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Influence of water deficit on growth parameters of perennial grass species

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Abstract. Water is one of the most important environmental factors controlling the production of perennial grass species under semi arid Mediterranean conditions. In this experiment, the influence of water deficit on the growth parameters of three perennial grasses (*Agropyron intermedium*, *Bromus inermis* and *Phalaris aquatica*) was investigated. For this reason the shoot weight, the leaf weight and the leaf area were measured every fifteen days during the growing season and the specific leaf area (SLA) was calculated. *P. aquatica* presented the highest leaf and shoot weight, leaf area and SLA while *A. intermedium* the lowest leaf and shoot weight, leaf area and SLA. *B. inermis* showed an intermediate behaviour. The results suggest a differential performance of the three species in terms of growth under water deficit conditions. *P. aquatica* showed higher tolerance under drought conditions followed by *B. inermis.*

Keywords. *Agropyron intermedium* L. – *Bromus inermis* L. – Drought – *Phalaris aquatica* L. – Specific leaf area.

L'influence du déficit de l'eau sur les paramètres de croissance des espèces graminées pérennes

Résumé. *L'eau est une des facteurs environnementaux les plus importantes pour contrôler la production des espèces vivaces d'herbe dans des conditions méditerranéennes semi arides. Dans cette expérience on a étudié l'influence du déficit de l'eau sur les paramètres de croissance de trois herbes vivaces (*Agropyron intermedium, Bromus inermis *et* Phalaris aquatica*). Pour cette raison, le poids de tige, le poids foliaire et la surface foliaire ont été mesurés tous les quinze jours pendant la période de végétation et la surface foliaire spécifique (SLA) a été calculée. Le* P. aquatica *a présenté le poids foliaire et le poids de pousse le plus élevé, la surface foliaire et le SLA tandis que l'*A. intermedium *a présenté le poids foliaire et le poids de tige le moins élevé, la surface foliaire et SLA. Le* B. inermis *a montré un comportement intermédiaire. Les résultats suggèrent que les trois espèces n'aient pas présenté la même représentation en termes de croissance dans des conditions de déficit de l'eau avec le* P. aquatica *montrant une tolérance plus élevée dans des conditions de sécheresse suivies de* B. inermis.

Mots-clés. Agropyron intermedium *L.* – Bromus inermis *L.* – *Sécheresse* – Phalaris aquatica *L.* – *Surface spécifique des feuilles.*

I – Introduction

Drought is the most important environmental stress and many efforts have been made to improve crop productivity under water-limiting conditions (Cattivelli *et al.*, 2008). It is predicted that climate of the Mediterranean region will change with prevalence of drier and hotter summers as resulting from global warming leading to significant yield losses (IPCC, 2007; Jacobsen *et al.*, 2012).

Differential ability of plant species to survive under drought conditions may be a major factor influencing plant-community composition. Thus, an appropriate study of the specific variations in drought resistance and the factors involved in its determination is of special interest in order to forecast future plant-community changes (Matías *et al.*, 2012). At the species level, changes in habitat characteristics within an ecosystem may alter growth traits such as plant size, specific leaf

area (SLA) or biomass-allocation patterns, resulting ultimately in a shift in drought resistance (Lloret *et al*., 1999; Poorter *et al*., 2009). Published information suggest that annual species present higher values of SLA than the perennial ones (Garnier *et al*., 1997) while variations have been found in perennial species with different pattern of distribution (Li *et al.*, 2005). Moreover, in the Mediterranean region species belonging to the same growth form or even the same genus have been found to follow different mechanisms to cope with water deficit conditions (Corcuera *et al*., 2002; Karatassiou *et al*., 2009; Karatassiou and Noitsakis, 2010).

The aim of this work was to investigate the influence of water deficit on the growth parameters of three perennial grasses (*Agropyron intermedium*, *Bromus inermis* and *Phalaris aquatica*).

II – Materials and methods

The research was conducted in natural vegetation in the farm of the Aristotle University of Thessaloniki, Northern Greece (longitude: 40° 34‘, latitude: 23° 43‘), at an altitude of 10 m above sea-level. The climate of the area could be characterized as Mediterranean semiarid with cold winters. The mean annual precipitation is 400 mm and the mean annual temperature is 15.5°C. The monthly average precipitation (mm) and the minimum temperature (°C) during the experimental period ranged from approximately 17.02 to 55.64 mm and from 14.6 to 23.4°C respectively.

Measurements were taken in three perennial C_3 grass species: *Agropyron intermedium* (Host) Beauv, *Bromus inermis* Leyss and *Phalaris aquatica* L. These species are widespread in grasslands of the low zone of Northern Greece and their contribution to the grassland production is very important. All measurements were taken during the growing season at four different phenological stages: (i) early vegetative, (ii) vegetative, (iii) flowering, and (iv) inflorescence. Fifteen plants of each species were randomly selected along a line. Three lines and a total of 45 plant species have been considered for each species (Cornelissen *et al.*, 2003). In each phenological stage one tiller from each plant was collected; and the leaf area as well as the fresh weight of shoots and leaves were measured. Leaf area was measured using the portable leaf area measurement system Li-3000A (LiCor Lincoln, Nebraska, USA). Then to determine the dry weight the samples (leaves, stems) were placed in the oven for 48 hours at 70°C. Specific leaf area (SLA) was calculated as the ratio of leaf area to leaf dry weight.

General linear models procedures (SPSS 17 for Windows) was used for data analyses. The LSD at the 0.05 probability level was used to detect the differences among means (Steel and Torrie, 1980).

