Potential use of seeded peanuts as warm-season legumes in the U.S. southern Coastal Plains

Final Report for GS14-129

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Graduate Student:

Edwin Mozley

Major Professor:

Dr. Jose Dubeux, Jr.
University of Florida - NFREC

Project Information

Summary:

Rhizoma peanut (*Arachis glabrata* Benth.) is one of the few warm-season perennial legumes available for producers in the southeastern USA. The high cost associated with planting and its slow establishment have reduced producer adoption of this legume. Seeded perennial (*A. pintoi Krapov. & W.C. Greg.*) and annual peanut (*A. hypogea* L.), with proper management, can be viable alternatives. In this project, four peanut entries were evaluated following planting in ‘Pensacola’ bahiagrass (*Paspalum notatum* Flügge) or Tifton-85 bermudagrass (*Cynodon* spp.) sod, in two independent trials. For the 'Pensacola' bahiagrass trial, treatments were: 1) *A. glabrata* cv. Florigraze; 2) *A. glabrata* cv. Ecoturf; 3) *A. pintoi* cv. Amarillo; 4) *A. hypogea* cv. TUFRunner 727; 5) Pensacola bahiagrass with N fertilizer (60 kg N ha^{-1} after each harvest); and 6) Pensacola bahiagrass without N fertilizer. For the Tifton-85 trial, treatments were similar, except for the N fertilization. In both trials, the experimental design was a randomized complete block with four replications. Plots were harvested every 5 wk from May to October 2014, 2015, and 2016. In the Pensacola bahiagrass trial, total dry matter yield was similar among grass-legume mixtures, but greater yields were observed for fertilized bahiagrass. Peanut participation in botanical composition was < 15% with *A. pintoi* presenting less stand (6 plants m^{-1}) than other peanuts (13 plants m^{-1}). Grass in vitro digestibility (IVOMD) was affected by mixture, with bahiagrass IVOMD ranging from 498 to 525 g kg^{-1}. *Arachis pintoi* presented lower IVOMD (610 g kg^{-1}) compared with an average of 700 g kg^{-1} for the other peanuts. Bahiagrass fertilized with N had greater herbage N concentration (19 g kg^{-1}) compared with an average of 15 g kg^{-1} for bahiagrass from other treatments. TUFRunner N concentration (31 g kg^{-1}) was greater compared with an average of 25 g kg^{-1} from other peanuts. Inclusion of forage peanut improved herbage nutritive value but did not increase yield. Nitrogen fertilization provided greater biomass yield and improved bahiagrass N concentration over that of grass-peanut mixtures. In the Tifton-85 trial, mixtures (306 kg DM ha^{-1} $harvest^{-1}$) yielded more (P = 0.008) than unfertilized grass plots (200 kg DM ha^{-1} $harvest^{-1}$) in 2015. Weed control was problematic and reduced yields in 2015, but in 2016 Ecoturf followed by Florigraze mixtures produced greater biomass than other treatments because of greater legume yields. In three out of four evaluations, N concentration was greater for *A. hypogea* (average of 30 g kg^{-1}) compared with *A. glabrata* cultivars (average of 25 g kg^{-1}). Grass yield was similar among treatments (P > 0.05), but grass N concentration was greater when mixed with *A. glabrata* compared with *A. pintoi* (16.8 vs. 14.8 g kg^{-1}, respectively). Because of the small contribution of legume to the swards, biological N_2-fixation by shoots was negligible in the first year, but it increased in the second year, particularly for *A. glabrata* mixtures. In hay systems with low N inputs, mixtures of *Arachis glabrata* and Tifton 85 bermudagrass performed better than seeded peanut or unfertilized Tifton85 bermudagrass.

