White clover to improve natural grasslands in southern Brazil

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ABSTRACT
Nine white clover *(Trifolium repens* L.) cultivars, among them 2 bred in Rio Grande do Sul, were evaluated in association with annual ryegrass and pensacola bahiagrass. In a plot experiment, during 4 years, 17 harvests were cut to determine the dry matter (DM) yield of the mixture components. The annual ryegrass produced in the first year 1634 kg/ha DM and in the second year, by natural reseeding, only 120 kg/ha. The pensacola bahiagrass increased DM yield from 954 kg/ha in the second year to 4588 kg/ha in the fourth year without any nitrogen (N) fertilisation. The white clover cultivars produced an average DM yield, in the first year, of 1900 kg/ha and then stabilised around 600 kg/ha. The new cultivars Guaíba S_1 and Jacuí S_2 in the first, third and fourth years were among the best performing cultivars. In the second year cv. Haifa was the highest in DM yield.

KEYWORDS: Brazil, cultivars, forage mixtures, forage quality, persistence, *Trifolium repens*

INTRODUCTION
The State of Rio Grande do Sul in southern Brazil has around 16 million ha of natural and improved grasslands. Nearly 800 grass species and 250 forage legumes are native to these grasslands. Most of them are summer growing and during winter they are damaged or growth is stopped by low temperatures and frost. Winter annuals and perennials of introduced cultivated species give higher live-weight gains during winter-spring than summer-autumn, in some areas of the State.

Winter forage legumes are very important in this area, improving (DM) production, forage quality and fixing atmospheric (N). An effort was made to breed cultivars of white clover with adaptation and persistence for these conditions, where during the summer the temperatures reach over 30°C and are usually associated with low rainfall. The parent material used in this breeding programme were stolons that survived a long dry period during summer and autumn 1977-78, in Rio Grande do Sul. They were selected from old pastures and experiments evaluating germplasm introduced from Florida, USA. Selected genotypes were polycrossed and half-sib families tested in comparison with others white clover cultivars (Dall'Agnol et al. 1982). The 2 cultivars obtained, Guaíba S_1 and Jacuí S_2, combine characteristics of a large leaf type for growth and DM production, with persistent stolons, presence of HCN in the leaflets and flowering during all the year, except in the winter, and able to produce reasonable amounts of seeds for harvest and natural reseeding (Moraes et al. 1989, 1990; Andrade et al. 1990a, 1990b; Domingues et al. 1991; Franke & Nabinger 1991a, 1991b).

METHODS
The white clover (*Trifolium repens* L.) cultivars Regal, Yi, Bayucuá, Huia, Pitau, Bagé, Haifa, Guaba S_1 and Jacuí S_2 were evaluated in association with annual ryegrass (*Lolium multiflorum* Lam.) and pensacola bahiagrass (*Paspalum notatum* var. *saurae* Parodi), during 1983-1987 at Agronomic Experimental Station of the Federal University of Rio Grande do Sul (EEA-UFRGS). The soil (ground water laterite) had an initial pH 5.0, phosphorus 3 ppm, potassium 112 ppm, organic matter 2.0% and aluminium 0.9 me./dl. It was limed with dolomite 3 t/ha and 120 kg P_2O_5/ha/year (concentrated superphosphate) and 100 kg K_2/ha/yr (potassium chloride) applied. The seeding rate was 2 kg/ha for the white clover cultivars, inoculated with specific *Rhizobium*, 100% of pure and viable seeds, and 15 kg/ha for ryegrass and pensacola bahiagrass. Sowing date was 31 May 1983. Plots measured 2 x 5 m and were located in a randomised complete-block design with 5 replications. Four harvests were done every year, except in the second year when there were 5. Plots were cut when the sward height was 15-20 cm and a stubble of 3 cm was left after each cut. The mixture components were separated in white clover, ryegrass, pensacola bahiagrass, others grasses and weeds, when present in the samples. For the crude protein content and *in vitro* digestibility analysis, the weeds fraction was discarded. The techniques used were the Kjeldhal modified by Bremner & Keeney (1966) and Tilley & Terry (1963), respectively. Data were analysed using an analysis of variance with a subplot model (Steel & Torrie 1980) with the white clover cultivars treatments in the main plots and years in the subplots. To complement the analysis the cluster method for grouping means was used (Scott & Knott 1974).

