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COOL SEASON FORAGE LEGUMES IN SOUTHWESTERN OF PARANÁ

LEGUMINOSAS FORRAGEIRAS DE ESTAÇÃO FRIA NO SUDOESTE DO PARANÁ

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ABSTRACT

Forage shortage during cool season at the southern Brazil is one of the most serious problems faced by farmers and due to it, cool season species represents an important alternative. The aim of this research was to verify the nutritional value and forage production of white clover (*Trifolium repens*), red clover (*Trifolim pratense*), birdsfoot trefoil (*Lotus corniculatus*) and annual Lotus (*Lotus subbiflorus*) genotypes. The experiment was carried out at Pato Branco the southwestern of Paraná state,Brazil and laid out as a random block design with four replications to the white and red clover genotypes and five replications to the Lotus genotypes. Forage production was high along the evaluated period, especially for birdsfoot trefoil, which showed an average production among its four genotypes of 9,757 kg ha^{-1} of DM, and as well as for to the red clover genotypes, which showed an average production of 8,184 kg ha^{-1} of DM. The birdsfoot trefoil genotypes San Gabriel Ijuí, San Gabriel and UFGRS highlighted as being the most productive among all the tested genotypes, although white and red clover showed better nutritional value when compared with birdsfoot trefoil. The white clover genotypes stood out by having the best nutritional value although with lower forage production than the other three species.

Key-words: annual Lotus; birdsfoot trefoil; forage production; nutritional composition; red clover; white clover.

RESUMO

A escassez de forragem durante a estação fria no Sul do Brasil constitui um dos problemas mais sérios enfrentados pelos pecuaristas e as espécies de clima temperado tornam-se alternativas importantes. O objetivo desse trabalho foi verificar o valor nutritivo e a produção de forragem de genótipos de trevo-branco (*Trifolium repens*), trevo-vermelho (*Trifolim pretense*), cornichão (*Lotus corniculatus*) e cornichão anual (*Lotus subbiflorus*) em ensaio na região sudoeste do Paraná, município de Pato Branco-PR. O delineamento experimental foi o de blocos ao acaso com quatro repetições para genótipos de trevo-branco e trevo-vermelho e cinco repetições para de cornichão. Observou-se elevada produção de forragem pelas leguminosas no período avaliado, especialmente para cornichão, que teve produção média dos quatro genótipos de 9.757 kg ha^{-1} MS, e, também para trevo-vermelho, com média das cinco cultivares de 8.184 kg ha^{-1} de MS. Os genótipos de cornichão São Gabriel Ijuí, São Gabriel e UFGRS destacaram-se como mais produtivos entre todos os genótipos testados, contudo foram inferiores no aspecto nutricional quando comparados com trevos. As cultivares de trevo-branco destacam-se pelo melhor valor nutricional, contudo tem menor produtividade se comparadas com às das outras três espécies.

Palavras-chave: composição bromatológica, cornichão, cornichão anual, produção de forragem, trevo-vermelho, trevo-branco.

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INTRODUCTION

Meat and dairy production in Brazil are almost solely dependant upon forage grasses and in a less extent, on forage legumes production. Forage legumes, although, when properly managed, are rich sources of protein, fiber, and energy to livestock and can improvise animal production. Furthermore, the inclusion of forage legumes in pastures is important for sustainable meat and dairy productions especially in infertile soils of the tropics and subtropics they can be seeded for improving grasses production and for fixing nitrogen into the system (Soares et al., 2006). However, incorporation of improved legumes into these ecosystems has been slow due to high seed costs, and, lack of adapted species and of information on how to property grow them.

The main features to be considered on the choosing of forage species are their productivity capacity and nutritional value. However, these variables depend on the environmental conditions (rain, temperature, etc.) and also on the genotype within the same species. Furthermore, the use of forage legume with high levels of protein is important and justified by the fact that this feature can be a limiting factor for animal production (Blaser et al., 1974). Forages with protein levels below the animal critical value will prevent the animal to consume the sufficient amount of protein per day (Freitas et al., 1976), since the animal dry matter intake capacity is limited (Ensminger et al., 1990).