Introduction

N fertilization is one of the largest expenses in forage based cow-calf production systems, in addition to being the most common limiting factor in their forage productivity. Decreasing the N fertilizer requirements of pastures would reduce the carbon footprint of cattle production, as well as increasing the economic benefit reaped by producers. According to Lal (2004), carbon emissions due to the production, transportation, storage, and distribution of N fertilizers can range from 3.3-6.6 kg CO_2 equivalent per kg of N produced. Currently, many producers are limiting N application in efforts to reduce cost, and some are seeing grassland degradation from the lack of this limiting factor. The integration of mixed legume/grass stands could greatly decrease this expense to Florida farmers, and increase overall productivity of their operations at the same input level. There are currently few warm-season legumes available to Florida farmers, with perennial peanut (*Arachis glabrata* Benth.) being the most successful. Slow and costly establishment has served as the greatest barrier to its widespread adoption, as it is vegetatively propagated and typically requires two years for full establishment before producing significant returns.

Though N is the most abundant element in the atmosphere, it must be reduced to be useable by plants. N fixing legumes have a symbiotic relationship with bacteria that actively reduce atmospheric N_2 to NH_4, which is useable by plants for protein synthesis and growth. Therefore, an easily established, perennial warm-season legume that tolerates grazing and hay harvesting would greatly reduce the need for N fertilization in Florida cattle production systems. Pinto peanut (*Arachis pintoi*) is propagated by seed, and is perennial in its native regions in Brazil and in other regions of South America and Australia where it has been introduced, where it is heavily used in grazing systems. Seed propagation and perennial persistence are two key traits that could allow Pinto peanut to be used widely in the southern US, especially when used in mixed stands in existing bahiagrass pastures. Annual peanut (*Arachis hypogea*) is planted widely in Florida Panhandle and producers have skills and equipment for establishment. If proper grazing/harvesting management practices are used to allow the annual peanut to set pods to maturity, a seed bank might be created allowing the peanut to reseed in the following growing season. Legume propagation by seed (*A. pintoi* and *A. hypogea*) might be an option to alleviate planting costs and for faster establishment. It may also promote the forage seed industry in southeast USA.

Perennial warm-season legumes combined with perennial warm-season grasses (e.g., pinto peanut/bahiagrass), is a potential system to explore for cattle production in North Florida. This system would both reduce N fertilization requirements as well as increasing total crude protein content of the forage, thereby reducing the land area needed per animal unit due to the increased quality of forage. By fixing atmospheric nitrogen, less commercial fertilizer will be required for equal levels of production, and increased production in many scenarios where no N is typically applied.

Project Objectives:

The general objective of this proposal was to evaluate the potential use of different peanuts (*A. glabrata*, *A. hypogea*, *A. pintoi*) associated to two warm-season grasses (Pensacola bahiagrass and Tifton-85). Specific objectives included the determination of forage yield, botanical composition, stand, nutritive value, N biological fixation by the legumes and transfer to associated grass, reseeding potential of seeded peanuts. The establishment of peanut into existing forage production systems in Florida should 1)decrease the need for N fertilization, 2)increase economic and biological efficiency, 3) increase biodiversity, and 4) increase overall economic and ecological sustainability of these systems.

Cooperators

- Dr. Ann Blount

  paspalum@ufl.edu

  Professor

  UF/IFAS - NFREC

  3925 Highway 71
  Marianna, FL 32446

  (850) 394-9124 (office)

- Dr. Nicolas DiLorenzo

  dilorenzo@ufl.edu

  Assistant Professor

  3925 Highway 71
  Marianna, FL 32446

  (850) 394-9124 (office)

- Dr. Cheryl Mackowiak

  echo@ufl.edu

  Associate Professor

155 Research Road
Quincy, FL 32351
(850) 875-7100 (office)

- Dr. Lynn Sollenberger

  lesollen@ufl.edu
  Research Foundation Professor of Grassland Science
  University of Florida
  3111 McCarty Hall B
  Gainesville, FL 32611
  (352) 273-3420 (office)

- Dr. David Wright

  wright@ufl.edu
  Professor
  UF/IFAS - NFREC
  155 Research Road
  Quincy, FL 32351
  (850) 875-7100 (office)

Research

Materials and methods:

Two experiments were established at NFREC in Marianna. The first experiment was carried on Pensacola bahiagrass (*Paspalum notatum* Flugge) and the second one on Tifton-85 bermudagrass (*Cynodon* spp.). The overall goal was to compare different peanut species/varieties established on these two warm-season grasses. Treatments consisted of legume species/cultivar establishment onto grass sod, as follows: 1) *Arachis glabrata* cv. Florigraze; 2) *Arachis glabrata* cv. Ecoturf; 3) *Arachis pintoi* cv. Amarillo; 4) *Arachis hypogea* cv. Tufrunner 727; 5) grass only without N fertilizer. For the bahiagrass trial, we added an extra treatment (Bahiagrass + 60 lbs N/A after each harvest Each experiment was carried under a complete randomized block design, with four replications per treatment. The experimental unit measured 6 x 12 m. Perennial peanut (Florigraze and Ecoturf) was planted at a rate of 80 bushels of rhizomes per acre. Rhizome sprigs were dug and planted in the same day using a 4-row planter with 28” spacing between rows. After planting the rhizomes, the area was cultipacked using a brillion cultipacker. Seeded peanuts were strip-planted at the same spacing (28” per row) and four seeds per linear foot. The Pensacola bahiagrass was already established and the Tifton-85 was planted in the same date of the perennial peanut establishment, using the same 4-row planter already described and applying 40 bushels per acre of rhizomes. During the legume establishment, bahiagrass growth was suppressed using one single application of Impose at 4 oz/A.

Response variables measured in both experiments included dry matter yield, botanical composition, soil coverage, peanut stand, peanut height, annual peanut reseeding potential, total N, ^{15}N, and IVOMD. Total N and ^{15}N analyzes were performed in the grass and legume components individually, in order to estimate N biological fixation of the legume and N transfer from legume to grass using the approach described by Unkovich et al. (2008). Undestructive measurements (stand, height, soil cover, and botanical composition) was initiated 56 days after peanut planting and continued every 35 d thereafter. The experimental period included three growing seasons (2014, 2015, and 2016). Herbage mass was measured every 35 days by harvesting a 5 x 10 ft. strip within the experimental unit. The botanical composition in each plot was determined by hand-separating the botanical components after each harvest. Soil cover was estimated visually by two observers by placing a 1-m^2 quadrat (0.5 x 2 m) divided into 100, 10- by 10-cm squares. Data was averaged across the 20 squares per observer in a given plot and then across observers to give an overall average for the plot (Interrante et al., 2009). Peanut stand was determined by counting peanut plants in a 1-m line randomly located at the plot. Peanut height was determined by taking 10 ruler measurements on each plot, every 35 d. Data was analyzed as repeated measurement using proc mixed from SAS. LSMEANS will be compared using PDIFF adjusted by Tukey at 5% probability.

Research results and discussion:

Pensacola bahiagrass trial:

Total dry matter yield was similar among grass-legume mixtures, but greater yields were observed for fertilized bahiagrass. Peanut participation in botanical composition was < 15% with *A. pintoi* presenting less stand (6 plants m^{-1}) than other peanuts (13 plants m^{-1}). Grass in vitro digestibility (IVOMD) was affected by mixture, with bahiagrass IVOMD ranging from 498 to 525 g kg^{-1}. *Arachis pintoi* presented lower IVOMD (610 g kg^{-1}) compared with an average of 700 g kg^{-1} for the other peanuts. Bahiagrass fertilized with N had greater herbage N concentration (19 g kg^{-1}) compared with an average of 15 g kg^{-1} for bahiagrass from other treatments. TUFRunner N concentration (31 g kg^{-1}) was greater compared with an average of 25 g kg^{-1} from other peanuts. Inclusion of forage peanut improved herbage nutritive value but did not increase yield. Nitrogen fertilization provided greater biomass yield and improved bahiagrass N concentration over that of grass-peanut mixtures.

