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EFFECTS OF CATTLE GRAZING ON A PERENNIAL LEGUME, BITUMEN TREFOIL (*BITUMINARIA BITUMINOSA* (L.) STIRTON), IN A MEDITERRANEAN GRASSLAND

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Abstract

A six-year study was conducted in a Mediterranean grassland in north-eastern Israel to investigate the effects of cattle grazing management on a perennial legume, Bitumen Trefoil (*Bituminaria bituminosa* (L.) Stirton). The relationship between grazing pressure and its relative plant cover was studied in the context of inter-annual variation in rainfall. Treatments included manipulations of stocking rates (moderate, heavy and very heavy) and of grazing regimes (continuous vs. seasonal), in a factorial design. The results showed that inter-seasonal rainfall variation was a dominant factor in the expression of plant cover changes of this species. Grazing showed no significant effect on plant cover of this species even under very heavy grazing pressure. The importance of this species as complementary forage at the end of the grazing season and its resistance to grazing is discussed within the framework of persistence of dominant species, despite wide variation in grazing regimes and climatic condition.

Keywords: *Bituminaria (Psoralea) bituminosa*, cattle grazing, forage, persistence, stocking rate.

Introduction

In the Mediterranean basin, grassland-type communities are characterized by a long history of grazing and high species diversity. Understanding the impact of grazing on the structure and the functioning of these communities is a key issue for their rational use, e.g. long-term sustainable maximization of livestock production, nature conservation and biodiversity preservation.

Bituminaria bituminosa (L.) Stirton is an hemicryptophyte Mediterranean legume characterized by secondary compounds in mature leaves and by resistance to heavy grazing. Its growing season extends prior to the onset of the rains to the end of the spring, attaining primary production double that of the common herbaceous species, such as *Hordeum bulbosum* and *Avena sterilis*. In winter and early spring, when more palatable species are available to the cattle, it is grazed only under heavy stocking rates. Cattle begin to graze it under moderate grazing pressures only in mid-spring, when the principal grasses become less palatable, due to maturation and growth of stalks. In late spring, when the herbaceous species dry up, *B. bituminosa* becomes the only species that remains green and cattle intensively graze the whole plant.

A comprehensive research program was initiated to study the effects of different intensive grazing systems on the structure and dynamics of the herbaceous community and of its seed bank (Gutman *et al.* 1999; Sternberg *et al.* 2000). Here we report the effects of different management systems of cattle grazing on *B. bituminosa* in a Mediterranean grassland community. We also speculate about the mechanisms that allow *B. bituminosa* to survive under a heavy grazing regime.

Materials and Methods

Study site

The study was carried out at the Karei Deshe Experimental Farm, located in north-eastern Israel. Soil type: brown basaltic protogrumosols. Altitude: 150 m a.s.l.. Climate: Mediterranean, with wet an mild winters (mean temperature: min 7^0C and max 14^0C) and hot, dry summers (mean temperature: min 19^0C and max 32^0C). Rainy season: October to April, with 570 mm average annual rainfall. At least consecutive five months with no rainfall.

Experimental design and sampling

Experiment started in 1993 in an area of 250 ha, comprising two blocks of four fenced paddock areas each (average paddock size 31 ha). Grazing treatments: 2 stocking rates, with and without subdivision of the grazing area, in a factorial arrangement of 4 grazing systems. In treatments without subdivision of the grazing area (continuous grazing- **C**) animals grazed from about January to October. In treatments in which the grazing area was subdivided (seasonal grazing- **S**): cows were on half of the paddock since the beginning of the grazing season (early grazing- **E**) and then moved to the other half of the paddock until October (late grazing- **L**). Grazing started after the early establishment of the vegetation, or when the green standing biomass exceeded 500 kg dry matter ha^{-1-} (deferred grazing). From October the herd was kept in corrals until the following grazing season (January-February). Thus, the four grazing systems resulted in six vegetation treatments (Table 1). Grazing pressure expressed as cow-days/ha was estimated as: $GP = n \times d/a$, where n = number of animals per paddock, d = duration of the grazing period (days), and a = area of the paddock (ha).

