Regrowth pattern of *Lotus corniculatus* L. natural populations under limited irrigation

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Abstract

Lotus corniculatus L. (birdsfoot trefoil) is a perennial legume forage species native to the Mediterranean basin, well adapted to marginal environments. In the present study, the regrowth pattern of two *L. corniculatus* natural populations from different origins was examined under optimum and limited irrigation. Plants from two semi-arid areas of northern Greece (Macedonia) were selected and transplanted to pots. They were grown under a transparent shelter in two water regimes: (1) irrigation up to field capacity, and (2) limited irrigation (40% of optimum). Plants were harvested at different dates (phenological stages) in spring and left to regrow. The harvested plants grew for 8, 30, 39 and 46 days. The yield, the leaf and stem weight and the number of stems were measured and the leaf weight ratio (LWR) was calculated. The results showed that limited irrigation reduced the yield and the number of stems of both tested populations. There was a greater decrease in stem biomass than of leaves, giving higher LWR under limited irrigation, especially in the 'Drama' population. This decline in yield suggests that this species is suitable for cultivation in semiarid Mediterranean areas under rain-fed conditions.

Keywords: birdsfoot trefoil, legume, drought, productivity, stem number

Introduction

Drought, a common phenomenon in Mediterranean areas, especially during summer, has many adverse impacts on plants, inhibiting their growth (Asgharipour and Heidari, 2011). The selection of species that produce more under drought can lengthen the time that farmland is productive and enhance eco-efficiency. The identification of morphological characteristics contributes to the study of species tolerance to stress (Acuna *et al.*, 2012; Keating *et al.*, 2010). *Lotus corniculatus* L. (birdsfoot trefoil) is an herbaceous, perennial legume, native to the Mediterranean basin, Europe and parts of Eurasia and Africa. It is an agronomicaly important legume of high nutritive value (Escaray *et al.*, 2012) similar or even higher value than *Medicago* spp. and *Trifolium* spp., mainly because of its non-bloating features when grazed directly by livestock. It is drought-tolerant and well adapted to marginal environments (Carter *et al.*, 1997; Escaray *et al.*, 2012).

The aim of the present study was to compare the regrowth pattern of two natural populations of *Lotus corniculatus* L. of different origin under optimum and limited irrigation.

Materials and methods

Two natural populations of *Lotus corniculatus* L. were sampled from semi-arid areas of central Macedonia, Greece: Drama (temperature 15.22 °C; precipitation 621.3 mm; altitude 100 m.a.s.l.) and Theodosia Kilkis (Kilkis) (temperature 12.2 °C; precipitation 585 mm; altitude 570 m.a.s.l.) in autumn of 2012. The collected plants were transplanted into small pots, at the farm of the Aristotle University of Thessaloniki, Northern Greece (40°31' E, 23°59' N; altitude 6 m.a.s.l.), where the climate is Mediterranean semi-arid with mean annual air temperature of 15.5 °C. In the beginning of March of 2013, 32 plants from each

population were transplanted – one plant per pot – into larger pots (16 cm diameter and 45 cm height), filled with medium-texture soil from the farm. After a period of plant establishment, a transparent shelter was placed over the plants. Two irrigation treatments were applied by drip: full irrigation up to field capacity (Ir) and limited irrigation (LI) (40% water of that received by Ir). The first plant harvest was performed at 4 cm above the soil surface, at four different dates (phenological stages): 1st cut: 21 May 2013, 2nd cut: 29 May 2013, 3rd cut: 5 June 2013, 4th cut: June, 2013. After that, all the pots were harvested simultaneously on 5 July in order to estimate the plant regrowth. The regrowth days were: 8, 30, 39 and 46, depending on the first harvest date. The fresh and dry yield of each plant was measured after each cutting. The number of stems per plant, the stem and leaf dry weight was measured. Leaf weight ratio (leaf dry weight/shoot dry weight: LWR) was calculated. A completely randomized design with four replications of each treatment was used. Three-way ANOVA analysis was performed using IBM SPSS statistical software v. 21.0 (SPSS Inc., Chicago, IL, USA), in order to determine differences among populations, days of regrowth and irrigation treatments. The least significant difference (LSD) at the 0.05 probability level was used to detect the differences among means.

Results and discussion

The number days of regrowth and the irrigation level significantly affected the yield, but there were no significant differences between the populations and no significant interactions among the main effects (data not sown). On average (mean across the irrigation level and the populations), significantly lower yield was recorded at 8 and 30 days of regrowth (Table 1). No significant differences were detected between 39 and 49 days of regrowth. That means that the highest growth was at 39 days, for both populations at both irrigation treatments, which is suggested as the appropriate harvest time. Under LI both populations produced less than half the yield of Ir. Similar reductions of yield under drought stress has been reported for this species by many researchers (Acuna *et al.*, 2012; Karatassiou *et al.*, 2014) and for field-grown lucerne (Lazaridou *et al.*, 2003). This result suggests there is potential for use of both of these *L. corniculatus* populations for improving farmland eco-efficiency.

The number of stems was significantly increased up to 39 days, with no significant differences between populations, and there were significantly fewer stems under limited irrigation in both populations (Table 1). The stem number increased during the regrowth period (and also the yield), and the increase was greater under limited irrigation. The leaf weight ratio (LWR), one of the most important allometric indexes determining the photosynthetic rate, plant growth and forage quality, was also significantly affected by population, irrigation and days of regrowth. The LWR increases during regrowth and it is higher under LI than in Ir. Moreover, the 'Drama' population had a significantly higher LWR in both

Table 1. The yield per plant (g), the number of stems per plant and the leaf weight ratio (LWR) of two natural populations of *Lotus corniculatus* under full and limited irrigation.[1]

Treatment	Irrigation			Regrowth days			Populations		
	Yield, g	Stem/plant	LWR	Yield, g	Stem/plant	LWR			
Full irrigation	44 a	60 a	0.33 b				Yield, g	Stem/plant	LWR
Limited irrigation	19 b	53 b	0.50 a						
8 days				3 c	14 c	0.51 b			
30 days				35 b	64 b	0.40 a			
39 days				44 a	71 ab	0.39 a			
46 days				45 a	77 a	0.37 a			
Drama							34 a	56 a	0.46 a
Kilkis							30 a	56 a	0.37 b

[1] Values given are the means of four replicates. Different letters in each column indicate significant differences ($P \leq 0.05$).

irrigation treatments than 'Kilkis'. No significant effect of limited irrigation on LWR was recorded at the first growth of the plant (Karatassiou *et al.*, 2014). Erice *et al.* (2010) reported that the effect of water deficit on LWR varies, and it depends on cultivar and on severity of drought.

Conclusions

Limited irrigation decreased the yield and the number of stems of both the tested populations of *Lotus corniculatus*. There was a greater decrease in stem biomass than of leaves, giving a higher LWR under limited irrigation, especially in the 'Drama' population. This decline in yield suggests that the species is suitable for cultivation in semiarid Mediterranean areas under rain-fed conditions.

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