Tifton-85 bermudagrass trial:

Mixtures (306 kg DM ha^{-1} $harvest^{-1}$) yielded more ($P = 0.008$) than unfertilized grass plots (200 kg DM ha^{-1} $harvest^{-1}$) in 2015. Weed control was problematic and reduced yields in 2015, but in 2016 Ecoturf followed by Florigraze mixtures produced greater biomass than other treatments because of greater legume yields. In three out of four evaluations, N concentration was greater for *A. hypogea* (average of 30 g kg^{-1}) compared with *A. glabrata* cultivars (average of 25 g kg^{-1}). Grass yield was similar among treatments ($P > 0.05$), but grass N concentration was greater when mixed with *A. glabrata* compared with *A. pintoi* (16.8 vs. 14.8 g kg^{-1}, respectively). Because of the small contribution of legume to the swards, biological N_2-fixation by shoots was negligible in the first year, but it increased in the second year, particularly for *A. glabrata* mixtures. In hay systems with low N inputs, mixtures of *Arachis glabrata* and Tifton 85 bermudagrass performed better than seeded peanut or unfertilized Tifton85 bermudagrass.

Participation Summary

Educational & Outreach Activities

PARTICIPATION SUMMARY:

Education/outreach description:

This project was included in the annual field days that we hosted at UF/IFAS NFREC Beef and Forage Field Days in 2014, 2015, and 2016. We had an average of 120 producers attending each year, therefore, the outreach for these events was approximately 360 producers. We also presented the results in the rhizoma peanut annual field days in 2015 (Marianna) and 2016 (Quincy), with approximately 100 producers per event. In addition, we presented our results in County Extension Talks and In Service Training for extension personell that occurred during the duration of the project. Finally, graduate students and interns had the opportunity to develop the research and value the importance of grass/legume mixtures. The final results will be presented by the graduate student David Jaramillo in the National Agronomy Meeting (ASA-CSSA-SSSA) in November 2016 held in Phoenix, AZ.

Project Outcomes

Project outcomes:

Results obtained in this project have a potential significant impact in sustainable livestock production in the Gulf Coast Region. Integrating rhizoma peanut and/or seeded peanut into warm-season perennial grasses such as bahiagrass and bermudagrass showed as a viable option to reduce N fertilization and to improve forage nutritive value. Considering that bahiagrass is planted in approximately 2 million acres in Florida and 4 million acres in SE USA, there is a great potential to promote the integrated system. Bermudagrass is also widely cultivated as a hay crop in SE USA and integrating forage legumes in bermudagrass hay fields can be a valued management practice to reduce N fertilizer inputs.

Economic Analysis

We haven't performed a full economic analysis, but integrating rhizoma peanut into warm-season perennial grass pastures might cost approximately US$ 300-400 per acre, using a strip-planting approach. Under grazing conditions, results from other ongoing project indicates that livestock perform at least 40% better in mixed rhizoma peanut/bahiagrass pastures (1.4 lbs/head/d) compared to bahiagrass monoculture (1 lb/head/d). This improved performance, considering an average stocking rate of 1.5 steers/A and 180 grazing days in the warm-season pastures, would cover the establishment cost in approximately 3 years, assuming US$1.2/lb of livestock weight. These systems are long-lived and perennial, therefore, policies should be put in place to help producers to establish these mixtures. Results would be more sustainable livestock systems in SE USA.

Farmer Adoption

Several producers have been in contact with us at UF/IFAS NFREC regarding the use of rhizoma peanut in their systems. After field days (Beef and Forage Field day and Perennial Peanut field days), a significant (> 40%) proportion of the producers indicated in the exit survey that they want to incorporate legumes in their production system. Recently we have been working with governmental agencies such as NRCS and Basin Management Committees in order to promote the system and try to include in the EQIP program. We will continue working on this area and will submit proposals to develop on-farm projects measuring livestock gains. We believe this would be a powerful way to show producers how better livestock can perform on mixed grass/legume pastures, reducing the cost of N fertilization.

Recommendations:

Areas needing additional study

We learned how to establish these integrated rhizoma peanut/warm-season grasses. Now the next step is trying to get livestock performance data on producer's sites. The information generated from such a project would be a powerful way to disseminate the technology.