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Differences in growth characteristics between ecotypes of *Dactylis glomerata* L. under water-deficit conditions

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Abstract. It has been predicted that in the Mediterranean region the climate will become warmer and drier in the following years as a result of global changes. As consequent, the development of improved water-saving varieties is a high priority in forage grass breeding programs. In this experiment the adaptation responses to water-deficit conditions of two ecotypes of *Dactylis glomerata* L. (cocksfoot) were studied. The experiment was conducted in the farm of Aristotle University of Thessaloniki, northern Greece. Two ecotypes of cocksfoot originating from different mountainous habitats, a fir forest and an adjacent open grassland, were selected in 2008. Plants of these ecotypes were planted into pots and subjected to the following water supplies during the growing season from April to June: (i) well-watered conditions; and (ii) rainfed conditions. The number of tillers and the leaf area were measured weekly and the above biomass production was determined at the end of the experimental period. According to the results, the grassland ecotypes tended to have higher number of tillers than the forest ecotype under well-water conditions but lower under rainfed conditions. Additionally, at the end of the experimental season the forest ecotype had significantly higher specific leaf area and dry matter production in comparison to the grassland ecotype in both well-watered and rainfed conditions.

Keywords. Adaptation – Drought – Grasses.

Différentiation des paramètres allométriques chez des écotypes de *Dactylis glomerata* L. sous contrainte hydrique

Résumé. Il est prévu que dans la région méditerranéenne le climat devienne plus chaud et plus sec dans les années à venir suite aux changements globaux. Il en résulte que le développement de variétés nécessitant moins d'apports en eau est une haute priorité des programmes de recherche sur les céréales. Dans l'étude présentée ici, les réponses adaptatives de deux écotypes de *Dactylis glomerata* L. à un stress hydrique sont étudiées. L'étude a été réalisée à l'Université Aristote de Thessalonique en Grèce du Nord. Deux écotypes de dactyles agglomérés provenant de différents milieux montagneux, une forêt de sapins et une prairie adjacente, ont été prélevés en 2008. Les plants ont été empotés et alimentés en eau lors de la période de croissance entre avril et juin suivant deux procédures : abondant ou analogue à celui fourni par les pluies. Le nombre de jeunes pousses est comptabilisé toutes les semaines, et la surface foliaire et la production de biomasse déterminées à la fin de l'étude. Les résultats indiquent que l'écotype de prairie présente plus de pousses que celui de forêt lorsque l'apport en eau est abondant, mais moins dans le cas d'un apport analogue aux pluies. De plus, à la fin de l'expérimentation, l'écotype de forêt avait une surface foliaire et une production de matière sèche significativement plus importante que l'écotype de prairie, dans les conditions normales de précipitations.

Mots-clés. Adaptation – Sécheresse – Allométrie.

I – Introduction

Water is one of the major environmental factors controlling persistence and production of

perennial grasses grown under rain-fed conditions in Mediterranean areas (Lelievre and Mansat, 1990). As it has been predicted, the climate will become warmer and drier in the following years, therefore the development of improved water-saving varieties is of high priority in forage grass breeding programs.

Perennial grasses are widespread in their adaptation, due to the vast diversity they possess in physiology and growth form. Their adaptation depends on plasticity of plant growth habit and on how the environment affects its expression (Nelson, 2000). Knowledge about these characteristics of grasses is essential for effective management and genetic improvement.

Dactylis glomerata L. is a widespread perennial grass species, well adapted to dry conditions (Volaire and Thomas, 1995). Its populations thrive in a variety of environments and as it has been reported they differ in their ability to grow and survive under water deficit conditions (Volaire, 1991). The objective of this paper was to study the growth responses of two different ecotypes of *Dactylis glomerata* under both well-watered and rainfed conditions.

II – Materials and methods

The experiment was conducted 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 according to the bioclimatogram of Emberger (1942) could be characterized as Mediterranean semiarid with cold winters. The mean annual precipitation is 443 mm and the mean annual temperature is 15.5°C. The monthly average precipitation (mm) and temperature (°C) during the experimental period are presented in Table 1.

Table 1. Monthly precipitation (mm) and average temperature (°C) over the experimental period

	January	February	March	April	May	June	July
Precipitation (mm)	96	11	51	14	44	59	12
Temperature (°C)	6.2	6.0	9.6	13.3	20.3	23.3	26.6

Vegetative tillers from 40 randomly selected individual plants of *D.gl* were collected from a fir forest and from adjacent open grassland at Pertouli area (a.s.l. between 1200-1600 m, Central Pindus mountains, central Greece) in autumn of 2008. Approximately five single tillers of each plant were initially planted into plastic pots, filled with organic matter. The pots were placed in a greenhouse for two months. Eight plants were randomly selected from each ecotype (fir forest and open grassland) and two similar in growth tillers from each plant transplanted to 16 plastic pots (30 cm diameter, 30 cm depth) full of soil from the farm. Plants were subjected during the growing season from April to June to two water supplies: (i) well-watered conditions (up to field capacity) (WW); and (ii) rainfed (RN) conditions. The pots were arranged in a randomized complete-block design with four replications. The number of tillers was measured weekly, in a total of four times. At the end of the experiment the plants were cut at the ground level for the determination of the dry matter production. Leaf area was measured using an area measurement system (Delta-T Devices, Cambridge, UK) (Norman and Campbell, 1991); the same sample was then oven dried at 70°C for 48 h in order to assess its dry weight. Specific leaf area (SLA) was calculated as the ratio of leaf area to leaf dry weight.

