Strip-planting Rhizoma Peanut in Existing Bahiagrass Pastures: A Strategy to Include Legumes in Florida’s Forage-livestock Systems

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Placing rhizoma peanut in strips in existing bahiagrass pastures is a viable approach to achieve a grass-legume mixture. Defoliation strategies and weed management during the year of establishment are critical to ensure successful establishment and spread of rhizome peanut into the grass component.

Summary
Novel approaches are needed for overcoming barriers to successful association of herbaceous legumes with grasses in warm-climate pastures and to identify low-cost, long-term solutions to the problem of N limitation in low-input forage-livestock systems. The general objective was to evaluate the viability of planting rhizoma peanut (RP) in strips in existing bahiagrass pastures. The specific objectives were to investigate: 1) defoliation strategies during the year of establishment (Experiment 1), and 2) N fertilization and weed management strategies (Experiment 2) to allow successful establishment and spread of RP. The results indicated that defoliation strategy and weed management are critical to ensure successful establishment of RP when strip-planted. Due to apparent animal preference for forage in the legume-planted strips, production of hay is the best option for utilizing the grass forage during the year of establishment. Single application of imazapic or imazapic + 2,4-D amine offers sufficient control of competition to improve establishment of strip-planted RP, and application of N fertilizer increases RP establishment if grass and weed competition is controlled.

Introduction
Rhizoma peanut (Arachis glabrata Benth.; RP) is a warm-season perennial forage legume that has documented persistence under grazing (Ortega et al., 1992) and ability to compete effectively with perennial grasses in mixed pastures (Williams, 1994). It is high in nutritive value, and in multi-year grazing studies has resulted in gains of yearling beef steers of 2.1 lb/d (nearly pure stands of RP; Sollenberger et al., 1989) and gains of 6- to 12-mo-old dairy heifers of 1.3 lb/d (pasture botanical composition of ~90% RP) (Hernandez Garay et al., 2004). Further, greater animal production (gain/ac) of up to 290 lb has been reported for animals grazing RP compared to N-fertilized (110 lb N•ac⁻¹•yr⁻¹) bahiagrass (Paspalum notatum Flügge) pastures (Sollenberger et al., 1989). The mechanism by which greater animal production occurred was sustained high nutritive value (i.e., crude protein and in vitro organic matter digestibility) of RP compared to bahiagrass, especially in the latter half of the growing season which is typically referred to as the “summer slump” period for tropical grasses in FL.

In addition to its impact on forage nutritive value and increased animal responses, the capacity of RP and other legumes to fix atmospheric N₂ makes them an alternative to expensive inorganic fertilizer as a source of N for grasslands. Thus, use of legumes in general, and RP specifically, should improve the likelihood of long-term pasture persistence while maintaining and/or improving productivity of low-input forage-livestock systems.

Despite demonstrated potential of RP for grazing systems in the southeastern USA, it has not been used widely in pastures. High costs associated with vegetative establishment, management for weeds, and removal of land from grazing to allow adequate time for adequate time for establishment have limited RP

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use primarily to production of high-quality hay for dairy and equine rations.

The overall objective was to investigate the viability of planting RP in strips in existing bahiagrass pastures as a cost-effective approach for achieving mixed pastures without having to undergo costly deep tillage and herbicide applications of the entire pasture. The specific objectives were to investigate: 1) defoliation strategies during the year of establishment (Experiment 1), and 2) N fertilization and weed management strategies (Experiment 2) to allow successful establishment and spread of RP.

Materials and Methods

Experimental Site

The study was conducted for 2 yr (2010 and 2011) at the University of Florida Beef Research Unit near Gainesville, FL. A new area was planted each year with RP. The site was chosen because of available well-established (at least 10 yr) and uniform ‘Pensacola’ bahiagrass pastures and because nearby RP pastures at this site have persisted for 30 yr, indicative of adaptation to the area. Based on recommended target soil pH and fertilization (except N), dolomitic lime (1 ton/ac) and muriate of potash (0–0–60; 53 lb/ac) were applied at the beginning of the growing season each year. Total rainfall was 43.4 and 40.5 in. in 2010 and 2011, respectively. Last freeze events before planting in spring occurred on March 8 and 14 in. 2010 and 2011, respectively. Last freeze events before planting in spring occurred on March 8 and 14 in. 2010 and 2011, respectively.

Land Preparation and Planting

In preparation for strip-planting ‘Florigraze’ RP rhizomes into existing bahiagrass sod, strips were plowed in February with a moldboard plow and heavily disked several times to ensure grass- and weed-free planting area. The strips were 13.3 ft wide and accommodated eight rows of RP, with spacing between rows of 20 in. The first and the last rows of planted RP were 10 in from the undisturbed edge of bahiagrass sod (Fig. 1). Florigraze RP rhizomes were planted using a conventional Bermuda King sprig planter on March 25, 2010 and April 5, 2011. The rhizomes were planted at a rate of 890 lb/ac (packed at ~ 5 lb ft^3) to approximately 2-in. depth. After planting, the plots were cultipacked to ensure adequate soil-rhizome contact. Irrigation was applied during April and May each year such that weekly rainfall plus irrigation equaled the 30-yr average weekly rainfall (0.7 and 0.8 in. per week in April and May, respectively). Defoliation treatments were initiated in June and no further irrigation was provided.

