Proceedings of the 7th Hungarian Congress on Plant Physiology, 2002
S2-P03

Volume 46(3-4):81-82, 2002
Acta Biologica Szegediensis
http://www.sci.u-szeged.hu/ABS

The role of rhizome system in the distribution of cadmium load among ramets of *Phragmites australis*

László Bankó, Mónika Ördög, László Erdei*

Department of Plant Physiology University of Szeged, Szeged, Hungary

ABSTRACT The common reed, *Phragmites australis* (Cav.) Trin. ex Steud., is a clonal plant which is sensitive to environmental disturbances. A clone is composed of large number of ramets which are physically interconnected. In this work the translocation of cadmium from a selected ramet towards the rhizome network of 15 to 30 ramets was investigated in model experiments with known rhizome systems. At the site of treatment, Cd^{2+} uptake was much higher both in the roots and rhizome than in the shoot, however, at the distal ramets, shoots accumulated higher concentration of Cd^{2+} than roots and rhizomes, and the ramets at the farthest site contained the highest levels of Cd^{2+}. The control of transport through the rhizome network by the distal ramet so far has not been described. The mechanism by which the farthest ramet attracts the heavy metal remains to be investigated.
Acta Biol Szeged 46(3-4):81-82 (2002)

KEY WORDS

cadmium
clonal plants
Phragmites australis
reed
rhizome network

The common reed, *Phragmites australis* (Cav.) Trin. ex Steud., is a clonal plant which is often used for cleaning wastewaters and polluted environment. At the same time this species is sensitive to certain environmental disturbances and its closed stands undergo fragmentation and die-back as seen also along the shores of Lake Balaton (Erdei et al. 2001). The capability of reed to accumulate the heavy metal cadmium, one of the most frequent environmental pollutants, was recently investigated and compared to that of in cattail (*Typha latifolia* L.) (Fediuc and Erdei 2002). It was found that the defense strategy in reed, unlike cattail, relies on increased antioxidant enzyme activities rather than on thiol induction characteristics.

Under natural conditions, in a closed stand, a clone is composed of large number of ramets which are physically interconnected. This network may help the clone in giving an adequate response to the effects of the spatial heterogeneity of the habitat. The unfavourable or favourable conditions alter the growth pattern or growth rule of the clone ("division of labour", foraging response, etc.) (Oborny and Cain 1997). We hypothesized that a point-like source, in this case cadmium, taken up by one selected ramet would be translocated via the rhizome system to a certain distance and may exert its effect on any ramet of the network. For this reason, model experiments were carried out on known rhizome networks of 15 to 30 ramets.

Materials and Methods

Single rhizome cuttings with at least 2 buds were prepared from a clone originated from the wastewater canal *Csukásér* near the village Gátér, Hungary, in 1996. The rhizome segments were placed in 7-L plastic containers of 40 x 40 cm in size, the rhizomes were covered with perlite and the container filled up with complete nutrient solution. During the time course, shoots appeared and in a period of 5 years physically interconnected network system developed, containing 15 to 30 ramets in each of the containers. Plants were grown in a greenhouse with additional light intensity of 100 µmol m^{-2} s^{-1} for 12 hours. Day/night temperature was 24/18°C.

At the start of the treatment, a ramet, usually grown at one of the edges of the containers, was selected and carefully placed into a glass containing 100 ml of 100 µmol $CdCl_2$. Nine containers were treated with cadmium and 3 containers were left untreated as control. Sampling was taken after 140-day treatments.

At sampling, perlite was carefully washed out so that the rhizome network and root systems became free of the supporting medium. The ramets and rhizome internodes in the system were numbered and the network was projected and drawn on paper (for example: Fig. 1). Each ramet was

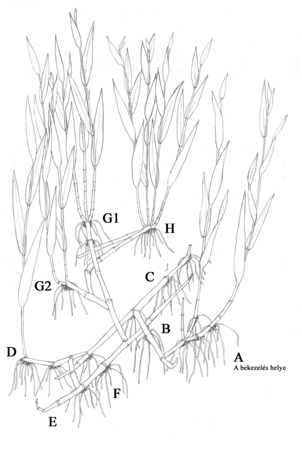

Figure 1. Example for a model plant. The site of treatment was at ramet A, samples for analysis were taken from the sites marked with letters from B to H.

