BIOLOGIA PLANTARUM 42 (1): 129-131, 1999

BRIEF COMMUNICATION

Response of *Calamagrostis arundinacea* and *C. epigeios* to short- and long-term water stress

E. KRAMÁŘOVÁ*, M. KLEMŠ**, B. KLEJDUS** and D. VESELÁ*

*Faculty of Pharmacy, University of Veterinary and Pharmaceutical Sciences, Palackého 1-3, CZ-612 42 Brno, Czech Republic**
*Department of Chemistry and Biochemistry, Mendel's Agriculture and Forestry University, Zemědělská 1, CZ-600 00 Brno, Czech Republic***

Abstract

Water relations of two rapidly expanding species in deforested localities, *Calamagrostis epigeios* and *Calamagrostis arundinacea*, were compared. After short- or long-term water stress, water content and specific leaf area were more reduced in *C. epigeios* than in *C. arundinacea*. After short-term stress, osmotic potential was similar in both species, but after long-term stress, it was much lower in *C. epigeios* plants. Abscisic acid and proline contents were higher in stressed plants of *C. epigeios* than in those of *C. arundinacea*.

Additional key words: abscisic acid, osmotic potential, proline, specific leaf area.

Plant communities rapidly change in deforested localities. Among species rapidly colonising these localities are *Calamagrostis epigeios* and *C. arundinacea*, the former in particular, being a rapidly expanding species in such localities after radical changes to their microclimate, frequently creating closed stands. *C. epigeios* and *C. arundinacea* differ in their growth strategies in natural conditions (Gloser and Barták 1994, Gloser and Gloser 1996). Investigations were therefore carried out to find reasons why *C. epigeios* is more competitive than *C. arundinacea*. Studies of selected parameters of water relations and growth should be a contribution to recognition of the strategies of these species.

Calamagrostis arundinacea (L.) Roth and *Calamagrostis epigeios* (L.) Roth plants were propagated vegetatively. The plants were planted in 10 × 10 × 20 cm containers

Received 18 March 1998, accepted 27 April 1998.
Fax: (+420) 5 41219751

in loamy soil in a glasshouse under natural irradiance, temperature 22 ± 5 °C and relative air humidity 65 ± 10 % for 8 weeks. Control plants were watered regularly to full capillary capacity. After 5 weeks a short-term water stress was induced by exposure of plants to dry air (temperature of 27 ± 2 °C and relative humidity of 35 ± 10 %) for 72 h without watering. The long-term stressed plants were grown under soil moisture of 50 % full capillary capacity and relative air humidity of 45 ± 10 % for the whole period. For the analyses, we took the last fully developed leaves. The endogenous level of ABA was determined using a monoclonal antibody AFRC MAC 252 raised against (+)-S-ABA (*Monoclonal Antibody Centre*, Cambridge, England) according to the RIA method of Quarrie *et al.* (1988). Aqueous extracts of plant leaves were assayed without any purification because this monoclonal antibody has an affinity for metabolites and derivates of ABA. The leaves were homogenised in distilled water and extracted overnight on a shaker at 4 °C. The extract was centrifuged at 6 000 *g* for 10 min at 4 °C. A sample (0.05 cm^3) of the supernatant was assayed by RIA. The radioactivity of the samples was measured by liquid scintillation counting on a spectrophotometer *Packard 2 000 CA* (*Hewlett Packard*, Waldbronn, Germany). The calibration curve and appropriate values of the ABA level were calculated using the *Packard 2 000 CA Securia* programme. HPLC was used for the detection of proline using a *Packard HP 1100* liquid chromatograph equipped with diode array detector. Samples of leaves (2.00 g) were boiled for 5 min with 20 cm^3 80 % ethanol, and the mixtures filtered through *Whatman No. 4* paper. The extracts were evaporated to dryness in a rotary vacuum evaporator and residues were disolved in 2 cm^3 water. *SPE SCX* columns were used for isolation of amino acids. Parallel samples of leaves were taken for specific leaf area (SLA) determination (leaf area/dry biomass ratio) and for measurements of the osmotic potential. The osmotic potential was measured in frozen and thawed tissue samples by the dew point method using a *C 52* chamber and *Wescor HR33T* (Logan, USA) microvoltmeter. The resulting values were elaborated using *Excel* and were statistically treated using the *ANOVA* in *Statgraphics* v. 6. 0.

