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Effects of sheep grazing on legume composition and production in a Mediterranean grassland in Central Greece

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Summary - In a Mediterranean grassland of Central Greece, dominated by annual species and grazed throughout the winter and spring (November to May) with sheep, an area of 0.1 ha was fenced out and compared with an adjacent grazed one of similar size for three consecutive years. It was found that legumes were represented only by four annual species, namely *Medicago minima*, *Trifolium subterraneum*, *T. nigrescens* and *T. glomeratum*. Despite this low number, however, their biomass was making more than 50% of the total production in the ungrazed plot while overgrazing resulted in its significant reduction. Moreover, the results indicate that legumes were affected not only by sheep grazing but also by the extreme weather conditions in the winter months.

Key-words: grazing, Greece, legume composition, legume production, semi-arid Mediterranean grassland

Résumé - Une prairie naturelle du centre de la Grèce dominée par des espèces annuelles et pâturée de novembre à mai par des brebis a été partiellement clôturée pour évaluer, pendant trois ans, l'impact d'une mise en défens. *Medicago minima*, *Trifolium subterraneum*, *T. nigrescens* et *T. glomeratum* étaient les seules légumineuses représentées. Malgré ce faible nombre, elles constituaient plus de 50% de la phytomasse totale de la prairie en défens contre un niveau beaucoup plus faible dans la zone surpâturée. Il est démontré que les légumineuses sont affectées à la fois par le pâturage des brebis et la forte variabilité climatique des mois d'hiver.

Mots-clés: pâturage, Grèce, légumineuses, production fourragère, prairie méditerranéenne semi-aride

Introduction

Mediterranean grasslands are rich in plant species. A significant proportion of these species belong to legumes which are important both for their high nutritive value and for their environmental role, especially for improvement of soil fertility. The majority of the leguminous species are self-reseeding annuals which can withstand heavy grazing (Piano and Talamucci, 1996). For this reason, they are commonly found in heavily grazed areas while protection from grazing may lead to their reduction or even complete elimination.

In Greece, grasslands occupy 1.7 million hectares and their flora has a sizeable proportion of leguminous species. In the semi-arid zone, all legumes are annual but as we go to the sub-humid Mediterranean zone annual legumes are replaced by perennial species (Papanastasis, 1981). Their production changes from one year to the next due to the weather changes (Papanastasis, 1982). Papanastasis and Koukoura (1992) have shown that moderate grazing of grasslands is the key factor for grassland conservation. Overgrazing may have detrimental effects on biomass production (Tsiouvaras *et al.* 1998). However, it is not clear to what extent overgrazing affects the legumes.

In this paper, the effect of overgrazing on legume composition and production is investigated so that appropriate grazing management strategies are drawn and implemented.

Materials and methods

The research was conducted at the village of Amphithea, 15 km northeast of Larissa, Central Greece (39° 37'N, 22° 27'E). The experimental area has an altitude of 120 m. Annual precipitation is 407 mm (15-year average) and the mean minimum temperature of the coldest month (January) is 1.8 °C (Tsiontsis, 1996), thus indicating a semi-arid Mediterranean climate with cold winters (Le Houerou, 1981). Soils are derived from conglomerate deposits of the tertiary period and metamorphic rocks with a depth of about 0.6 m, pH 6.6, Ca 4.5 meq/100g, Mg 2.5 meq/100g, K 0.75 meq/100g, N 0.15 % and P Olsen 2.2 mg/100g.

The experimental site was a grassland grazed by sheep with a stocking rate of 2 sheep/ha/yr which means that more than 70% of the annual biomass was removed (grazed) every year (unpublished data). In the autumn of 1996, paired plots of 0.2 ha were established in a representative area of the grassland. One plot was freely grazed and the other was fenced out to protect it from grazing. In each plot, eight sub-plots with a size of 3x3 m each were delineated and arranged in four blocks. In seven of them, the months January, March, April, May, June, September, and November were randomly assigned and herbage production was measured. The eighth sub-plot was used for composition estimation in late May for three consecutive growing seasons (1997-99). The species composition was carried out with the point method by taking 20 ten-point frames.

