Ecophysiological approach of two herbaceous species in a grazed Robinia pseudoacacia L. silvopastoral system

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Ecophysiological approach of two herbaceous species in a grazed *Robinia pseudoacacia* L. silvopastoral system

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Abstract. The water relations and the ecophysiological mechanisms of the herbaceous understory vegetation were studied in a *Robinia pseudocacia* L. (Black locust) silvopastoral system under moderate grazing. The research was conducted at Scholari village, Thessaloniki, north Greece. The experimental area was separated into six plots, which were fenced in order to exclude the uncontrolled grazing. Three of them were randomly assigned to be grazed (0.9 sheep/ha/year) while the other three remained ungrazed. In all plots black locust was planted. Half of every plot was ploughed and seeded with *Dactylis glomerata* L. cv 'Palestina' while the other half remained with the natural herbaceous vegetation. The water potential and relative water content of *Dactylis glomerata* and of the dominant native grass *Poa bulbosa* L. were measured. The results have shown that there was no significant difference in water balance of *Dactylis glomerata* and *Poa bulbosa* due to grazing. *Dactylis glomerata* seems to have the ability of controlling its internal water balance by using the physiological mechanism of hydraulic resistance while *Poa bulbosa* controls it by osmotic adjustments.

Keywords. Water potential – Relative water content – *Dactylis glomerata* – *Poa bulbosa.*

Approche écophysiologiques de deux espèces herbacées dans un système sylvopastoral de* Robinia pseudoacacia *pâturé

Résumé. *La recherche a été conduite au village de Scholari de Salonique au nord de la Grèce. L'objectif de cette recherche était d'étudier les relations entre l'eau et les mécanismes écophysiologiques de la végétation du sous-étage herbacée dans un système sylvopastoral de* Robinia pseudocacia *L. sous pâturage modéré. La surface expérimentale a été séparée en six parcelles clôturées afin d'exclure le pâturage non contrôlé. Trois d'entre elles ont été aléatoirement assignées pour être pâturées tandis que les autres trois restaient non pâturées. Dans toutes les parcelles de terrain* Robinia pseudocacia *a été plantée. La moitié de chaque parcelle de terrain a été labourée et semée avec* Dactylis glomerata *L. cv 'Palestina' tandis que l'autre moitié demeurait avec la végétation herbacée naturelle. Le potentiel hydrique et la teneur en eau relative de* Dactylis glomerata *et* Poa bulbosa *L. ont été mesurés. Les résultats ont prouvé qu'il n'y a aucune différence significative dans le bilan hydrique entre le* Dactylis glomerata *et le* Poa bulbosa *due au pâturage. Le* Dactylis glomerata *semble avoir la capacité de réguler la contrainte hydrique en employant le mécanisme physiologique de la résistance hydraulique tandis que le* Poa bulbosa *la maîtrise par des ajustements osmotiques.*

Mots-clés. *Potentiel hydrique – Teneur en eau relative –* Dactylis glomerata – Poa bulbosa.

I – Introduction

The establishment of a silvopastoral system in degraded Mediterranean semiarid grasslands is expected to fill up the feed gap of the grazing animals during summer (Ainalis and Tsiouvaras, 1998). Such a system can use valuable woody fodder species combined with herbaceous species in the understory (Sklavou, 2002). Nevertheless, water availability is the most limiting factor for plant growth in arid and semiarid areas. Plants in these environments have developed an array of adaptation mechanisms to drought conditions. They can avoid water stress by maximising water uptake or minimizing water loss (Arndt *et al*., 2001) modificating morphological and physiological characteristics. The improvement of grazing and drought tolerance of C_3 perennial species is an important component of many plant improvement programmes and based on an understanding of the ecophysiology of grass growth (Kemp and Culvenor, 1994).

The aim of this paper was to investigate the water relations and the ecophysiological mechanisms of two herbaceous species in a *Robinia pseudoacacia* L. (Black locust) silvopastoral system under moderate grazing conditions.

II – Materials and methods

The research was conducted at a low elevation Mediterranean grassland in Northern Greece. The experimental area (40°41' north latitude, 23°14' east longitude) was located 45 km east of Thessaloniki, at Scholari village and at an altitude of 100 m a.s.l. The climate of the area is characterized as Mediterranean semiarid with cold winters. The long term average annual rainfall in the area is 454.5 mm and the mean air temperature 15.7°C (Sklavou, 2002). The soil texture is sandy to sandy silt, derived from conglometares of the tertiary period and colluvials from river or torrent bank deposits (Ainalis *et al*., 2006). The organic matter content was 0.97% and the pH 5.5 (Ainalis, 1996).

The experimental area was separated into six plots (0.141 ha each plot), which were fenced in order to exclude the uncontrolled grazing. Three of the plots were randomly assigned to be grazed by sheep at a stocking rate of 0.9 sheep/ha/year while the other three remained ungrazed (control). In all plots *Robinia pseudoacacia* (Black locust) was planted. Half of every plot was ploughed and seeded with *Dactylis glomerata* cv 'Palestina' (R.ps. + *D. glomerata*) while the other half remained with the natural herbaceous vegetation. Leaf water potential (Ψ) and relative water content (RWC) were measured in *Dactylis glomerata* and in the dominant native grass *Poa bulbosa* L. (*P. bulbosa*). The measurements were conducted every 15 days at midday during the growing season on mature and intact full expanded upper leaves. For each parameter the values represented averages of four plants. Leaf water potential in both species was measured using the pressure chamber technique (Koide *et al.,* 1991). The RWC was determined on 4 mm diameter discs from leaves similar in age and orientation, and from the same plant to those used for the determination. The RWC was calculated by the formula: RWC= [(Fresh weight-Dry weight)/(Satured weight-Dry weight)] (Lannucci *et al.,* 2002).