Both the water content and specific leaf area were substantially reduced by water stress. In *C. epigeios*, water content decreased by 10 % in short-term stressed plants and by 45 % in long-term stressed plants as compared with control plants. In *C. arundinacea*, water content decreased by 2 % in short-term stressed plants and by 14 % in the long-term stressed ones. Thus *C. epigeios* plants were subjected to a much quicker desiccation during water stress than that of *C. arundinacea* (Table 1). Osmotic potentials of control and short-term stressed plants were similar in *C. epigeios* and *C. arundinacea*, while the differences between the long-term stressed *C. epigeios* and *C. arundinacea* plants were statistically significant. The reduction of osmotic potential corresponding to 10 % of the loss of water from leaves of the short-term stressed variants was 0.10 MPa in *C. epigeios* and 0.14 MPa in *C. arundinacea*. ABA contents in leaves of *C. epigeios* and *C. arundinacea* plants grown under different water supply increased at the beginning of water stress and then decreased after long-term water stress. During short-term stress the content of ABA in *C. epigeios* increased to 1015 %, and in *C. arundinacea* to 363 %. In the long-term

stressed plants the contents of ABA in *C. epigeios* were 378 % and in *C. arundinacea* plants 140 % as compared with the control variant (Table 1).

Table 1. Water content [g(H_2O) g^{-1}(d.m.)] (means + SD, n = 6), osmotic potential, ψ_s [MPa] (n = 10), SLA [m^2 kg^{-1}(d.m.)] (n = 6), ABA content [ng g^{-1}(f.m.)] (n = 4 - 10), and proline content [nmol g^{-1}(f.m.)] (n = 3) in the leaves of control and short- and long-term stressed plants of *Calamagrostis epigeios* and *C. arundinacea*. Means with different letter are statistically different from control at $P < 0.01$.

Species	Variants	Water content	SLA	ψ_s	ABA	Proline
C. e.	control	2.787±0.04a	29.44±5.22a	-0.702±0.04a	74.72±24.28a	13.25±1.71c
	short stress	2.508±0.11ab	23.31±1.37b	-0.830±0.03b	833.17±60.6d	27.33±1.88b
	long stress	1.533±0.19d	16.79±1.94bc	-1.610±0.12c	357.48±46.03b	71.03±1.25a
C. a.	control	2.212±0.08cb	21.35±1.25bc	-0.687±0.07a	127.20±51.69a	0.61±0.52d
	short stress	2.172±0.23cb	19.83±2.62c	-0.806±0.03b	588.67±51.47c	1.11±0.21d
	long stress	1.911±0.27cd	16.77±1.70c	-0.858±0.04b	305.16±37.61b	1.87±0.52d

The proline content increased in both species with increasing period of stress. In the short-term stressed *C. epigeios* variant the proline content increased by 106 % of control variants and by 436 % in the long-term stressed variant as compared with the control variant. The absolute amount of proline in the *C. arundinacea* was lower, and the content increase by 90 and 206 % in the short-term and long-term stressed variants, respectively, compared with the proline content in control plants.

The contents of both ABA and proline in plants were dependent on the way of water stress induction and on the length of its duration. *C. arundinacea* did not reach such a degree of water stress as *C. epigeios*, which was confirmed by the concentrations of ABA and proline. However, the conditions of experiments carried out in containers were different from those in the field. *C. epigeios* had a higher relative growth rate and SLA than *C. arundinacea* (Gloser and Gloser 1996). Also rooting of the two compared species were different. That is why in the pot experiments *C. epigeios* might be handicaped.

References

Gloser, J., Barták, M.: Net photosynthesis, growth rate and biomass allocation in rhizomatous grass *Calamagrostis epigeios* grown at elevated CO_2 concentration. - Photosynthetica **30**: 143-150, 1994.

Gloser, V., Gloser, J.: Acclimation capability of *Calamagrostis epigeios* and *C. arundinacea* to changes in radiation environment. - Photosynthetica **32**: 203-212, 1996.

Quarrie, S.A., Whitford, P.N., Appledorf, N.E.J., Wang, T.L., Cook, S.K., Henson, I.E., Loveys, B.R.: A monoclonal antibody to (S)-abscisic acid: its characterisation and use in radioimmunoassay for measuring abscisic acid in crude extracts of cereal and lupin leaves. - Planta **183**: 330-339, 1988.