	3.1 a	88.1 b	1.3 a	92.5 b	7.5 a
Sod	21.9 b	28.4	38.4 b	88.4 b	11.6 a	12.5 b	59.4 a	13.4 b	85.3 a	14.7 b
No herbicide										
Rotovated	12.8 a	23.4 ns	8.1 a	44.4 a	55.6 b	25.0 a	58.4 b	1.6 a	85.0 a	15.0 b
Sod	43.7 b	20.9	25.0 b	89.7 b	10.3 a	74.4 b	9.4 a	10.9 b	94.7 b	5.3 a
					Summer					
Herbicide										
Rotovated	28.1 a	22.5 ns	6.3 ns	56.9 a	43.1 b	32.5 a	26.3 b	16.9 ns	75.6 a	24.4 b
Sod	46.5 b	16.6	4.4	67.5 b	32.5 a	60.7 b	8.7 a	27.3	96.7 b	3.3 a
No herbicide										
Rotovated	60.6 a	6.3 ns	0.0	66.9 a	33.1 b	40.6 a	27.5 b	10.6 a	78.7 a	21.3 b
Sod	70.6 b	7.5	0.0	78.1 b	21.9 a	56.5 b	6.5 a	34.7 b	97.6 b	2.4 a

† Total cover = grass + forb + dead.
‡ Winter (24 Jan. 1996 and 27 Jan. 1997) and summer planting dates (15 Aug. 1996 and 1997).
§ Glyphosate broadcast-applied at the rate of 2.24 kg a.i. ha^{-1} in 290 L ha^{-1} water in October and July of each year.
¶ Means in columns for ground preparation within planting date and herbicide combinations followed by the same letter do not differ (Duncan's multiple range test, $P = 0.05$).

aration generally affected total sprout emergence, which on average was two to four times greater in rotovated plots than nonrotovated plots (Fig. 1 and 2). One of the most obvious differences between rotovated and nonrotovated (sod) plots was ground cover. No single component of ground cover (grass, forb, or dead material) explained greater than 20% of the difference in final sprout counts (Table 2). The negative correlation between total ground cover (grass, forb, and dead) and total sprout emergence was only moderate ($r = -0.37$). Although final sprout count was only moderately related to total ground cover, as in previous studies (Adjei and Prine, 1976), rhizoma peanut coverage by at least 1 yr postplanting was enhanced by practices that reduced initial competition (herbicide and rotovation).

Currently, the only herbicides registered for use on rhizoma peanut have 12 mo grazing–haying restrictions, which means they are of limited use in most animal production situations. Glyphosate, which has a general pasture label, was chosen for use in this study as a means of suppressing the competition of the grass sod. Unfortunately, the effect of preplant glyphosate treatment on rhizoma peanut sprout emergence was not consistent, being overly severe in the winter and giving inadequate grass control in the summer. Although live-grass ground cover at summer planting dates ranged from about 30 to 40% compared with <20% for winter planting dates, there was no improvement in sprout emergence. In contrast, late fall herbicide application was detrimental to the survival of existing grass sod. But again, this was not found to be advantageous to rhizoma peanut sprout emergence because of high levels of forb emergence 1 yr (Table 2). The use of herbicides to suppress a grass sward for the establishment of rhizoma peanut should be done cautiously. Under certain environmental conditions, the practice can result in a substitution of competition from forbs instead of grass, with no benefit to rhizoma peanut emergence. Additionally, in most rhizoma peanut production situations, grass is a more desirable component of a mixture than most forbs commonly found in Florida.

Although density of rhizoma peanut sprouts can be quite high (>100 m^{-2}) for dryland plantings in both winter and summer at this location (Williams et al., 1997), this has proved to be the exception rather than the rule. Numerous observations of field plantings and previous research (Williams, 1993) have shown that the low sprout counts in this study (<4 m^{-2}) are typical for dryland plantings at this location. Even these low 12-wk sprout counts were useful for indicating relative rhizoma peanut cover at 12 or 18 mo after planting. The relatively low percent ground cover of rhizoma peanut found the following year is consistent with previous observations (Williams, 1993; Venuto et al., 1997; Williams et al., 1997) that it can take up to 3 yr for rhizoma peanut to successfully establish.

CONCLUSION

Current planter types were found to be equally effective in establishing rhizoma peanut in a prepared plantbed or bemudagrass sod. Preplant treatment of grass sods with herbicide to suppress grass competition may not be beneficial due to the enhanced potential for invasion of forbs. Establishment practices that best ensure rapid development of rhizoma peanut plantings should be selected to fit the production goals (clean cultivation establishment for hay production or dairy cattle grazing and sod planting for beef cattle, roadside, turf, or wildlife situations). Regardless of establishment practices imposed, establishment of rhizoma peanut can be slow, particularly under dryland situations.