General linear models procedure of SPSS statistical software (SPSS Rel.16.0 for windows, 2007) was used for ANOVA. The LSD at the 0.05 probability level was used to detect the differences among means (Steel and Torrie, 1980).

III – Results and discussion

The number of tillers was not affected by time in both ecotypes under rainfed conditions. On the other hand, well water conditions significantly increased ($P \leq 0.05$) the number of tillers of both ecotypes from the second week and on (Fig. 1). Although the grassland ecotype tended to have higher number of tillers under well water conditions compared to the forest ecotype this increase did not produce significant results. On the contrary, the forest ecotype had significantly ($P \leq 0.05$) higher number of tillers under rainfed conditions.

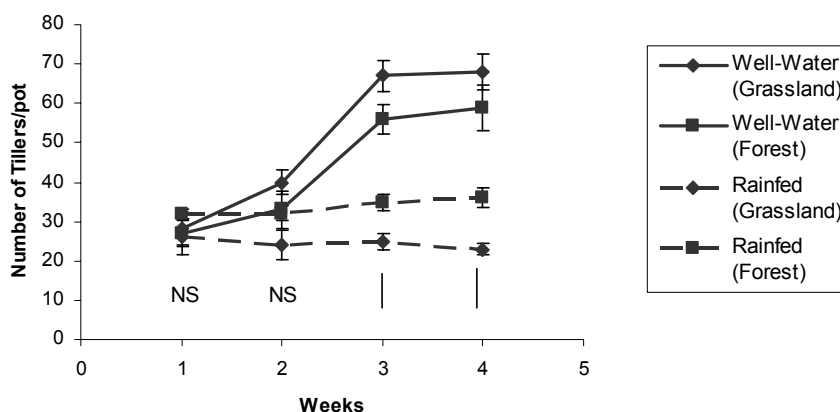


Fig. 1. The number of tillers/pot of Forest and Grassland ecotypes of *Dactylis glomerata* L. under well-watered and rainfed conditions during the experimental period. Bars on the lines represent standard error of mean and vertical bars on the bottom of the figure indicate LSD values ($P \leq 0.05$) for ecotypes comparison at a given week of treatment ($n=4$).

As it was expected, watering led in a significant increase of SLA and dry matter production of both ecotypes (Table 2). However, no significant differences were detected among the ecotypes under well water conditions. Under rainfed conditions the forest ecotype had significantly higher value of SLA and dry matter production compared to the grassland ecotype.

Table 2. Mean values of dry matter production (DM) (g/pot) and specific leaf area (SLA) of two ecotypes (F: forest and G: grassland) of *Dactylis glomerata* under well watered (WW) and rainfed (RN) conditions at the end of the growing season

	Treatment			
	F-WW	G-WW	F-RN	G-RN
Dry matter production (g/pot)	7.2 a	5.3 a	2.4 c	1.6 d
SLA	156.1 a	148.0 a	107.1 b	79.9 c

a,b,c,d: Different letters in each row indicate significant differences ($P \leq 0.05$).

According to these results the forest ecotype had higher number of tillers and higher dry matter production under the moderate water stress that the rainfed conditions produced, as there were rains during the experimental period (Table 1). This could be attributed to the fact that the forest ecotype maintained the efficiency of its photosynthetic machinery, which probably led to higher dry matter production (Kostopoulou *et al.*, data under publication in this issue). On the other

hand, the grassland ecotype had a more drought avoidance behaviour, which could be used as an adaptation mechanism to the more intense drought conditions faced in open grasslands. Additionally, the lower SLA value of the grassland ecotype is indicative of the existence of more old leaves than new ones on the plants (Gunn *et al.*, 1999).

Populations of *D. glomerata* from different bioclimatic zones use different adaptation mechanisms to water deficit conditions (Volaire, 1995; Abraham *et al.*, 2006). It seems that even in the same bioclimatic zone, the environments that plants grow could affect their response to water stress. However, these results are preliminary. A further test of the genotypes from forest and grassland is needed for more years and under more severe water stress, as it is possible the response of forest ecotype to be the result of phenotypic plasticity and not adaptation (Pérez de la Vega, 1997).

IV – Conclusions

These preliminary results indicated that the forest ecotype of *D. glomerata* had better response under moderate water-deficit conditions in comparison to grassland ecotype. In other words, it seems that genotypes of *D. glomerata* growing under forest are more productive under drought conditions than genotypes growing in open grassland. From this point of view, the selection of plants growing in forest understory, it is possible to be more efficient in a breeding program for the development of water-saving varieties.

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