The crude protein level is considered a major nutritional component in assessing the nutritional value of fodder, once the animals need nitrogen for the establishment and replenishment of tissues (Stoddart & Smith, 1955). In addition, another common merit attributed to legumes is the increased content of crude protein in the forage, exerting a beneficial effect, especially in increasing the protein value in the "non-legume" in fodder mixtures (Dall'Agnol, 1981). Important cool season legume pasture species include clovers (*Trifolium* spp.), birdsfoot trefoil (*Lotus corniculatus*), and vetches (*Vicia* spp.).

Considering these factors and that the adaptation of forage production and nutritive value germoplasm to certain conditions of climate and soil is essential, this work aimed to evaluate of different genotypes of four forage legumes species at the southwest of Paraná State, Brazil.

MATERIAL AND METHODS

The experiment was carried out at the Federal Technologic University of Paraná (UTFPR) experimental unit of Pato Branco – PR, located at 26º 07' South and 52º 41' West with an average altitude of 720 m above sea level. The climate of the region is humid subtropical, according to Köppen is classification (Maak, 1968), and the soil at the experimental site is classified as an Oxisol (EMBRAPA, 2006). Soil analyses was performed and the soil fertilization was done according to the soil fertilization manual (Comissão de Química e Fertilidade do Solo, 2004) recommendations for cool season forage legumes. The meteorological conditions are showed in Figure 1 (Iapar, 2008).

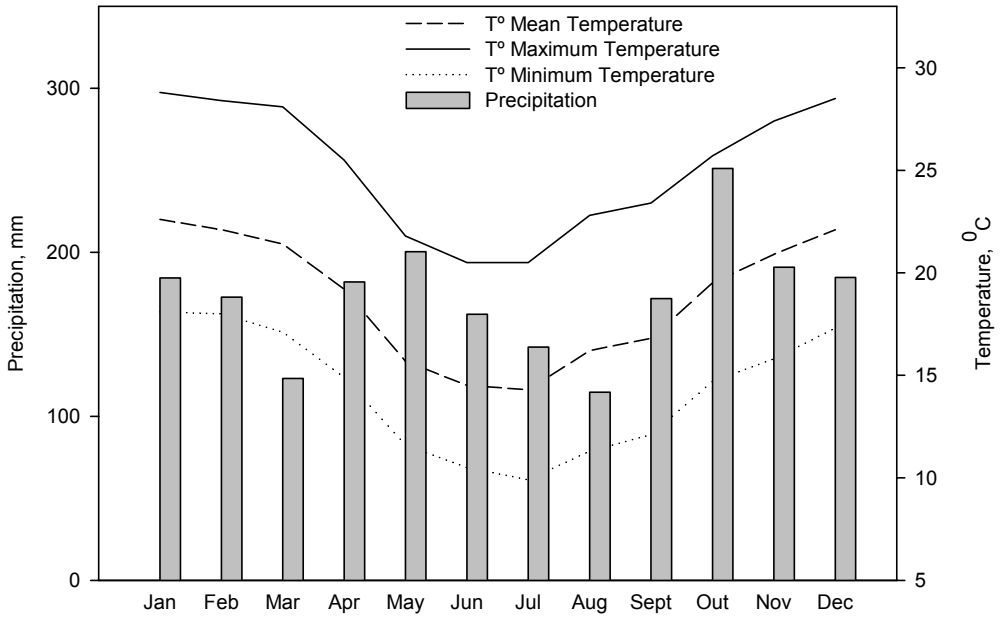

FIGURE 1 - Meteorological data, mean historical of 1979-2006 (Agronomic Institute of Paraná - IAPAR, 2008).

Fourteem genotypes of four cool season legumes species were evaluated: white clover (*Trifolium repens*), red clover (*Trifolium pretense*), birdsfoot trefoil (*Lotus corniculatus*) and annual lotus (*Lotus subbiflorus*) as genotypes: white clover - Bagé, UFRGS, Jacuí, Zapican and Yí; red clover - Quiñequelli, UFRGS, Quiñequelli Ijuí, Kenland and Nova Santana; birdsfoot trefoil - San Gabriel, San Gabriel Ijuí, UFRGS and annual Lotus - El Rincon. The experiment was laid out as a random block design with four replications for the white and red clovers and five replications for the Lotus species. The forage legume were sown in rows distanced 20 cm apart, in plots of nine square meters (1.8 m x 5 m) at a seeding rate of 4 kg ha^{-1} of viable clover seeds and 10 kg ha^{-1} of viable Lotus seeds.

