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EFFECTS OF CULTIVATION AND LIMING ON THE ANNUAL RESEED AND BOTANICAL COMPOSITION OF A MEDITERRANEAN ANNUAL-TYPE SEEDED PASTURE

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ABSTRACT

An experiment was conducted on a low fertility acid soil during 1987-1992, to investigate the influence of lime placement and method of cultivation on the botanical composition and subclover seedling density of a rainfed Mediterranean subclover-based sown pasture.

Two different methods of cultivation, ploughing and scarifying, were factorially combined with three types of lime application, before, after, and half before plus half after cultivation. Lime at four rates, 0, 2, 4 and 6 t lime/ha was applied in a split arrangement.

Liming and scarifying treatments increased sown species (subclovers, white clover and tall fescue) and decreased native species and bare ground. With the first lime increment the sown legumes percentage almost tripled while bare ground cover decreased by more than three times.

Subclover seedling density was higher with scarifying as method of cultivation. The results indicate that lime should never be applied before cultivation.

Both botanical composition and subclover seedling density show that the effect of lime rates was mainly obtained with the first level of 2 t/ha.

Coefficients of linear correlation indicate that lime rate and DM yield were positively related with sown species (grasses and mainly legumes) and negatively related with native species (grasses, legumes and other species) and bare ground.

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INTRODUCTION

Soil acidity is one of the most important factors that influence dry matter yield, botanical composition and species persistence.

According to Lambert *et al.* (1986) in grazed grass-legume hill pastures, management should be designed to maximize legume growth, and effects of botanical composition on animal production are likely to be limited chiefly to those indirectly attributable to legume content.

The effectiveness of lime application as acidity neutralizer depends on several factors. However, Black and Cameron (1984) found that the degree of soil mixing was one of the most important.

Most soils in the northeast region of Portugal require lime for sucessful establishment and maximum production of rainfed Mediterranean annual-type pastures. Many areas, because of slope and rockiness, are not suited to conventional seeding. No-till seeding is becoming increasingly recommended as a practice for conserving valuable top soil and, in addition, it saves the farmer time and machinery costs (Rechcigl *et al.*, 1985). However, the no-tillage seeding methods preclude the incorporation of lime and may decrease the effectiveness of lime application (Koch and Estes, 1986).

A study (1987-1992) was conducted to investigate the influence of the combined effects of method of cultivation and lime placement on the establishment and yield of rainfed Mediterranean subclover-based sown pastures in an infertile acid soil. Measurements of dry-matter yield and soil parameters were made and the results are presented in a separate paper (Moreira *et al.*, 1993). Subclover annual reseed and botanical composition of the pasture were determined, and the results are presented here.

MATERIAL AND METHODS

The experiment was carried out in Vila Real (Northeast Portugal, 41° 19'N, 7° 44'W, altitude 470 m asl). The experimental site is a humid Mediterranean rainfed area.

The soil is a shallow acid infertile cambisol derived from schist, a fine sandy loam, with the following chemical characteristics: pH in H_2O (1:2.5), 5.1-5.4; OM, 8.1-11.5 mg/kg; available P, 4-7 mg/kg and exchangeable acidity, 1.2-1.6 cmol(+)/kg.

In October 1987 a commercial mixture of subclovers (Nungarin, S. Park, Woogenellup, Esperance and Clare), 12 kg seed/ha, with 0.5 kg Huia white clover and 4 kg/ha Ondine tall fescue, was sown, fertilized with P and K. No nitrogen was applied at any stage in the experiment, and in the autumn of 1990 P and K were broadcast.

Two different methods of cultivation, ploughing at 30 cm (**P**) and scarifying at 15 cm (**S**), were factorially combined with three types of lime application, before (**B**), after (**A**) and half before plus half after cultivation (**H**). Lime at four rates, **0**, **2**, **4** and **6** t lime/ha was applied in a split arrangement. All treatments were subjected to a final superficial (5 cm) seed bed preparation with a toothed harrow. Moreira *et al.* (1993) outline experimental treatments and environmental conditions in detail.

