Clover-annual Ryegrass Mixtures to Extend the Grazing Season in North Florida

E.R.S. Santos[1], H.M.S. Silva[1], A.C.C. Melo[1], M. Ruiz-Moreno[1], A. Blount[1], C. Mackowiak[1], N. DiLorenzo, L. E. Sollenberger[2], J.C.B. Dubeux Jr[1]

Synopsis

Legumes can be a source of nitrogen for grasses when mixed in a system. The utilization of cool-season legumes in mixtures with annual ryegrass pastures can increase the total forage mass, improve animal performance, and extend the grazing season.

Summary

Symbiotic association between forage legumes and N_2-fixing microorganisms reduces the need for pasture N fertilization and increases forage N concentration. Pastures of cool-season legumes mixed with annual ryegrass are an option to extend the grazing season in subtropical regions. We investigated the association of four cool-season legumes with annual ryegrass and contrasted these mixtures with annual ryegrass in monoculture. Clovers tested included: balansa, ball, berseem, and crimson. Treatments were replicated 4 times in a randomized complete block design. Response variables analyzed included total dry matter yield (DMY), clover DMY, annual ryegrass DMY, ^{15}N grass, ^{15}N legume, botanical composition, N concentration of grass and legume components, shoot N yield for grass and legume, percentage of N derived from atmosphere (%Ndfa), and N_2-fixation by the legume. Legume-annual ryegrass mixtures yielded more biomass (average of 2,310 lb of DM/acre) compared with unfertilized annual ryegrass (870 lb DM/acre). Among mixtures, crimson clover-annual ryegrass was the most productive (4,090 lb DM/acre). Crimson (1,990 lb DM/acre) and berseem (1,530 lb DM/acre) clovers were the most productive legumes. Annual ryegrass yielded more biomass when mixed with crimson clover compared with other clovers. Clover percentage in the mixtures ranged from 26 to 74%, with berseem showing the highest proportion. Total shoot N yields were 26, 37, 44, 78, and 10 lb N/acre for balansa, ball, berseem, crimson, and unfertilized ryegrass, respectively. The %Ndfa for all clovers was high, varying from 67 to 98%. N_2-fixation ranged from 10 to 46 lb N/acre, with crimson fixing the greatest amount. Crimson clover presented the best overall performance when mixed with annual ryegrass in North Florida.

Introduction

Legumes are known for their capability of associating with bacteria for fixing atmospheric N_2 (Russelle, 2008). Legumes provide carbon to bacteria and benefit from the nitrogen that these microorganisms can fix from the atmosphere. Fixed nitrogen can become available to associated grasses via nodule exudation, litter decomposition, and animal excreta, if used in a grazing system.

Mixtures of legumes and grasses can increase farm profitability and provide environmental services. In addition to fixing atmospheric N_2, legumes have greater digestibility and crude protein concentration than grasses, which can improve animal diet and consequently animal production. Grass-legume mixtures have potential to mitigate greenhouse gas emissions if compared with industrial N fertilizer due to less CO_2 emission from fossil fuels in the former (Lal, 2004). In addition, methane emission by livestock might be reduced in diets containing forage legumes due to greater digestibility. Finally, nitrous and nitric oxide

---

[1]University of Florida/IFAS – North Florida Research and Education Center, 3925 Highway 71, Marianna, FL.
[2]University of Florida/IFAS – Agronomy Department, Gainesville, FL.

emissions are greater after N fertilization (Bouwman et al., 2002; cited by Sollenberger, 2014). Refer to paper for comment.

In Florida, agriculture plays an important role for the state income, and it is the state's second largest industry. Warm-season grasses such as bahiagrass (*Paspalum notatum* Flugge) and bermudagrass (*Cynodon dactylon*) are the forage crops most used for grazing and hay. However, these plants are sensitive to cold temperatures, short days, and they are dormant during the cool season.

Ryegrass is a cool-season grass that is broadly used in Florida during the late winter and spring. Introduction of cool-season legumes into ryegrass pastures may be a tool to increase forage production, animal product, and provide environmental services while adopting a low input sustainable system. The genus *Trifolium* has a number of species that are well adapted to Florida environments and can be used for grazing.

Therefore, a study was conducted to evaluate the association of balansa clover (*Trifolium michelianum* Savi), ball clover (*Trifolium nigrescens* Viv.), berseem clover (*Trifolium alexandrinum* L.), and crimson clover (*Trifolium incarnatum* L.) with ryegrass in contrast with ryegrass in monoculture.

Materials and Methods

The experiment was conducted at North Florida Research and Education Center, Marianna, FL. In order to stablish the trial, soil samples were collected and fertilization followed the UF/IFAS Standardized Fertilization Recommendations for Agronomic Crops (Mylavarapu, 1997).

Treatments were the four species of clover planted in association with ryegrass. Tested clover species included balansa, ball, berseem, and crimson. In addition, a ryegrass monoculture was added as a control (Figure 1).

Seeding rates were 30 lb/acre for ryegrass in monoculture and 20 lb/acre for ryegrass in the mixtures. Seeding rates for ball clover, balansa clover, berseem clover, and crimson clover were 3, 6, 15, and 20 lb/acre, respectively. The plots measured 6 x 20 ft and were established in a randomized complete block design with 5 treatments and 4 replicates. Yield samples were taken on April 10, 2014, by harvesting two 2.7 sq. ft. quadrats per plot at a 2-inch stubble height. Samples were dried at 131°F for 72 h after sampling.