The experiment was carried out from 22 de June 2006 up to 01 de January 2007. In each plot, two samples of 0.25 m^2 were cut when the sward height reached 15, 25 and 20 cm respectively to the white clover, red clover and Lotus species, leaving a forage residue of 4, 4 and 8 cm of height respectively for the white clover, red clover and Lotus species. The birdsfoot trefoil, red clover and annual Lotus genotypes forage production was achieved in three evaluations (10/20/06, 12/20/06 and 01/07/07), white clover provided only two cuts (10/20/06 and 12/20/06). After the cuts, the samples were dried in a air-forced oven at 55 °C until constant weight to determine the forage production in each cut. The total forage production was obtained by the sum of the cuts (kg ha^{-1} of DM).

From a composed forage sample containing all the evaluated cuts from each forage genotype evaluated, a sub-sample was took out to assess the forage nutritive value. The levels of crude protein (CP), total detergent nutrients (TDN), neutral detergent fiber (NDF), acid digestible fiber (ADF), calcium (Ca), phosphorous (P), potassium (K) and magnesium (Mg) were determined. The samples were analyzed by the near-infrared reflectance spectrum (NIRS)

The results were submitted to the variance analysis to detect possible differences between genotypes using a significance level of 5% of error probability by F test. Subsequently, the averages were submitted to the Tukey test at 5% of significance.

RESULTS AND DISCUSSION

There was a significant difference of forage production among the evaluated genotypes being the birdsfoot trefoil genotypes more productive than the other genotypes studied, with total forage production above 10 t ha^{-1} (Table 1). The same observations can be made within each assessment period, where the three birdsfoot trefoil genotypes were superior in productivity. The annual Lotus cultivar El Rincón was less productive among the species, however, this cultivar has a prostrate habit of growth which confers grazing resistance. These results are similar to the ones obtained by Assmann et al. (2004) at Guarapuava, PR, Scheffer-Basso et al. (2005) at Rio Grande do Sul state and Olmos (2001) at Uruguay.

TABLE 1 – Forage production of different genotypes of white clover, red clover, birdsfoot trefoil and annual Lotus from June 2006 up to January 2007. UTFPR, Pato Branco, PR, Brazil.

Germplasm	10/20/2006	12/20/2006	01/07/2007	Total
Birdsfoot trefoil San Gabriel	2.481 ab	4.549 a	4.210 ab	11.239 a
Birdsfoot trefoil San Gabriel Ijuí	1.884 abcde	4.553 a	4.887 a	11.327 a
Annual Lotus El Rincon	1.175 e	1.677 f	3.036 bcd	5.888 c
Birdsfoot trefoil UFRGS	2.106 abcd	4.721 a	4.721 a	10.573 a
Red clover Quiñequelli	2.722 a	2.890 cd	8.159 b	8.159 b
Red clover UFRGS	1.858 abcde	3.728 b	2.101 d	7.687 b
Red clover Quiñequelli Ijuí	2.257 abc	2.812 cd	3.218 bcd	8.287 b
Red clover Kenland	2.045 abcde	3.007 cb	2.848 bcd	7.900 b
Red clover Nova Sanatana	2.238 abc	3.260 cb	3.387 bcd	8.885 b
White clover Bagé	1.517 cde	2.070 edf	0 e	3.587 d
White clover UFRGS	1.755 bcde	1.847 ef	0 e	3.602 d
White clover Jacuí	1.229 de	1.448 f	0 e	2.677 d
White clover Zapican	1.607 bcde	2.524 cde	0 e	4.131 cd
White clover Yí	1.665 bcde	2.666 cd	0 e	4.331 cd
Mean	1.897	3.042	2.263	7.202
C.V	29,4	20,0	20,6	16,8

* Means in the same column followed by different lowercase letters differ (5%) by the Tukey test.