In early May 1991 pasture botanical composition and bare ground were estimated with a point quadrat method as described by Daget and Poissonet (1971). Botanical composition is considered here in terms of 5 species categories: sown legumes, subclover (*Trifolium* *subterraneum* L.) and white clover (*Trifolium repens* L.); native legumes, mainly *Ornithopus* spp., *Medicago* spp., *Lotus* spp. and *Trifolium* spp.; sown grasses, tall fescue (*Festuca arundinacea* Schreb.); native grasses and other species. Subclover seedling density (annual reseed) was evaluated at the beginning of five growing seasons (88-89 to 92-93) by counting seedlings per quadrat of 0.04 m^2 at ten randomly selected locations in each plot.

Transformed botanical composition (arcsin √ proportion) and subclover seedling density data were analysed with a three factor factorial with split layout for analyses of variance to test significant effects and interactions.

RESULTS AND DISCUSSION

The effects of lime rate and method of cultivation on botanical composition and bare ground are presented in Figures 1 and 2, respectively.

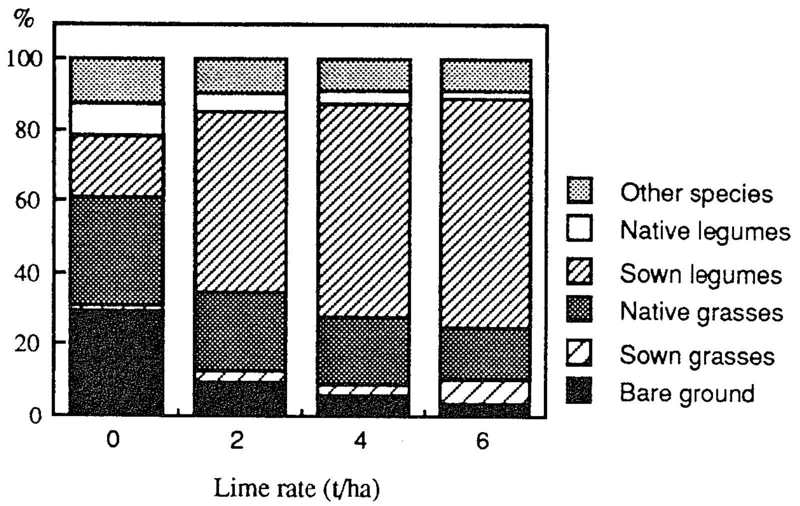

Figure 1- Effect of lime rate on pasture botanical composition and bare ground (early May 1991)

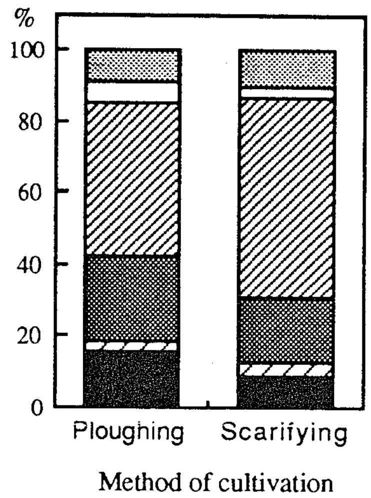

Figure 2- Effect of method of cultivation on pasture botanical composition and bare ground (early May 1991)

Lime rate significantly ($P < 0,001$) modified all species categories and bare ground cover (Figure 1). Sown species (%) increased and native species and bare ground decreased with increasing lime rates of application. The greater changes occurred between levels of nil and 2 t lime/ha. Sown legumes were the categorie more influenced with increases of 191, 244 and 270% when comparing nil lime treatments with 2, 4 and 6 t lime/ha, respectively. The results show that sown grasses tended to be increased mainly at the maximum lime rate.

Method of cultivation, as is shown in Figure 2, significantly ($P < 0,05$) influenced pasture botanical composition with scarifying treatments favouring sown legumes and decreasing native grasses and legumes and bare ground.

Percentage of bare ground was also significantly ($P < 0,05$) influenced by type of lime application, being 16% when lime was applied before cultivation (**B**), 13,3% on treatment **H** and 7,3% on treatment **A**.