REFERENCES

Adjei, M.B., and G.M. Prine. 1976. Establishment of perennial peanut. Proc. Soil Crop Sci. Soc. Fla. 35:50–53.
Beltranena, R., J. Breman, and G.M. Prine. 1981. Yield and quality of Florigraze perennial peanut (*Arachis glabrata* Benth.) as affected

by cutting height and frequency. Proc. Soil Crop Sci. Soc. Fla. 40:153–156.

Bennett, L.L., A.C. Hammond, M.J. Williams, W.E. Kunkle, D.D. Johnson, R.L. Preston, and M.F. Miller. 1995. Performance, carcass yield, and carcass quality characteristics of steers finished on rhizoma peanut (*Arachis glabrata*)–tropical grass pasture. J. Anim. Sci. 73:1881–1887.

French, E.C. 1988. Perennial peanut: A promising forage for dairy herd management in the tropics. p. C20–C41. *In* Proc. Int. Conf. Livestock Tropics, Gainesville, FL. 19–25 June 1988. IFAS, Univ. of Florida, Gainesville.

French, E.C., and G.M. Prine. 1991. Perennial peanut establishment guide. Agronomy facts. SS-AGR-35. Agron. Dep., Univ. of Florida, Gainesville.

Ocumpaugh, W.R. 1990. Production and nutritive value of Florigraze rhizoma peanut in a semiarid climate. Agron. J. 82:179–182.

Ortega-S., J.A., L.E. Sollenberger, K.H. Quesenberry, J.H. Cornell, and C.S. Jones, Jr. 1992. Productivity and persistence of rhizoma peanut pastures under different grazing managements. Agron. J. 84:930–934.

Prine, G.M., L.S. Dunavin, R.J. Glennon, and R.D. Roush. 1986. Arbrook rhizoma peanut, a perennial forage legume. Circ. S-332. Univ. of Florida, Gainesville.

Prine, G.M., L.S. Dunavin, J.E. Moore, and R.D. Roush. 1981. Florigraze rhizoma peanut, a perennial forage legume. Cir. S-275. Univ. of Florida, Gainesville.

SAS Institute. 1989. SAS/STAT user's guide. Version 6. 4th ed. Vol. 1 and 2. SAS Inst., Cary, NC.

Sollenberger, L.E., C.S. Jones, Jr., and G.M. Prine. 1989. Animal performance on dwarf elephantgrass and rhizoma peanut pastures. p. 1189–1190. *In* R. Desroches (ed.) Proc. Int. Grassland Congress, 16th, Nice, France. 4–11 Oct. 1989. The French Grassl. Soc., Versailles Cedex, France.

Valencia, E., M.J. Williams, C.C. Chase, Jr., L.E. Sollenberger, A.C. Hammond, R.S. Kalmbacher, and W.E. Kunkle. 1999. Management effects on herbage yield and botanical composition of rhizoma peanut–mixed grass associations. Agron. J. 91:431–438.

Valentim, J.F., O.C. Ruelke, and G.M. Prine. 1986. Yield and quality responses of tropical grasses, a legume and a grass–legume association as affected by fertilizer nitrogen. Proc. Soil Crop Sci. Soc. Fla. 45:138–143.

Venuto, B.C., W.M. Elkins, R.W. Hintz, and R.L. Reed. 1997. Comparison of seed-derived lines from 'Florigraze' rhizoma peanut. Crop Sci. 37:1098–1102.

Williams, M.J. 1993. Planting date and preplant tillage effects on emergence and survival of rhizoma perennial peanut. Crop Sci. 33:132–163.

Williams, M.J., and C.G. Chambliss. 1999. Rhizoma perennial peanut. p. 49–52. *In* C.G. Chambliss (ed.) Florida forage handbook. Rep. SP253. Univ. of Florida Coop. Ext. Ser., Gainesville, FL.

Williams, M.J., A.C. Hammond, W.E. Kunkle, and T.H. Spreen. 1991. Stocker performance on continuously stocked mixed grass–rhizoma peanut and bahiagrass pastures. J. Prod. Agric. 4:19–24.

Williams, M.J., C.A. Kelly-Begazo, R.L. Stanley, Jr., K.H. Quesenberry, and G.M. Prine. 1997. Establishment of rhizoma peanut: Interaction of cultivar, planting date, and location on emergence and rate of cover. Agron. J. 89:981–987.