III – Results and discussion

During the growing season significant changes in growth and allometric parameters of the three grass species were detected. The shoot dry weight in all species (Fig. 1a) showed an increasing trend, while the leaf dry weight (Fig. 1b) a rather decreasing one over the season. In the early phenological stages, the higher dry weight of shoots and leaves was found in *P. aquatica* while in the stage of inflorescence in *B. inermis* but without significant differences between them. Throughout the growing season *A. intermedium* showed the lowest dry weight of shoots and leaves. *P. aquatica* presented the higher mean forage production and *A. intermedium* the lower under semi arid Mediterranean conditions.

As far as the LA is concerned, *P. aquatica* showed the highest average values LA (88.6 cm^2), followed by *B. inermis* (66.7 cm^2) and *A. intermedium* (22.5 cm^2). The SLA, an important trait to survive through a Mediterranan climate, is associated with relative growth rate and plant abilities to use light and soil resources (Grotkopp and Rejmánek, 2007). From the changes of SLA (Fig. 2) during the growing season it becomes apparent that *A. intermedium* and *B. inermis* presented

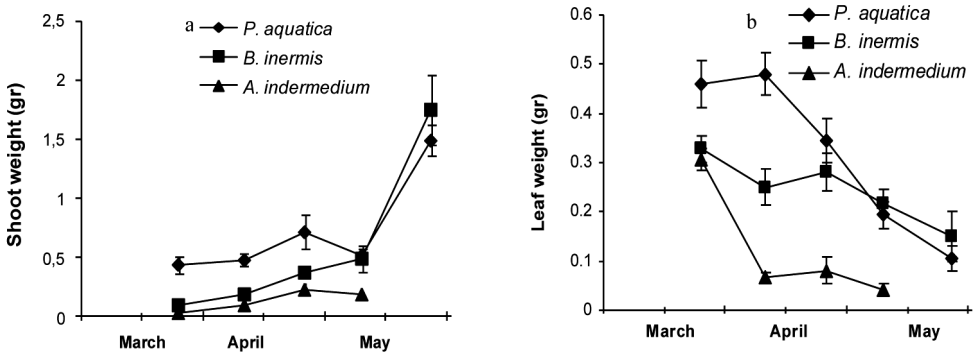

Fig. 1a,b. Seasonal changes of dry weight of a) shoots and b) leaves of three perennial grasses.

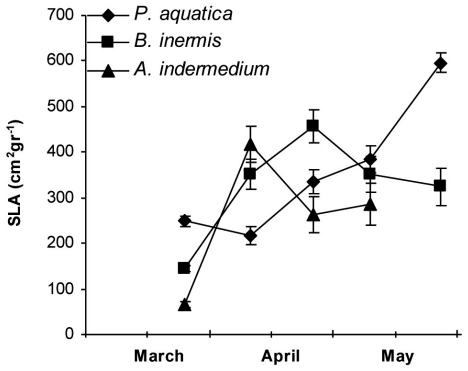

Fig. 2. Seasonal changes of specific leaf area (SLA) of three perennial grasses.

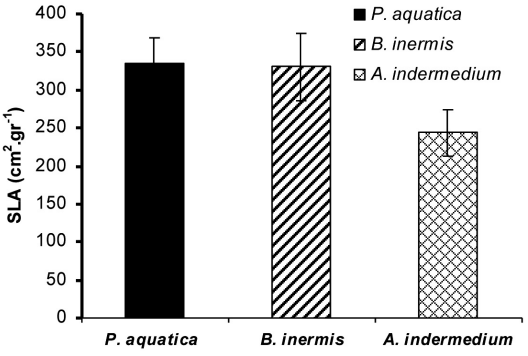

Fig. 3. Mean specific leaf area (SLA) of three perennial grasses during the growing season.

similar behaviour since they both showed an increased trend in SLA until the first days of April followed by a significant decrease from that point towards the inflorescence stage. On the other hand, SLA in *P. aquatica* followed a completely different pattern with a stabilizing trend until the first days of April that abruptly increased until the stage of inflorescence. In the inflorescence stage, when the water deficit was higher, *P. aquatica* presented the higher SLA and consequently the higher production. The increased trend in SLA and the decreasing pattern of the leaf weight of *P. aquatica* in May indicates that this species in the mature vegetative stage developed large but thin leaves to capture the available light more efficiently and continued to grow (Gurevich *et al.*, 2006). *P. aquatica* has the capacity to maintain an optimum water balance under drought conditions (Karatassiou *et al.,* 2010) exhibiting also higher productivity (Li *et al.,* 2005). Moreover, no significant differences in the values of mean SLA between *P. aquatica* and *B. inermis* were found, while *A. intermedium* showed the lowest values (Fig. 3). The three perennial grasses showed differences in their SLA and consequently in their relative growth rate and survival under semi arid Mediterranean conditions(Grotkopp and Rejmánek, 2007). It seems that *P. aquatica* and to a

lesser extent, *B. inermis* showed a higher SLA because of their capacity to maintain optimum water balance under drought conditions, allowing the function of stomatal apparatus (Karatassiou *et al.*, 2010). Therefore, in the Mediterranean region *P. aquatica* could be considered as a more tolerant and productive species followed by *B. inermis.*

IV – Conclusions

Plant species with the same life form did not follow the same growth and biomass allocation patterns under drought conditions. *P. aquatica* and *B. inermis* showed higher specific leaf area index and therefore greater adaptation to drought than *A. intermedium*. These species are desirable in the vegetation of Mediterranean grasslands in order to provide high amounts of food production for small ruminants.

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