Herbage production was also measured for three years (1997-99) by taking five quadrats, 0.50x0.50 m each, in every treatment. In the laboratory, the collected production was hand separated into live and old growth. The live production was further separated into grasses, legumes and other forbs and weighed after oven-drying at 70 °C for 48 hours. In November of each year, the old growth in the protected plot was cut by machine right after sampling and removed from it.

The production data were subjected (separately for each year) to analysis of variance and significant differences among means were detected by using LSD at the 0.05 level. In this paper, only the species composition and production data related to legumes are reported.

Results and discussion

Vegetation was dominated by the perennial grass *Anthoxanthum odoratum* and several annual grasses such as *Avena barbata*, *A. sterilis*, *Vulpia ciliata*, *V. myuros*, *Agrostis spica venti* and *Hordeum murinum*. Annual legumes were very few in both the protected and the freely grazed plots. They included *Medicago minima*, *Trifolium glomeratum*, *T. nigrescens* and *T. subterraneum*. This low number is perhaps related to the long history of overgrazing of the study area. Despite their low number, however, they were making about 45 % of the species cover at the end of the season in 1997, thus indicating their importance in the particular grassland studied (Figure 1).

In the subsequent two years, their contribution to the grassland vegetation declined, especially in the ungrazed plots. This latter can be attributed not to their disappearance but to the fact that the annual grasses overgrew because of the protection and covered most of the legumes thus making difficult their recording with the point frame during the period of measurements.

Legume production at the six periods over the three years is shown in figure 2. The seventh period (June) is not recorded because no live legumes were found during that period. The results show significantly higher values in the ungrazed than in the grazed plot. The

decreased values observed in the third year may be attributed to the climatic conditions. Table 1 shows that mean air temperature of the winter months of 1999 were much lower than in the previous two years while rainfall was much lower not only in the winter months but also in late autumn of 1998 which largely determined the establishment and early growth of legumes during the growing season 1998-99.

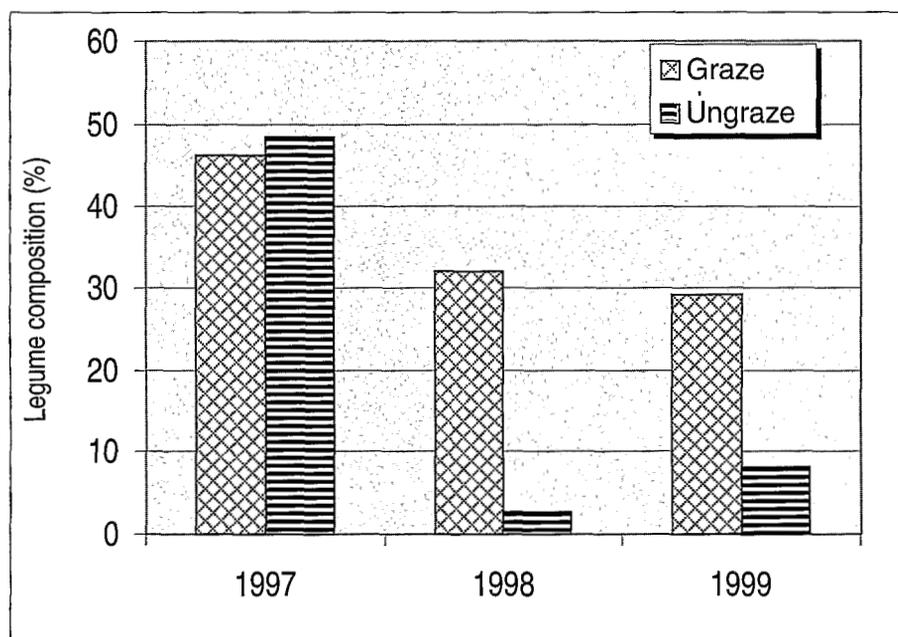


Fig. 1. Legume composition (%) during the experimental period 1997-99 in the grazed and ungrazed plots.