The vegetation was monitored in spring (early to mid-April), during the peak season of primary production. Plant cover and species composition were estimated using the step-

point method, along permanent transects, 500 to 700 m long, that traversed the paddocks from fence to fence. A thin stick was placed vertically in the vegetation at every two steps.

Analysis of variance (ANOVA) and repeated measures of ANOVA were carried out to test effects of treatments and time on the vegetation.

Results and Discussion

The results showed significant changes in *B. bituminosa* plant cover through the years ($F_{5,5}$ = 2.71, P = 0.034). However, no significant effects of grazing treatments were noted when the full model was considered. Grazing pressure (GP) at the paddocks changed significantly through the seasons ($F_{5,5}$ = 28.8, P = <.0001, Fig. 1). The inter-annual rainfall variation and its distribution through the grazing season varied significantly during the research six-year period. The first two and the last season (1994-95 and 1999) were relatively dry; onset of the rains was late and total rainfall amounted to 63%, 46% and 55% respectively, of the long-term annual average for the site. Vegetation did not begin new growth until January 1994-95 and 1999. Consequently, the cattle were introduced in the paddocks relatively late, when the available green forage exceeded the 500 kg DM ha^{-1}. In the following seasons, effective rain for germination fell during November, when total rainfall was close to average.

When comparing grazing pressure between continuous moderate and continuous heavy grazing (CM vs. CH), significant differences between years and treatment were noted ($F_{5,5}$ = 63.3, P = <.0001, $F_{1,1}$ = 709, P = <.0001, respectively. Fig. 1a). *B. bituminosa* plant cover significantly change through the seasons ($F_{5,5}$ = 7.79, P = 0.002), but was not affected by treatment (Fig. 1d). Also when contrasting seasonal heavy early (S-HE) vs. seasonal heavy late (S-HL), and seasonal very heavy early (S-VHE) vs. seasonal very heavy late (S-VHL) no

significant grazing and year effects were noted (Fig. 1e,f). However, significant differences in grazing pressure were noted for both seasonal treatments (Fig. 1b,c).

The lack of grazing effect on plant cover of *B. bituminosa* at the peak of primary productivity (time of the vegetation sample) despite very heavy grazing pressure, is presumed to be related to cattle feeding preferences to more palatable neighbor species present at that time. As grazing continued through the green season and more palatable species are eaten and reduced, the cattle shift to *B. bituminosa* and forage on it intensively. At the end of the grazing season *B. bituminosa* is one of the few species with green leaves.

A remarkable attribute of this species is its persistence and tolerance to grazing. Changes in plant cover of *B. bituminosa* were mainly related to rainfall conditions and not to grazing pressure, even at very high grazing intensity. It appear to be adapted to survive under heavy and very heavy grazing pressure, as its perennating buds are buried near the soil surface and most of their shoots desiccate in summer. Its persistence is also associated with the development of secondary chemical compounds. They are also less dependent on seed production compared to annual species. This hemicryptophytic strategy and associated morphology allows fast growth and early establishment after the first rains, and a higher tolerance of grazing. Its importance as complementary forage at the end of the green season deserves further investigation.

References

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Table 1 - Experimental design and grazing treatments.

Grazing system	Stocking rate	(cow ha^{-1} $year^{-1}$)	Timing of grazing	Grazing vegetation treatment
Continuous	Moderate	0.55	All season	CM
	Heavy	1.1	All season	CH
Seasonal	Heavy	1.1	Early	S-HE
			Late	S-HL
	Very heavy	2.2	Early	S-VHE
			Late	S-VHL