Response variables included total dry matter yield (DMY), clover DMY, annual ryegrass DMY, ^{15}N grass, ^{15}N legume, botanical composition, N concentration of grass and legume components, shoot N yield for grass and legume, percentage of N derived from atmosphere (%Ndfa), and N_2-fixation by the legume. The proportion of nitrogen derived from atmosphere was determined by using the equation described by Unkovich et al. (2008).

Data were analyzed by using the Proc Mixed from SAS and means were compared using PDIFF adjusted by Tukey ($P<0.05$). Treatments were considered fixed effects, and the random effects included blocks and its interaction with fixed effects.

Results

There was a significant difference among treatments for total DMY ($P<0.0001$). Annual ryegrass-crimson clover mixture yielded 4,090 lb DM/acre, and it was the treatment with the greatest production. The mixtures with balansa clover (1,550 lb DM/acre), ball clover (2,090 lb DM/acre) and berseem clover (2,030 lb DM/acre) did not differ from each other, however all of them were better when compared to the annual ryegrass monoculture (870 lb DM/acre, Table 1).

Crimson clover and berseem clover made the greatest contribution to the total DMY. They produced 1,990 and 1,530 lb DM/acre, respectively, and were significantly different (*P*<0.0001) from the contribution of balansa and ball clovers (420 and 540 lb DM/acre, respectively). Also, the annual ryegrass DMY (1,960 lb DM/acre) was influenced by the presence of crimson clover (*P*<0.0006), and ryegrass DMY was greater in association with crimson than with the other clovers or in monoculture (Table 1).

Total N yield did not differ among clover varieties, and the values ranged from 78 lb/acre for crimson clover to 26 lb/acre for balansa clover. The %Ndfa was greater in annual ryegrass-balansa clover and annual ryegrass-crimson clover mixtures, 98% and 95%, respectively. Biological N_2-fixation was greater for crimson clover (*P*<0.0001), with 46 lb/acre of N fixed, followed by berseem clover with 32 lb/acre. Balansa and ball clover did not differ from each other, fixing 12 and 10 lb/acre, respectively.

Conclusions

Annual ryegrass dry matter yield increased when it was grown in mixtures with cool-season clovers compared with when it grew alone with no N fertilizer. The N_2-fixation by clovers ranged from 10 to 46 lb N/acre. Among the clovers, crimson clover presented the best overall performance when mixed with annual ryegrass in North Florida. The annual ryegrass-clover mixtures are an alternative to N-fertilized systems, adding N to the system and improving livestock nutrition.

Literature Cited

Bouwman, A.F., et al. 2002. Global Biogeochemical Cycles 16:6-1 – 6-13. DOI: 10.1029/2001GB001811.
Lal, R. 2004. Environment International. 30:981-990.
Mylavarapu, R., et al, G. UF/IFAS Standardized Fertilization Recommendations for Agronomic Crops. UF/IFAS extension, 1997.
Russelle, M.P. 2008. p. 281-359. In: Nitrogen in Agricultural Systems (Agronomy Monograph 49). American Society of Agronomy, Crop Science Society of America, Soil Science Society of America. Madison, WI.
SAS Institute. 1996. SAS statistics user's guide. Release version 6. SAS Inst., Cary, NC.
Sollenberger, L.E. 2014. *In* Proc. Brazilian Soc. Animal Sci. Mtg., 51st, Barra dos Coqueiros, Brazil. 29 July-1 Aug. 2014. Sociedade Brasileira de Zootecnica, Brasilia, Brazil.

Figure 1. Demonstration of experimental area at UF/IFAS – NFREC, Marianna, FL.

Table 1. Total dry matter yield (DMY), clover DMY, and annual ryegrass DMY in different ryegrass-clover mixtures.

Treatments	Total DMY, lb/ac	Clover DMY, lb/ac	Ryegrass DMY, lb/ac
Ryegrass-Balansa Clover	1,550[b]	420[b]	1,040[b]
Ryegrass-Ball Clover	2,090[b]	540[b]	1,490[b]
Ryegrass-Berseem Clover	2,030[b]	1,530[a]	4,80[b]
Ryegrass-Crimson Clover	4,090[a]	1,990[a]	1,960[a]
Unfertilized Annual Ryegrass	870[c]	---	850[b]
SE	247	201	173
P	< 0.0001	<0.0001	0.0006

[a,b,c]Means in a column with different superscripts differ, $P<0.05$

Table 2. Total nitrogen yield, % of nitrogen derived from atmosphere, and nitrogen fixation in different ryegrass-clover mixtures.

Treatments	Total N Yield, lb/ac	Ndfa, %	N Fixation, lb/ac
Ryegrass-Balansa Clover	26[b]	98[a]	12[c]
Ryegrass-Ball Clover	36[b]	67[c]	10[c]
Ryegrass-Berseem Clover	44[a]	86[b]	32[b]
Ryegrass-Crimson Clover	78[ab]	95[a]	46[a]
Unfertilized Annual Ryegrass	10[c]	---	---
SE	6	2	4
P	< 0.0001	< 0.0001	< 0.0001

[1]Nitrogen derived from atmosphere

[a,b,c]Means in a column with different superscripts differ, P<0.05