Table 1. Mean air temperature and rainfall of the study area during the experimental period.

Months	Mean air temperature (°C)			Rainfall (mm)		
	1997	1998	1999	1997	1998	1999
Jan	5.2	5.1	4.9	43.0	12.6	1.0
Feb	5.9	7.3	4.6	12.2	58.2	0.6
Mar	7.8	6.6	9.3	20.4	28.0	76.2
Apr	9.5	14.7	13.9	5.4	5.6	24.2
May	19.2	17.5	19.2	1.0	118.6	4.2
Jun	24.5	24.5	24.8	12.6	14.8	4.0
Jul	26.3	27.0	26.1	3.0	0.2	0.0
Aug	23.4	26.3		53.0	0.2	
Sep	19.1	20.4		1.6	38.8	
Oct	13.6	16.3		51.6	17.0	
Nov	10.4	10.4		21.2	7.8	
Dec	5.9	4.1		75.8	2.4	

The significantly highest legume production was found in the ungrazed plot at the end of May (2,335 kg/ha in 1997, 2,030 kg/ha in 1998 and 621 kg/ha in 1999). These amounts were making more than 50% of the total production of May (data not shown). In the grazed plot, on the contrary, the contribution of legumes was much less (about one third) indicating that sheep were grazing them much more heavily than the other species.

The high annual legume production of the spring months may potentially meet the animals' demand for feed. It is known that legumes are recognized for their high quality (high preference, digestibility and crude protein). In this experiment, a high crude protein value of the available forage (consisted of 85% legumes and 15% grass and forbs) was recorded during the spring months in 1997 (March to May: ≈ 170 g/kg DM), which, however, declined to a low of 75 g/kg DM during the dry summer period (June to September; Forest Research Institute, unpublished data), as a result of maturity.

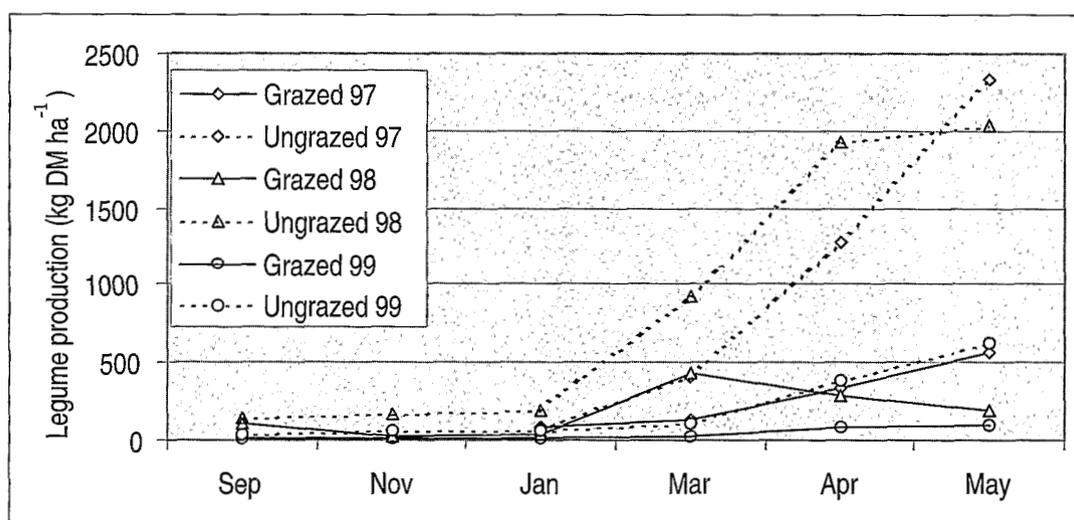


Fig. 2. Evolution of legume production (kg DM ha⁻¹) in different months of the growing season in the grazed and ungrazed plots.

Conclusions

The results suggest that although the number of legume species present in the grassland was limited their biomass was making more than 50% of the total production at the end of the growing season. Legume production, however, was negatively affected by the extreme weather condition during the autumn and winter months and it was significantly reduced by overgrazing.

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