There was no significant forage yield differences among the red clover genotypes, which showed total forage production between 7,687 and 8,885 kg of DM ha^{-1}. However, this species showed higher total production than the white clover genotypes, which produced an average of 3,665 kg of DM ha^{-1} among the five genotypes, showing to be less productive in this environment. Moreover, while the birdsfoot trefoil, red clover and annual Lotus genotypes forage production was achieved in three evaluations (10/20/06, 12/20/06 and 01/07/07), white clover provided only two cuts (10/20/06 and 12/20/06), leading to lower production to the species. Besides the high demand for soil fertility and climate, these species to of considerable time from sowing until the first cut, since, more than 119 days were necessary for achieving cutting height.

A research evaluating forage production of these legumes species seeded into native pasture showed production bettween 1,729 and 2,026 kg ha^{-1} of DM, respectively, for red and white clover (Vidor & Jacques, 1998). These values were inferior than the ones found in this work (Table 1), where the species were grown in monoculture. Growing these species in a singular way may provide a higher forage production, although, it is also important to consider the positive benefits of the legume species such as nitrogen fixation into the system as well as improvements in pasture quality.

The highest forage yields of the birdsfoot trefoil genotypes were not accompanied by better nutritional value. The contrary occurred with forage quality as the nutritional value of the white clover was superior than in the others species, followed by red clover, annual Lotus and birdsfoot trefoil (Tables 2 and 3). The white clover crude protein levels are below than those reported by Coelho et al. (2002), which found an average, CP level of 26.5% throughout three years of evaluation. Soster et al. (2004) comparing crude protein content of birdsfoot trefoil genotypes reported values of 21.8% and 11.2% respectively during vegetative and reproductive stages.

TABLE 2 – Mean forage crude protein (CP), neutral detergent fiber (NDF), total digestible nutrients (TDN), and acid detergent fiber (ADF) content of different genotypes of white clover, red clover and birdsfoot trefoil and annual Lotus from June 2006 up to January 2007. UTFPR, Pato Branco, PR, Brazil.

Germplasm	CP (dag kg^{-1})	NDF (dag kg^{-1})	ADF (dag kg^{-1})	TDN (dag kg^{-1})
Birdsfoot trefoil San Gabriel	11,6 d	59,9 a	40,6 a	59,4 c
Birdsfoot trefoil San Gabriel Ijuí	11,5 d	59,9 a	40,6 a	59,4 c
Annual Lotus El Rincon	12,0 cd	52,8 ab	37,8 ab	61,4 bc
Red clover Quiñequelli	13,1 cd	52,9 ab	39,8 ab	60,0 bc
Red clover UFRGS	13,0 cd	53,0 ab	40,3 a	59,6 c
Red clover Quiñequelli Ijuí	13,4 bcd	52,8 ab	40,2 a	59,7 c
Red clover Kenland	12,5 cd	52,6 ab	39,4 ab	60,2 bc
Red clover Nova Sanatana	13,5 bcd	52,8 ab	39,0 ab	60,6 bc
White clover Bagé	17,3 a	39,1 cd	31,5 bc	65,7 ab
White clover UFRGS	16,4 ab	43,2 cd	33,6 abc	64,3 abc
White clover Jacuí	14,9 abc	47,3 cd	35,3 abc	63,1 abc
White clover Zapican	16,3 ab	43,7 cd	32,6 abc	65,0 abc
White clover Yí	17,7 a	38,5 d	28,6 c	67,8 a
CV.	7,46	5,75	7,49	3,12

* Means in the same column followed by different lowercase letters differ (5%) by the Tukey test.

TABLE 3 – Mean forage calcium (Ca), phosphorous (P), potassium (K) and magnesium (Mg) content of different genotypes of white clover, red clover, birdsfoot trefoil and annual Lotus from June 2006 up to January 2007. Pato Branco, PR, Brazil.