RESULTS
Dry matter yield of the components differed only between years ($P<0.01$). Annual ryegrass yields (kg/ha) were: 1634 in the first year and 120 in the second year; pensacola bahiagrass, 954 in the second year, 2356 in the third and 4588 in the fourth; other grasses 114, 983, 1087 and 531 in years 1-4 respectively; weeds 461, 506, 210 and 202 in years 1-4, respectively.

The DM yield of the white clover cultivars is presented in groups according to the cluster analysis. In the first year 5 clusters were separated, in the second year, 4, in the third year, 2, and in the fourth year only 1 (Table 1). The death of plants and the natural reseeding with exchange of pollen between treatments may explain this situation. During these 4 years of evaluation, low rainfall occurred in the late spring and summer, and with natural reseeding there was a tendency for uniform swards to not occur until the fourth year. The new cultivars, with the exception of the second year, when cv. Haifa was superior, were among the best, in the first group.

Table 1 Average DM yield (kg/ha) of white clover cultivars, during 4 years of evaluation

Groups of cultivars	Year 1983/84	1984/85	1985/86	1986/87
Group 1	2519 Guaíba 2515 Jacuí 2501 Haifa 2405 Yi	1610 Haifa	945 Guaíba 848 Haifa 840 Yi 751 Jacuí 741 Bagé	796 Yi 673 Bagé 658 Jacuí 617 Regal 610 Guaíba 603 Bayucua 577 Haifa 549 Pitau 424 Huia
Group 2	2189 Bagé 2091 Regal	966 Jacuí	645 Bayucua 431 Pitau 421 Regal 331 Huia	
Group 3	1682 Bayucua	742 Yi 655 Bayucua 598 Guaíba 540 Bagé		
Group 4	1094 Huia	226 Pitau 129 Regal 54 Huia		
Group 5	107 Pitau			
Means	1900	613	641	612

Cluster analysis of total DM yields gave 2 groups during the 4 years with superior yields, generally following the best performing cultivars (Table 2). The percentage crude protein in the mixtures, in the 17 harvests, showed a large variation (4-20%) according to sward composition. The lower values corresponded to harvests with low white clover content and a predominance of pensacola bahiagrass and native grasses; the higher values corresponded to periods of active growth of the white clover cultivars.

In vitro dry matter digestibility of swards followed the same situation. In the first year the mean value was 63.39%, in the second 73.83% and in the third and fourth years, when the content of pensacola bahiagrass increased were 48.01% and 42.60, respectively.

Table 2 Total DM yield (kg/ha) of all components of the mixture, for the 4 years of evaluation

Groups of cultivars	Year 1983/84	1984/85	1985/86	1986/87
Group 1	5002 Guaíba 4717 Jacuí 4671 Haifa 4441 Yi 4423 Bagé 4323 Regal 3816 Bayucua	4412 Haifa 3705 Jacuí 3539 Yi 3407 Guaíba	4934 Guaíba 4818 Haifa 4578 Yi 4471 Bagé 4408 Jacuí	6804 Guaíba 6502 Yi 6301 Bagé 6147 Haifa 6138 Jacuí
Group 2	2955 Huia 2634 Pitau	3109 Bagé 3086 Bayucua 2586 Regal 2466 Huia 2279 Pitau	3974 Bayucua 3926 Huia 3779 Pitau 3759 Regal	5693 Regal 5366 Pitau 5363 Bayucua 5089 Huia
Means	4109	3177	4294	5934

DISCUSSION

In the climatic conditions of Rio Grande do Sul, in southern Brazil, both stolon survival and natural reseeding are important factors ensuring the persistence of white clover in pastures. "Native" white clover in this region tends to behave as an annual species, particularly in warmer conditions. Increasing persistence by stolon survival, during dry periods, will result in DM production being more evenly distributed throughout the year.

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