Treatments

For Experiment 1 treatments were: 1) Control (no defoliation of the planted RP strip during the establishment year with adjacent bahiagrass harvested for hay production every 28 d to a 4-in. stubble height; 2) Hay Production (RP strip and adjacent bahiagrass both harvested for hay production every 28 d to a 4-in. stubble height); 3) Simulated Continuous Grazing (pastures grazed weekly throughout the entire growing season to a 6-in. bahiagrass stubble height); and 4) Rotational Grazing (pastures grazed every 28 d to 6-in. bahiagrass stubble height). Bahiagrass stubble height was chosen as a reference point because RP plants were expected to be short early in the establishment period. Each experimental unit was 30-ft. wide × 50-ft long, and consisted of one 13.3-ft wide strip of RP running the length of the plot and bounded on each side by 8.2-ft strips of bahiagrass that also ran the length of the plot.

For Experiment 2 treatments were the factorial combination of two N rates and six weed management strategies. Nitrogen rates were 0 and 45 lb N/ac. Weed management strategies were: 1) Control (no herbicide or mowing in the planted strip); 2) Mowing (entire plot clipped every 28 d to 6-in. stubble height simulating a bahiagrass hay production treatment); and the application of herbicides: 3) Pendimethalin at a rate of 32 fl oz/ac at planting; 4) Clethodim at a rate of 12 fl oz/ac applied when grass weeds were 4- to 6-in. tall; 5) Imazapic at a rate of 4 fl oz/ac when grass or broadleaf weeds were 2- to 4-in. tall; and 6) Imazapic (4 fl oz/ac) mixed with 2,4-D amine at a rate of 8 fl oz/ac when grass or broadleaf weeds were 2- to 4-in. tall. Nitrogen was applied to the entire plot (i.e., both the strip planted with RP and the adjacent bahiagrass). Application of N occurred 2 wk after completion of herbicide treatments (May
The herbicides and rates were based on previous research, and these specific herbicides were chosen because they are the only ones labeled for use in RP pasture in Florida (Ferrell and Sellers, 2012). Pendimethalin is an exception to this criterion and it was included as a treatment because of its use as a pre-plant incorporated herbicide in plantings of annual peanut (Arachis hypogea L.) to manage competition from annual grasses.

Defoliation treatments were initiated 7 wk after sprout emergence began. First sprout emergence occurred 4 wk after planting in both years, so treatments were applied for the first time at 11 wk after planting on June 10, 2010 and June 21, 2012.

Response variables
Canopy cover, frequency, light environment, and spread were measured as indicators of RP establishment success in the strips. Canopy cover of RP was visually estimated using a 10.7 ft² quadrat. The quadrat was divided into 100 cells. Canopy cover was estimated in 20 of the 100 cells per quadrat and the average provided an estimation for each quadrat location. Frequency is a measurement of the extent to which RP is distributed throughout the strip. It was determined on the same dates and at the same quadrat locations used to estimate cover. Frequency was calculated as the percentage out of 20 cells assessed where RP was present. Light environment at the top of the RP canopy was estimated every 28 d during summer and early fall. Light environment represents the percentage of the photosynthetically active radiation (PAR) that reached the top of the RP canopy. Spread was measured once each yr on the day before the last clipping/grazing event of the season. It was defined as the distance from the center of the planted RP strip to the farthest point where identifiable RP plant parts (above ground) were found growing into the adjacent bahiagrass sod.

Statistical analysis
Data were analyzed as repeated measures using PROC GLIMMIX of SAS. Sampling date was considered a repeated measurement with an autoregressive covariate structure. Year and block were considered random effects. Year was considered random because a new set of plots was established each year. Treatments were fixed effects. Mean separations and pre-planned contrasts were done based on the SLICEDIFF and LSMETESTIMATE procedures of LSMEANS in SAS. Treatments were considered different when $P < 0.05$.

Results and Discussion

Experiment 1
Canopy cover and frequency followed the same pattern of response. From July through the remainder of the establishment year, grazing (Rotational or Simulated Continuous) reduced RP canopy cover compared to the Control and Hay Production treatments (Fig. 3). Frequency of RP was 67% for both Control and Hay Production treatments and 21% for both Simulated Continuous and Rotational Grazing by August (Fig. 3). Decreasing RP canopy cover and frequency in the grazing treatments can be attributed to apparent animal preference for RP and the other herbage that occurred in the strips planted to RP. When entering the pasture, animals first grazed closely the RP strips before beginning to graze the adjacent bahiagrass.

