FERTILIZER VERSUS LEGUME NITROGEN FOR TROPICAL GRASS-LEGUME ASSOCIATIONS[1]

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Abstract

The effects of fertilizer nitrogen and legume nitrogen on yield and quality of three tropical grasses, a legume and grass-legume associations was evaluated in 1984 and 1985. The grasses were of 'Pensacola' bahiagrass (Paspalum notatum Flugge.), Tifton 'Hybrid-81' bermudagrass [Cynodon dactylon (L.) Pers.], and 'Survenola' digitgrass (Digitaria X umfolozy Hall) and the legume was 'Florigraze' rhizoma peanuts (Arachis glabrata Benth.). Nitrogen fertilization resulted in increased yields of high quality forage in pure stands of tropical grasses. The association of tropical grasses with rhizoma peanuts resulted in increased crude protein content of the grass component and increased yields of higher quality forage in the associations. The ability of tropical grasses to compete with rhizoma peanuts was substantially increased by N fertilization, resulting in balanced associations of the legume with bermudagrass and digitgrass.

Introduction: Nitrogen is a nutrient widely used in the grassland areas of the world. Forage production in Puerto Rico (Vicente-Chandler et al., 1974) is based on a high level of nitrogen fertilization (up to 1600 kg/ha/year). However, in Australia, phosphorus is used to fertilize legumes, which in turn fix atmospheric nitrogen via the symbiotic association with the Rhizobium bacteria (Beaton and Berger, 1974). Grassland systems based respectively on legume and fertilizer nitrogen (N) each have their particular uses, advantages and disadvantages. According to Russel et al. (1974), the decision whether to use legume or fertilizer nitrogen depends upon the returns that can be expected from each source.

There is little doubt that legumes, as a cheap source of N and for their superior quality, will continue to form the basis of pasture improvement in many parts of the world. Indeed, it is possible to predict with some confidence that there will be an increased use of legumes following introduction, agronomic, and animal production studies. Nitrogen fertilized pastures with their more predictable higher yields, are likely to remain the basis of some intensive livestock systems.

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Replacing fertilizer N sources with N derived from forage legumes is receiving increasing interest around the world, especially in the North American agriculture. The potential for savings of energy is immense, and likewise the potential for reducing production costs.

The objective of this study was to compare the effects of fertilizer nitrogen and legume nitrogen on yield and quality of tropical grasses, a tropical legume, and mixtures of the legume and grasses.

Materials and Methods: This research was conducted on the University of Florida Agronomy Farm, Gainesville, Fla. The soil of the area is classified as Arredondo loamy fine sand (a loamy, siliceous, hypertermic Grossarenic Paleudult).

The experimental design was a split-plot with repeated measurements. The main plot treatments consisted of 'Pensacola' bahiagrass (*Paspalum notatum* Flugge), Tifton 'Hybrid-81' bermudagrass [*Cynodon dactylon* (L.) Pers.], 'Survenola' digitgrass (*Digitaria* X *umfolozi* Hall), and 'Florigraze' rhizoma peanut (*Arachis glabrata* Benth.) in pure stands and the association of the grasses with the legume. The subplot treatments were made up of three levels of N fertilization (0, 134, and 268 lbs/A/year) applied in the form of NH_4NO_3 in three split applications, one in early spring (April) and following the first and second harvests (June and August).

The forage species were established in 1983 and evaluated in 1984 and 1985. Rhizoma peanuts was planted in Feb.1983 at the planting rate of 80 bushels per acre of rhizomes as recommended by Prine *et al.* (1981) to achieve a fast and complete coverage by the end of the first season. The grasses were planted in June 1983 using vegetative material.

The subplots were harvested at intervals of 6 to 8 weeks (June, August and October). At each harvest a strip 3 ft. wide and 15 ft. long was cut to a 1.5 inch stubble height from the center of the subplots (50% over the legume row and 50% over the grass row in the associations) for dry matter yield determinations. A sub-sample was frozen and later separated into grass, legume and weeds, according to the treatment. Actual botanical composition was determined as the percentage of each component in the total dry weight of forage.