Germplasm	Ca (dag kg^{-1})	P (dag kg^{-1})	K (dag kg^{-1})	Mg (dag kg^{-1})
Birdsfoot trefoil San Gabriel	0,47 efg	0,21 ab	1,32 cd	0,19 d
Birdsfoot trefoil San Gabriel Ijuí	0,45 fg	0,19 b	1,35 cd	0,18 d
Annual Lotus El Rincon	0,44 g	0,21 ab	1,07 d	0,17 d
Red clover Quiñequelli	0,54 cde	0,23 ab	1,74 abcd	0,20 cd
Red clover UFRGS	0,60 abc	0,23 ab	1,14 cd	0,20 d
Red clover Quiñequelli Ijuí	0,52 defg	0,26 ab	2,13 ab	0,23 bcd
Red clover Kenland	0,53 def	0,21 ab	1,63 bcd	0,21 bcd
Red clover Nova Sanatana	0,55 cde	0,22 ab	1,81 abc	0,23 bcd
White clover Bagé	0,66 ab	0,26 ab	2,43 a	0,30 a
White clover UFRGS	0,63 abc	0,26 ab	2,21 ab	0,27 ab
White clover Jacuí	0,63 abc	0,24 ab	1,83 abc	0,23 bcd
White clover Zapican	0,71 ab	0,26 ab	1,93 abc	0,26 abc
White clover Yí	0,66 ab	0,27 a	2,42 a	0,31 a
CV.	5,13	9,70	12,92	8,78

* Means in the same column followed by different lowercase letters differ (5%) by the Tukey test.

The crude protein production of the white clover ranged from 399 to 767 kg ha^{-1} of CP. However, the best CP values of the white clover did not suffice to overcome the birdsfoot trefoil crude protein production (1,303 kg ha^{-1} of CP in the average of the two most productive genotypes) and the red clover CP production (1,073 kg ha^{-1} of CP averaging all the genotypes). Although, all the genotypes showed CP levels above those required to meet the need of adult cattle (9%) without limiting consumption (Cavalheiro & Trindade, 1992).

Gomes & Reis. (1999) evaluating *Lotus subbiflorus* cv. El Rincón observed different levels of crude protein along three years of evaluation with values ranging from 18.7 to 22.7% and with forage production of 4,752, 6,347 and 1,446 kg ha^{-1} of DM in 1994, 1995 and 1996, respectively.

The contents of NDF did not differ among birdsfoot trefoil, *Lotus subbiflorus* and red clover, but were higher than the levels found for white clover, which showed better nutritive value due to lower fiber content. The same trend was observed for ADF levels, but with less differences (Table 2).

It was also noticed that the percentage of TDN in the white clover forage dry matter was significantly higher, especially in the cultivar Yí, which also had better levels of CP, NDF and ADF, followed by red clover and the two Lotus species (Table 2). This is explained by the fact that crude protein, NDF and ADF are closely related with the feed digestibility. To Paterson et al. (1994) forages of high quality are characterized by NDF and ADF levels of about 60 and 30% respectively.

For cool season forage legumes Coelho et al. (2002) found NDF, ADF and TDN values of 38.5, 33.5 and 55.5%, respectively. Comparing these values with the ones found in this work, the TDN values were similar and the NDF and ADF were higher than the values found by Coelho et al. (2002). Soster et al. (2004) observed ADF average values of 24.2% and NDF values varying from 55.3 to 58.8% among birdsfoot trefoil genotypes.

As the plants grow and get closer to their physiological maturity, the proportion of plant cell walls increases and its digestibility decreases, with consequent reduction in the animal forage consumption (Wilkins, 1969; Vilela et al., 1978).

Some differences among genotypes were noticed as to the levels of Ca, K, and Mg values but with a tendency for phosphorus levels (Table 3). In these comparisons, the white clover genotypes showed higher mineral values. Coelho et al. (2002) observed mean values of 1.1% of Ca and 0.37% of P. When assessing the response of three cool season forage legumes to different rates of phosphorus and potassium, Krolow et al. (2004) observed ranges from 1.49 to 1.54% of Ca, 0.37 to 0.42% of Mg, 0.11 to 0.28% of P and 0.61 to 1.18% of K for the annual Lotus El Rincón, Persian clover and subterranean clover, respectively.

CONCLUSIONS

The birdsfoot trefoil genotypes are the most productive followed by red clover and white clover. Forage production values are considered satisfactory for the region.

The white clover genotypes have better nutritional values than the red clover and Lotus spp. genotypes.

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