*Corresponding author. E-mail: erdei@bio.u-szeged.hu

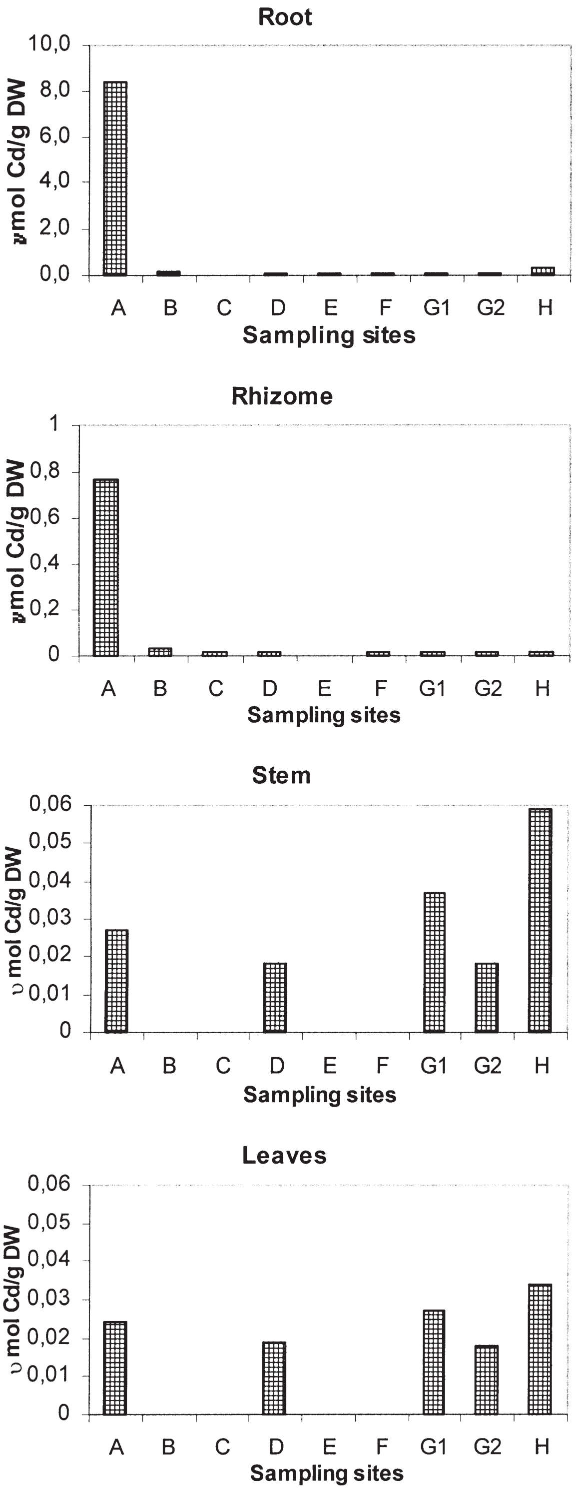

Figure 2. Cadmium transport and accumulation in the ramet network. Cadmium treatment was made at site A. For the location of sites from B to H, see Figure 1.

separated into roots, rhizome, stem and leaves. Internodes without ramets were also collected. Plant samples were dried at 80ºC and wet digested for the analysis of minerals and cadmium. The digest was analysed by a Zeeman-polarized atomic absorption spectrophotometer (Hitachi, Type Z8200).

Results and Discussion

Cadmium transport and distribution

In the ramet network, horizontally, a steep Cd^{2+} concentration gradient was built up between the treated (Fig. 1, site A) and the nearest positions, while toward the distal nodes the Cd^{2+} concentration remained at about the same low level with an increase at the distal ramets, especially in the stem (cane) and leaves. In general, in shoots Cd^{2+} concentration decreased toward the apex. At the site of treatment, Cd^{2+} uptake was the highest in the roots while by an order of magnitude lower concentrations were found in the rhizome and even less in the shoot (Fig. 2). Interestingly, a relative accumulation of cadmium occurred in the distal ramets, especially in the stems and leaves, and the farthest site contained the highest levels of Cd^{2+} within that category (Fig. 2, site H).

The controlling role of the distal ramet in the long distance transport through the rhizome network so far has not been described. For ion transport, obviously transpiration driven xylem transport can be considered as primary pathway and as the reason of the accummulation of cadmium in the farthest ramet. On the basis of the present experiments the mechanism by which the farthest ramet attracts the heavy metal, however, remains to be investigated.

Acknowledgments

This work was supported by the Hungarian Scientific Research Foundation (OTKA T 032 524). The research program is being carried out in the framework of COST Action 837 “Plant biotechnology for the removal of organic pollutants and toxic metals from wastewaters and contaminated sites”.

References

Armstrong J, Armstrong W, Beckett PM, Halder JE, Lythe S, Holt R, Sinclair A (1996) Pathways of aeration and the nmechsnism and beneficial effects of humidity- and Venturi-iduced convections in *Phragmites australis* (Cav.) Trin. ex Steud. Aquatic Botany 54:177-197.

Erdei L, Szegletes Z, Horváth F, Tari I, Pécsváradi A, Dulai S. (2001) Differences in photorespiration, glutamine synthetase and polyamines between fragmented and closed stands of *Phragmites australis* in lake Balaton. Aquatic Botany 69:165-176.

Fediuc E, Erdei L. (2002) Physiological and molecular aspects of cadmium toxicity and protective mechanisms induced in *Phragmites australis* and *Typha latifolia*. J Plant Physiol 159:265-271.

Oborny B, Cain ML (1997) Models of spatial spread and foraging in clonal plants. In de Kroon H, van Groenendael J, eds., The ecology and evolution of clonal plants. Backhuys Publ, Leiden, 155-183.