The grass and legume components of the sub-samples were ground in a Wiley mill to pass a 1mm mesh screen prior to analysis. Nitrogen content was determined by aluminum block digestion of plant material (Gallaher *et al.*, 1975), followed by automated determination of total N by a Technicon Autoanalyzer. Percent crude protein (CP) was computed by multiplying percent N x 6.25. Percent *in vitro* organic matter digestibility (IVOMD) was determined by a Tilley and Terry (1963) procedure as modified by Moore and Mott (1974).

Results and Discussion: When the species were grown in pure stands with no nitrogen fertilizer supplied, DM yields were highest for rhizoma peanuts and lowest for digitgrass. Application of nitrogen had no consistent effect on DM yields of rhizoma peanuts in pure stands. When 134 lbs/A/year of nitrogen was supplied to the grasses in pure stands it resulted in 73%, 88%, and 300% increase in DM yields of bahiagrass, bermudagrass, and digitgrass respectively. Further increase in the level of nitrogen fertilization to 268 lbs/A/year resulted in smaller increases in DM yields. Among the grasses in pure stands over all nitrogen levels bermudagrass was the highest yielding species (Table 1).

Over all nitrogen levels, the association of the grasses with the legume resulted in reduced DM yields of both components of the mixtures when compared to pure stands due to plant competition. However, total herbage produced by the associations was higher when compared with the species in pure stands. This indicates a more efficient utilization of light , nutrients and moisture, reflecting the differences in canopy and root structure of the legume and grasses in association (Table 1).

Application of nitrogen fertilizer had no consistent effect on DM yield of bahiagrass-rhizoma peanuts associations. However, when N was applied to bermudagrass and digitgrass in association with rhizoma peanuts it resulted in a consistent increase in DM yields of the grass component. Consequently, the legume growth was reduced, resulting in a smaller contribution to total herbage produced by the associations. (Table 1).

The crude protein content of the herbage produced by the grasses in pure stands with no N fertilizer was at or below 7%. However, when the grasses were associated with rhizoma peanuts with no N added the crude protein content of the grass component in the associations was above 7%. Application of increasing levels of N reflected in increased crude protein content of the grasses in pure stands and in association with rhizoma peanuts (Table 2).

Although bermudagrass and digitgrass in pure stands fertilized with nitrogen produced higher DM yields than rhizoma peanuts, pure stands of the legume produced equal or higher crude protein yields. Crude protein yield of rhizoma peanuts without N fertilizer was equivalent to crude protein yield of bermudagrass fertilized with 268 lbs/A/year (Table 3).

The results of this experiment indicate that nitrogen fertilization is essential to obtain high yields of high quality forage from grass pastures. Rhizoma peanuts can supply nitrogen to the associated grasses. However, due to the slow establishment of rhizoma peanuts, it is necessary to apply fertilizer N initially to guarantee the establishment of the grasses. This early nitrogen fertilization also stimulates the growth of the rhizoma peanuts, resulting in higher DM yields in the first growing season after establishment. The association of rhizoma peanuts with tropical grasses reflected in increased crude protein content of the grass component and the production of high yields of high quality forage. The ability of the tropical grasses to compete with rhizoma peanuts was substantially increased by N fertilization, resulting in balanced associations of the legume with bermudagrass and digitgrass. Rhizoma peanuts showed the ability to compete successfully with weeds and the grasses even at high levels of N fertilization.

Literature Cited:

Beaton , J. D. and J. Berger. 1974. Present and potential use of fertilizer for forage production in temperate zones. In: Mays, D. A. (ed.), Forage Fertilization. ASA, CSSA, SSSA. Madison, Wisconsin. P. 17-37.

Gallaher, R. N., C. O. Weldon, and J. G. Futral. 1975. An aluminum block digester for plant and soil analysis. Soil Sci. Soc. of Am. Proc. 39:803-806.