Values of subclover seedling density sampled at the beginning of five growing seasons are shown in Figures 3 and 4.

Subclover seedling density varied significantly with method of cultivation ($P < 0.001$), type of lime application ($P < 0.05$), lime rate ($P < 0.001$) and from one year to another ($P < 0.001$). Significant interactions were found among lime rate, type of lime application and method of cultivation (Figure 3) and between years and lime rate (Figure 4).

Figure 3 shows that with scarifying as method of cultivation, the number of subclover seedlings per unit area was higher, and better results were obtained with lime application after cultivation. Moreover, application of 2 t lime/ha was enough to reach almost the maximum seedling density.

Figure 4 shows an increasing difference in subclover seedling density from year to year between nil and the other three lime rates. Therefore, it seems that when no-lime was applied subclover species tended to disappear from the pasture. Although variation between years occurred, there was not a consistent increase in subclover seedling density above the 2 t/ha lime rate.

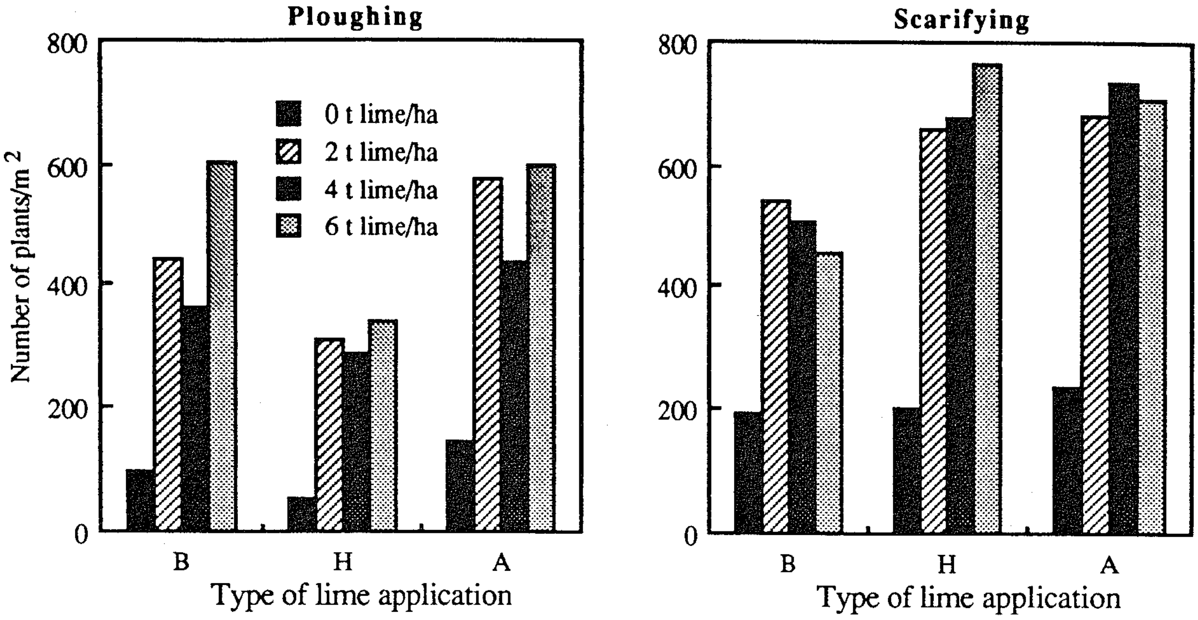

Figure 3- Effects of method of cultivation, type of lime application and lime rate on subclover seedling density (B), before; (H), half before plus half after; (A), after cultivation

