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Growth of *Morus alba* L. under water deficit conditions

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SUMMARY – *Morus alba* is a high quality and forage species, recently introduced in the Mediterranean rangelands. The effects of water stress on growth parameters of *M. alba* were studied. *M. alba* seedlings were planted under a transparent shelter. Three irrigation levels (100%, 50%, and 25% of water-holding capacity) were applied. Half of the plants were cut at 30% of their current stem length at the end of May. Water potential (Ψ) and relative water content (RWC) were measured every 15 days. Additionally, leaf and stem growth rates were estimated. The cutting plants maintained more favourable water balance in the leaf tissue than the control. Ψ in plants subject to the cutting treatment decreased as the water stress increased, whereas the plants in 100% water-holding capacity had higher Ψ and lower LGR/SGR ratio. These results suggest that *M. alba* could develop specific adaptation and growth mechanisms under water deficit conditions.

Keywords: Growth parameters, shrubs, water relations.

RESUME – *"Croissance de Morus alba L. en conditions de déficit hydrique". Le but du travail était d'étudier l'impact de la contrainte hydrique sur des paramètres de croissance chez* Morus alba*. Des plantes provenant de graines étaient plantées sous un couvert transparent. Trois régimes hydriques ont été effectués (100%, 50%, et 25% de la capacité de teneur en eau des pots) et deux traitements de coupe ont été opérés (0% et 30% de tige) à la fin mai. Le potentiel hydrique (Ψ) et la teneur en eau relative (TER) ont été mesurés tous les 15 jours au cours de la croissance. A la fin de cette période le rapport poids des feuilles/poids des tiges a été calculé. Les résultats obtenus suggèrent que la coupe affecta l'état hydrique, étant plus favorable chez les plantes coupées, et que le rapport feuilles/tiges augmenta en contrainte hydrique. Ainsi l'on pourrait avancer la thèse que* M. alba, *même en conditions d'aridité, avait la capacité de grandir, étant bien adapté à ces conditions.*

Mots-clés : *Paramètres de croissance, espèce fourragère, hydrique.*

Introduction

The hot dry summers, the cool wet winters and the variability and unpredictability of precipitation are the main characteristics of the semi-arid climates (Joffre *et al*., 1999). Especially, in the Mediterranean region the summer drought is considered the main environmental constraint for plant growth and survival (Galmés *et al*., 2007). Moreover, in Mediterranean region the climate tends to become warmer and drier as a result of global changes (Annon, 2001). In these environments plants use different strategies for acclimation to environmental conditions (Mudrik *et al*., 2003). Plant can avoid water stress by maximising water uptake or minimizing water loss (Arndt *et al*., 2001) modificating morphological and physiological characteristics as well as biomass allocation (Bargali and Tewari, 2004; Puigdefábregas and Pugnaire, 1999). Thus, the need of establishment of forage plants well adapted to dry conditions is obvious.

On the other hand, the annual pattern of the forage supply in relation to the forage demands of the small ruminants presents a negative balance over the dry period. *Morus alba* recently introduced in the Mediterranean rangelands, is multi-purpose species in Europe and temperate Asia. The interest of this species is due to its high forage quality, production as well as the other uses as timber, feeding of silkworm and windbreaks (Talammucci *et al*., 2000; Parissi, 2001). However, information about the growth and adaptation of this species to dry conditions are limited. Thus, the aim of this study was to investigate the effects of water deficit on growth parameters of *M. alba*.

Materials and methods

The experiment was carried out at the Aristotle University's farm (40º34´ E, 23º43´ N, at sea level)

in northern Greece. The climate is semi-arid, with mean annual temperature 17.5ºC, and total accumulative precipitation 339 mm. Seedlings of *Morus alba* L. were planted in 30 pots 50 cm diameter. The plants were placed under a transparent shelter and received full solar irradiance. Two treatment of cutting were applied (0% G0, 30% G1) at the end of May and three irrigation levels (100% Ho, 50% H1 and 25% H2 of water field capacity were used. The pots were arranged in rows with five replications in each treatment.

Leaf water potential (Ψ) and relative water content (RWC) were measured (Turner, 1981; Koide *et al*., 1991; Kramer 1995) every 15 days at midday. Leaf and stem length were measured during the experimental period in order to calculate the ratio leaf growth rate/stem growth rate (LGR/SGR). All measurements were conducted using completely expanded leaves from the 3rd to 4th leaf from the top of the plant.

Data were evaluated by analysis of variance using GLM procedures of SPSS 14.0 for Windows. Steel and Torrie (1980) least significant difference test (LSD) was used to detect differences between means.

Results and discussion

In Ho irrigation level the cutting does not seem to affect the water status in leaf tissue (Fig. 1a). On the contrary, in the H2 irrigation level the cutting seems to affect positively the internal water status (Fig. 1b). Since, at the same value of leaf water potential (Ψ) -1.5 MPa the cut plants (G1) have higher value of RWC compared to uncut plants (G0). Apparently, this favouring water balance in cut plant could maintain the photosynthetic capacity (Karatassiou, 1999; Chaitanya, 2003).