Moore, J. E., and G. O. Mott. 1974. Recovery of residual organic matter from in vitro digestion of forages. J. Dairy Sci. 57:1258-1259.

Prine, G. M., L. S. Dunavin, J. E. Moore, and R. D. Roush. 1981. 'Florigraze' rhizoma peanut, a perennial forage legume. Univ. of Fla. Agric. Exp. Sta. Circ. S-275. 22 p.

Russel, D. A., W. J. Free, and D. L. McCune. 1974. Potential for fertilizer use on tropical forages. In: Mays, D. A. (ed.), Forage Fertilization. ASA, CSSA, SSSA. Madison, Wisconsin. P. 39-62.

Tilley, J. M., and R. A. Terry. 1963. A two-stage technique the in vitro digestion of forage crops. J. Br. Grassld. Soc. 18:104-111.

Vicente-Chandler, J., F. Abruna, R. Caro-Costas, J. Figarella, S. Silva, and R. W. Perarson. 1974. Intensive grassland management in the humid tropics of Puerto Rico. Univ. of Puerto Rico. Bull. 233. Rio Piedras, PR.

Table 1 -- Dry matter (DM) yield of the grasses, the legume and the grass-legume associations (mean of 1984 and 1985).

Forages	Nitrogen Level (lbs/A/year) 0			134			268		
	G*	L*	T*	G	L	T	G	L	T
	tons DM/A/year								
Florigraze (F)	-	9.8	9.8	-	9.3	9.3	-	9.6	9.6
Pensacola	4.1	-	4.1	7.1	-	7.1	8.9	-	8.9
Hybrid-81	6.5	-	6.5	12.2	-	12.2	14.3	-	14.4
Survenola	2.7	-	2.7	10.9	-	10.9	11.6	-	11.6
Pensacola + F	1.9	8.0	9.9	2.0	8.4	10.4	2.5	8.3	10.8
Hybrid-81 + F	3.2	8.1	11.3	7.3	7.0	14.3	8.9	6.9	15.8
Survenola + F	1.3	8.6	9.9	5.1	6.9	12.0	7.3	6.1	13.4

* G= Grass, L= Legume, T= Total.

Table 2 -- Percent crude protein (CP) of the grasses and the legume in pure stands and in association (mean of 1984 and 1985).

Forages	Nitrogen Level (lbs/A/year) 0		134		268	
	G*	L*	G	L	G	L
	% Crude Protein					
Florigraze (F)	-	14.6	-	14.4	-	15.3
Pensacola	6.3	-	7.8	-	8.6	-
Hybrid-81	6.8	-	7.6	-	9.4	-
Survenola	7.0	-	7.6	-	9.6	-
Pensacola + F	7.9	14.6	8.9	14.6	9.3	14.9
Hybrid-81 + F	7.6	14.9	7.8	15.6	9.2	15.8
Survenola + F	7.2	14.8	7.9	14.6	9.6	15.6

* G= Grass, L= Legume.

Table 3 -- Total crude protein produced by the grasses, the legume and the grass-legume associations (mean of 1984 and 1985).

Forages	Nitrogen Level (lbs/A/year) 0			134			268		
	G*	L*	T*	G	L	T	G	L	T
	tons Crude Protein/A/year								
Florigraze (F)	-	1.3	1.3	-	1.2	1.2	-	1.3	1.3
Pensacola	0.2	-	0.2	0.4	-	0.4	0.6	-	0.6
Hybrid-81	0.4	-	0.4	0.9	-	0.9	1.3	-	1.3
Survenola	0.2	-	0.2	0.9	-	0.9	1.1	-	1.1
Pensacola + F	0.1	1.2	1.3	0.2	1.2	1.4	0.2	1.3	1.5
Hybrid-81 + F	0.2	1.2	1.4	0.6	1.1	1.7	0.8	1.1	1.9
Survenola + F	0.1	1.3	1.4	0.4	1.0	1.4	0.7	1.0	1.7

* G= Grass, L= Legume, T= Total.