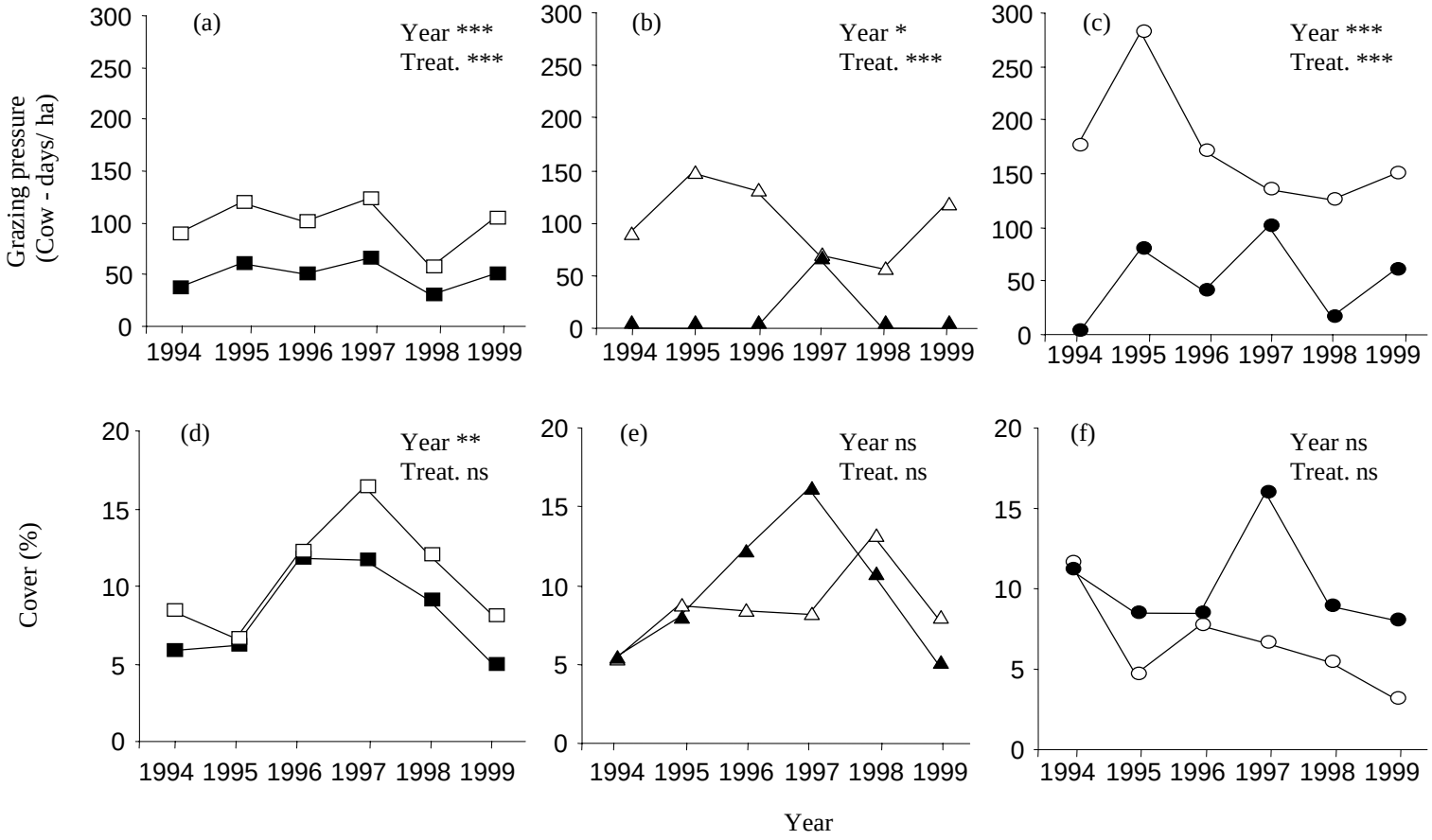

Figure 1- Changes in grazing pressure (a-c) and *Bituminaria bituminosa* cover.(d-f) Continuous moderate (black squares); continuous heavy (white squares); seasonal heavy early (white triangles); seasonal heavy late (black triangles); seasonal very heavy early (white circles); seasonal very heavy late (black circles).