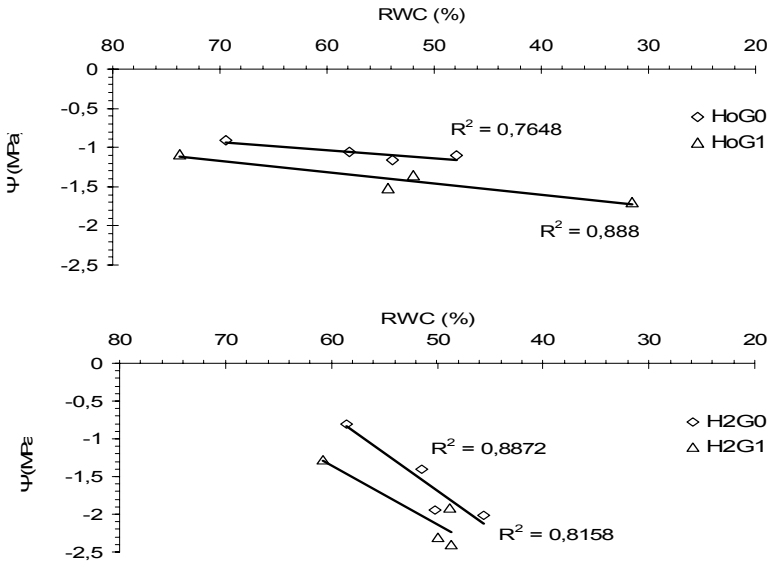

Fig. 1. Relationship between relative water content (RWC, %) and leaf water potential (Ψ, MPa) of *Morus alba* L. in control (G0) and cutting (G1) treatments in two irrigation level: (a) 100% (Ho) and (b) 25% of water holding capacity (H2).

The ability of *Morus alba* to present higher relative water content (RWC) under cutting conditions is depicted in Fig. 2 where at the same value of leaf water potential the higher RWC appeared in irrigation treatment H2 in respect to H1.

The effects of favouring water status on photosynthetic capacity clearly appear in Fig. 3 where the leaf growth rate in cut plants and H1 and H2 irrigation level seems to be higher compared to Ho

conditions at least by 27 June. Then on, the values of ratio LGR/SGR did not significantly differ. Consequently, the forage production of *Morus alba* under cutting and stress conditions consists more of leaves than of stems. This fact is significant for the Mediterranean region especially during the summer when the water is the main limited factor for production and also because leaves have higher nutritive value than stems (Mero and Uden, 1997; Parissi, 2001). These results suggest that *M. alba* could develop specific morphological or physiological mechanisms of adaptation and growth under water deficit conditions.

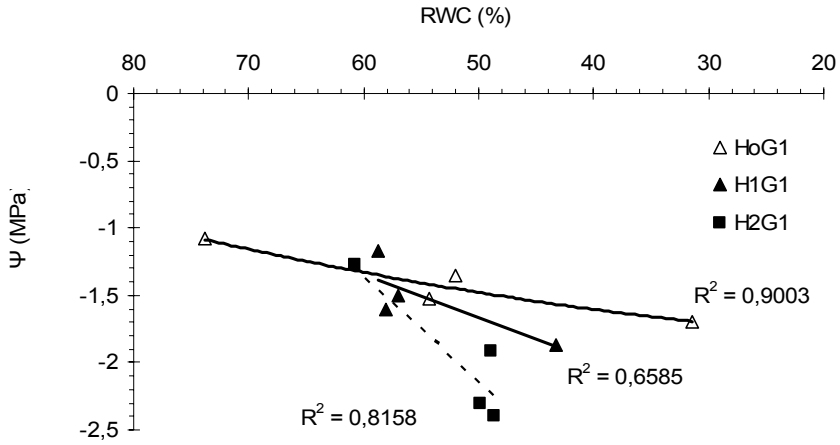

Fig. 2. Relationship between Relative Water Content (RWC, %) and leaf water potential (Ψ, MPa) of *Morus alba* L. cutting (G1) treatments in three irrigation levels 100% (Ho), 50% (H1) and 25% (H2) of water holding capacity.

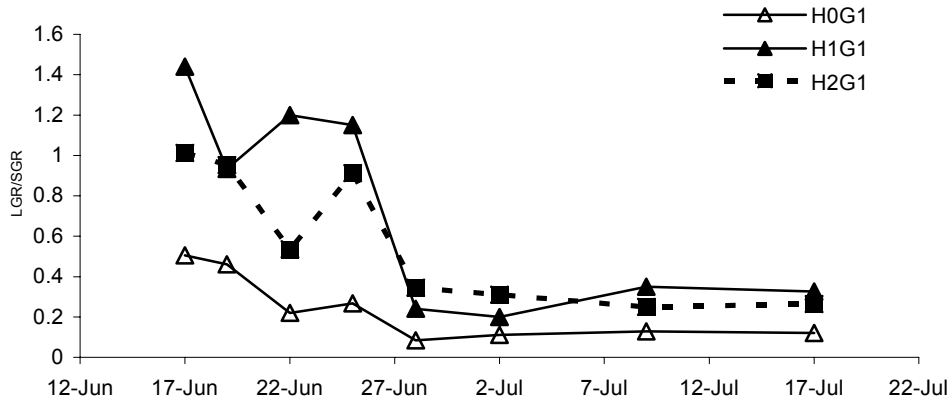

Fig. 3. The ratio leaf growth rate/stem growth rate (LGR/SGR) of *Morus alba* L. in cutting treatment in three irrigation levels 100% (Ho), 50% (H1) and 25% (H2) of water holding capacity.

Conclusions

The ability of *Morus alba* L. to maintain forage production in dry conditions suggests that it could be a promising species in semi arid Mediterranean zone.

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