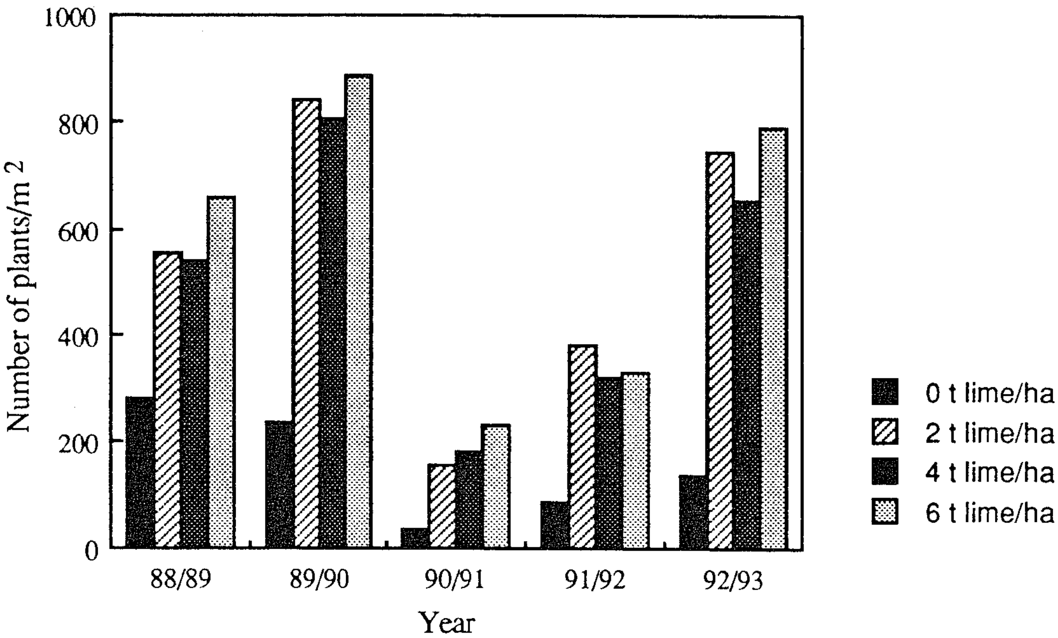

Figure 4- Variation of subclover seedling density among years and lime rates

Coefficients of linear correlation between lime rate, yield, subclover seedling density and botanical categories are shown in Table 1. They show clearly the influence of lime rate on all botanical categories, particularly a high positive effect on sown legumes and a high negative effect on native species and bare ground cover, showing the increasing competitive advantage of sown species over native ones as lime rate increases. DM yield is positively related with sown species (grasses and mainly legumes) and negatively related with native species (grasses, legumes and other species) and bare ground. The subclover seedling density accounts for the difference in sown species cover later in the growing season and is negatively related to bare ground and native species percentage cover.

Table 1- Coefficients of linear correlation between lime rate, DM yield, subclover seedling density and botanical categories

	Lime rate	DM yield	Subclover seedling density
DM yield	0.59		
Subclover seedling density	0.32	0.44	
Sown grasses	0.34*	0.35*	0.31*
Native grasses	-0.65	-0.72	-0.56
Sown legumes	0.75	0.83	0.63
Native legumes	-0.51	-0.58	-0.47
Other species	-0.40	-0.41	-0.29*
Sown species (grasses and legumes)	0.76	0.84	0.65
Native species (grasses and legumes)	-0.72	-0.81	-0.64
Bare ground	-0.60	-0.83	-0.64

* $P < 0.05$; all other values are significant at $P < 0.001$

Data from dry-matter yield (not shown) indicate that scarifying and lime application after cultivation provides a good establishment and pasture response with limited amounts of lime (2 t/ha) (Moreira *et al.*, 1993). In connection with the results presented here it seems that poorer growth and soil covering was achieved when the lime was incorporated or diluted in a greater soil volume. This may be due to the restricted rooting depth of the majority of species present, which enabled worthwhile benefits to be provided when small amounts of lime were applied to the top soil.

Surface applied lime moves slowly in the soil profile, as evidenced by the work of Adams *et al.* (1967). However there may be several explanations for the beneficial response to uncorporated liming. Since rizobia simbiosis function better at surface soil layers neutralizing the top few centimeters of soil may be more important than the adjustment of greater depths (Koch and Estes, 1986).

Furthermore, scarifying conserves the more fertile top soil, providing good establishment, yield and persistence of sown species.

The greater proportion of sown grasses at the higher level of lime application, as indicated by Lambert *et al.* (1986), may be a result of increased soil N availability due to greater legume growth and N-fixation.

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