General linear model procedure of the SPSS statistical software v. 17.0 (SPSS, Chicago, IL, USA) was used for ANOVA. The LSD at the 0.05 probability level was used to detect the differences among means (Steel and Torrie, 1980). Non-linear regressions of varying Ψ in respect to RWC were fitted per species and grazing treatment using a quadratic function at $p<0.05$.

III – Results and discussion

The seasonal changes of Ψ, in the non grazing treatment, showed differences between the two species (Fig. 1a). *D. glomerata* maintained higher Ψ compared to *P. bulbosa* and probably better internal water balance. This assumption is supported by the seasonal pattern of RWC (Fig. 2a). *D. glomerata* presented higher RWC in relation to *P. bulbosa*. In the grazing treatment (Fig. 1b) *P. bulbosa* presented higher Ψ in relation to *D. glomerata*. It was expected that the interference of grazing would improve the water balance of both species but this is not obvious (Fig. 1). However it seems that grazing tends to diminish the hydrodynamic differences between the two species (Fig. 2).

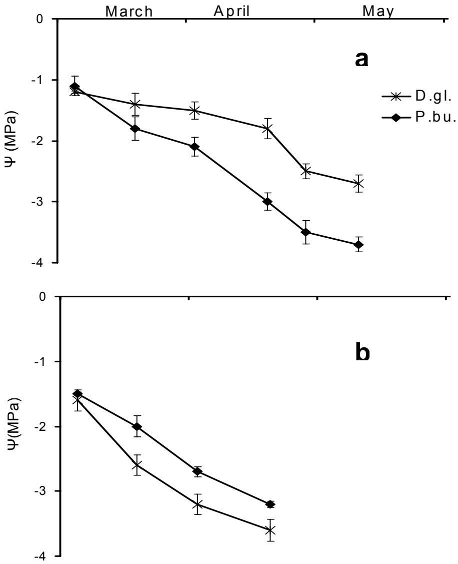

Fig. 1. Seasonal changes in water potential (Ψ) of *D. glomerata* and *P. bulbosa* in non grazing (a) and grazing (b) treatment. Values present means ± SE of four replicates per species.

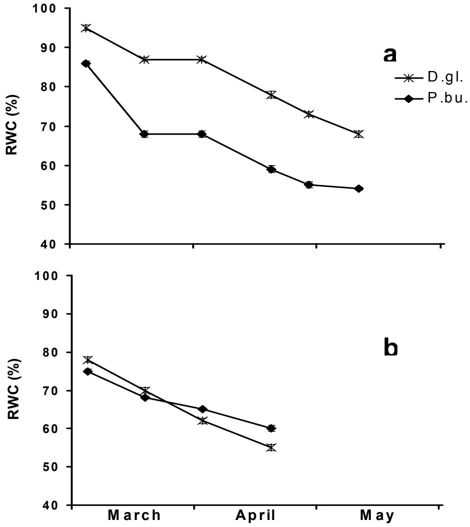

Fig. 2. Seasonal changes in relative water content (RWC) of *D. glomerata* and *P. bulbosa* in non grazing (a) and grazing (b) treatment. Values present means ± SE of four replicates per species.

The changes of Ψ in relation to RWC (Fig. 3) in the two treatments (non grazing, grazing) indicated that the Ψ of *D. glomerata* and *P. bulbosa* was decreased as water deficit increased. However, at the same value of Ψ *P. bulbosa* has lower value of RWC compared to *D. glomerata*. *D. glomerata* probably has the ability either to reduce transpiration losses or to absorb larger amounts of water, triggering the hydraulic conductivity mechanism (Noitsakis, 1981; Lovisolo and Schubert, 1998). The pattern of Ψ in relation to RWC in *D. glomerata* was typical and expected (Roy, 1980; Noitsakis, 1984) while *P. bulbosa* seems to present osmotic adjustements (Noitsakis and Tsiouvaras, 1990; Flexas and Medrano, 2002; Chaves *et al.*, 2003).

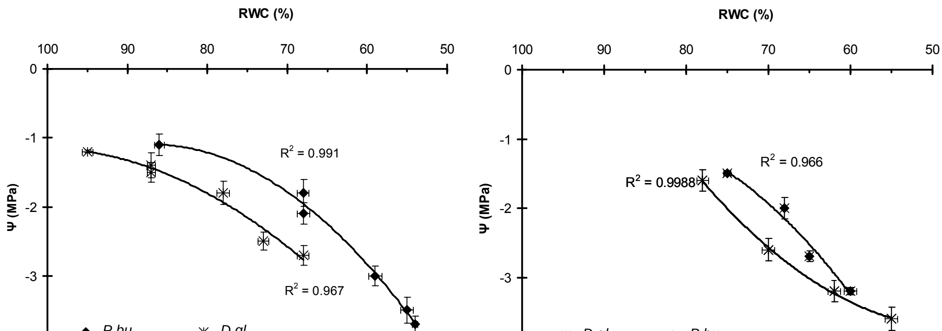

Fig. 3. The relationship between leaf water potential (Ψ) and relative water content (RWC) of *D. glomerata* and *P. bulbosa* in non grazing (a) and grazing (b) treatment. Values present means ± SE of four replicates per species.

The results suggest that *D. glomerata* and *P. bulbosa* could develop specific physiological adaptation and growth mechanisms under water deficit and grazing conditions in a *R. pseudoacacia* silvopastoral system.

IV – Conclusions

The grazing does not modify the internal water status of the two species; however, *D. glomerata* and *P. bulbosa* seem to have the ability of controlling their internal water balance by using the physiological mechanism of hydraulic resistance, the former, and by osmotic adjustments, the latter.

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