Spread was 72 in. for Control and Hay Production treatments, 66 in. for Simulated Continuous Grazing, and 70 in. for Rotational Grazing. The average of the mowed treatments was similar to Rotational Grazing ($P = 0.39$) and 6 in. greater than Simulated Continuous Grazing ($P = 0.02$). Given that the outer row of RP was planted 69 in. from the center of the strip, spread was minimal in the first year in all treatments. Simulated Continuous Grazing actually resulted in loss of plants in the outer row of the strip closest to bahiagrass resulting in a reduction in spread. The results indicate that defoliation management is critical during the year of establishment when strip-planting RP into bahiagrass pastures. Due to apparent animal preference of forage in the legume-planted strips, production of hay is the best option for utilizing the grass forage during the year of establishment. It may be possible to decrease the negative impact of grazing by utilizing rest
periods between grazing events longer than 28 d, but currently there has not been any research done to evaluate this option.

**Experiment 2**

Weed management strategy effects on canopy cover and frequency followed the same pattern of response. Starting in July (2\textsuperscript{nd} sampling date), canopy cover in Imazapic and Imazapic + 2,4-D was not different (20 and 19\%, respectively) and greater than Clethodim (7\%), Pendimethalin (4\%), Mowing (2\%) and Control (4\%). Greatest canopy cover was achieved in August and was similar for Imazapic and Imazapic + 2,4-D (27 and 34\%, respectively) and greater than the other treatments. Cover did not change from July through the remainder of the growing season for treatments which did not receive imazapic, while those receiving imazapic increased (Fig. 2, 4). Greatest frequency was achieved toward the end of the growing season with Imazapic and Imazapic + 2,4-D being not different (67 and 73\%, respectively) and greater than the other treatments which remained below 35\% (Fig. 2, 4).

Broadleaf weeds present in the strips planted to RP were mainly Mexican-tea (*Chenopodium ambrosioides* L.) and Cutleaf Ground-cherry (*Physalis angulata* L.), and they were most prevalent in the Control, Pendimethalin, Mowing, and Clethodim treatments. Also, there was a pronounced shift in weed population pressure to sedges (*Cyperus spp.*) after application of clethodim as opposed to bahiagrass and broadleaf weeds in the Control, Pendimethalin and Mowing treatments.

Nitrogen fertilization increased RP canopy cover and frequency (~10 and 15 percentage points) in Imazapic and Imazapic + 2,4-D treatments, but there was no effect of N on Mowing and a trend toward reduced canopy cover in Control, Pendimethalin, and Clethodim with N application. Light environment was greater (consistently above 96\%) in the treatments where weeds were effectively controlled (Imazapic and Imazapic +2,4-D) compared to Control (77\%), Mowing (81\%), Pendimethalin (75\%) and Clethodim (82\%). Treatment effect on light environment appeared to be a critical factor affecting RP establishment response to N fertilization. The benefits of N application are apparent when control of competition from weeds is suppressed for an extended period, as was the case in the Imazapic and Imazapic + 2,4-D treatments. In contrast, application of N can negatively affect establishment of RP planted in strips when other species are actively competing with RP for light.

There were no weed management strategy effects on spread during either the year-of- or year-after-establishment. Thus, spread was analyzed combining the 2-year data of the corresponding set of plots. Results indicated that on average RP spread 14 in. per year into the adjacent bahiagrass sod.

**Conclusions and Implications**

Due to apparent animal preference of forage in the legume-planted strips, production of hay is the best option for utilizing the grass forage during the year of establishment. It may be possible to decrease the negative impact of grazing by utilizing rest periods between grazing events longer than 28 d, but currently there are no data available to evaluate this option. Additional research is needed to evaluate the potential of longer rest periods between grazing events, and studies are needed to quantify the effect of grazing management during the year after establishment as well as the adaptation of other RP cultivars with different growth habits (i.e., more prostrate) to the strip-planting approach.

Single application of imazapic and imazapic + 2,4-D amine followed by application of 45 lb N\textsuperscript{ac} \textsuperscript{−1} \textsuperscript{·}yr\textsuperscript{−1} has the potential to improve establishment of RP planted in strips, increase bahiagrass dry matter harvested in the unplanted areas cut for hay, and aid in achieving a RP-bahiagrass mixture in the planted strip by the end of the establishment year.

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**Literature Cited**


Figure 1. Rhizoma peanut (RP) planted in strips (13.3 ft wide; RP row spacing is 20 in) into existing bahiagrass pastures (A); RP planting material (rhizomes; B).

Figure 2. Rhizoma peanut planted in strips in existing bahiagrass pastures treated with Imazapic + 2,4-D amine (A); untreated control (B).
Figure 3. Canopy cover and frequency of occurrence of rhizoma peanut planted in strips in existing bahiagrass pastures. Data are averages of 2 yr. Error bars represent treatment means (n = 6) ± one standard error.
Figure 4. Canopy cover and frequency of rhizoma peanut planted in existing bahia grass pastures. Data are means of 2 yr. Error bars represent treatment means (n = 6) ± one standard error.