

## THE INFLUENCE OF WATER EXTRACTS OF SELECTED TURFGRASS SPECIES ON GERMINATION AND INITIAL GROWTH OF *POA ANNUA* L.

Peter Kovár, Luboš Vozár, Ján Jančovič

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### Abstract

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The effect of *Lolium perenne* L., *Festuca rubra* L., *Festuca arundinacea* Schreb., *Poa pratensis* L. and *Poa annua* L. aqueous extracts on germination rate and total germinability of *Poa annua* L. seeds and length of *Poa annua* L. leaves and roots was studied in a laboratory experiment. Germination of seeds was conducted in the growth chamber at the light and temperature regime – day/night – 12/12 hours, 23/15°C, rh 70 %, for 42 days. Extracts significantly affected the total germinability and germination rate of *Poa annua* L. seeds ( $p = 0.000$ ). The lowest germinability ( $27.3 \pm 7.1 \%$ ) and germination rate ( $0.7 \pm 0.2$  seeds per day) had *Poa annua* L. seeds germinated in *Poa pratensis* L. aqueous extract. Used extracts (except for *Festuca rubra* L. extract) had significantly inhibitory effect on length of *Poa annua* L. roots in comparison with control variant. The positive effect of extract from *Lolium perenne* L. and *Festuca rubra* L. (not– significant) and the negative effect of extract from *Poa pratensis* L. and *Poa annua* L. (significant) were apparent on length of *Poa annua* L. leaves.

allelopathy, germinability, plants height, roots length

For properly maintain the functionality of lawns (especially ornamental and sports), it is important to contain undesirable species (weeds). One of the major weed species is the *Poa annua* L., which thanks naturally lighter green colouring distorts colour uniformity of lawn (mosaic appearance). Given that *Poa annua* L. is grass species (monocotyledon plant), the use of herbicides for its control is relatively difficult. Therefore, look for some alternative ways the occurrence eliminate *Poa annua* L. in turf. One possibility is to use the natural ability of plants to produce various chemicals and thus affect not only the germination of seeds in the soil but also surrounding plants, during the seed germination and further plant growth in natural conditions, interactions occur between plants and plant species. In most cases, this effect reflected inhibition, but in some cases there was a stimulating effect. These effects are caused by chemicals (allelochemicals)

that are secreted not only roots, but also leaves. They are secondary metabolites by origin (NILSEN, ORCUTT, 2000) and they have different composition (steroids, essential oils, terpenes, coumarins, phenols, etc.). Allelochemicals are also present in grass grains and to the environment are receiving by the action of water (dew, rain, irrigation) and act on the surrounding plants. Release of substances with allelopathic potential also performed in live, necrosis and decay of plant material (LAŠTŮVKA, 1986). It is especially significant in the grazed grassland, but also in the lawn, where decaying matter may have allelopathical effects on plants (HARKOT *et al.*, 2000; LIPINSKA, HARKOT, 2005) and can influence the composition of turfgrass community (KOVÁR, GREGOROVÁ, 2009).

Knowing a particular place of allelochemical activity in the cells of target plant species is interesting from theoretical and practical viewpoint.

Growth and development of plants, but also their metabolism are significantly influenced by the concentration of excreted or released allelochemicals. The habitus and age of plants, which are influenced by these substances, act the important role (INDERJIT, DAKSHINI, 1995). Significant is knowledge of autoinhibition effect. It eliminates the seed germination of its own seeds around the parent plant and it is also one of the causes of fatigue in multi-annual monocultural cultivation of legumes, cereals and other crops (CALLAWAY, ASCHEHOUGH, 2000).

There was found allelopathical potential of many plants in laboratory conditions, but under natural conditions these substances can be inactivated by adsorption on soil colloids, or become part of the metabolic cycles of microorganisms etc. (KHALID *et al.*, 2002). Although the mechanism of action of many allelochemicals is not adequately examined, this natural phenomenon has a significant impact not only on the rate of succession, but also the species composition of plant communities (BLÁHA *et al.*, 2003).

The aim of this paper was to assess potential influence of aqueous extracts of turfgrass species on the total germinability, germination rate, length of leaves and roots of *Poa annua* L., as one of the major weeds in lawns.

## MATERIALS AND METHODS

Seeds of *Poa annua* L. were harvested from natural conditions of stand Nitra.

Seeds (100 pieces in 3 replications) were placed on sand (150 ml) in Petri dishes (120 × 120 mm). The sand was moisturised by 50 ml of distilled water (control – V1) and 50 ml of 5 % (5 g of fresh matter in 100 ml of solution) aqueous extracts from following turfgrass species – *Lolium perenne* L. (V2), *Festuca rubra* L. (V3), *Festuca arundinacea* Schreb. (V4), *Poa pratensis* L. (V5) and *Poa annua* L. (V6). The aqueous extracts were prepared from fresh aboveground matter of individual turfgrass species. Homogenized fresh matter (5 g) was quantitatively took into 100-ml glass test tube and filled up with distilled water at 50 ml. Consequently, content of the test tube was warmed

up at 90 °C (for better extraction of substances from fresh matter and enzyme inactivation). Content of the test tube was filtered through Filtrak 388 filter paper in the volumetric tube after 24 hours. Filtrate was filled up with distilled water at 100 ml. After this manner prepared 5 % aqueous extract was storage at 4 °C in dark (EINHELLIG, 1995).

The seed cultivation was realized in the growth chamber (Climacell 404) at 23 °C/15 °C with photoperiod 12 hours light/12 hours darkness and relative air humidity (rh) 70%.

During the experimental period (42 days) was sand constantly moist. The germination of seeds was evaluated in 7-day interval. There were done 6 evaluations.

In this experiment were evaluated total germinability (%), rate of seed germination (by CHIAPUSIO, SANCHEZ, 1997):

$$S = (N_1) + (N_2 - N_1)/2 + (N_3 - N_2)/3 + \dots + (N_n - N_{n-1})/n,$$

where

S is rate of germination [number of seeds per day],  $N_1, N_2, N_3, \dots, N_{n-1}, N_n$  is number of germinated seeds at the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, ..., n – 1<sup>th</sup>, n<sup>th</sup> day) and the length of leaves and roots (mm) of *Poa annua* L. seedlings at the end of experiment.

The values of total germinability, germination rate, length of leaves and roots were evaluated in the program STATISTICA (Statsoft, Inc. (2005). Cz Statistica, version 7.1) by one-way analysis of variance (ANOVA) with subsequent testing of significance of differences by Fischer LSD test at the 95 % confidence level ( $\alpha = 0.05$ ).

## RESULTS AND DISCUSSION

In experiment aimed to study the influence of aqueous extracts of selected turfgrasses on seed germination of *Poa annua* L. were found as follows:

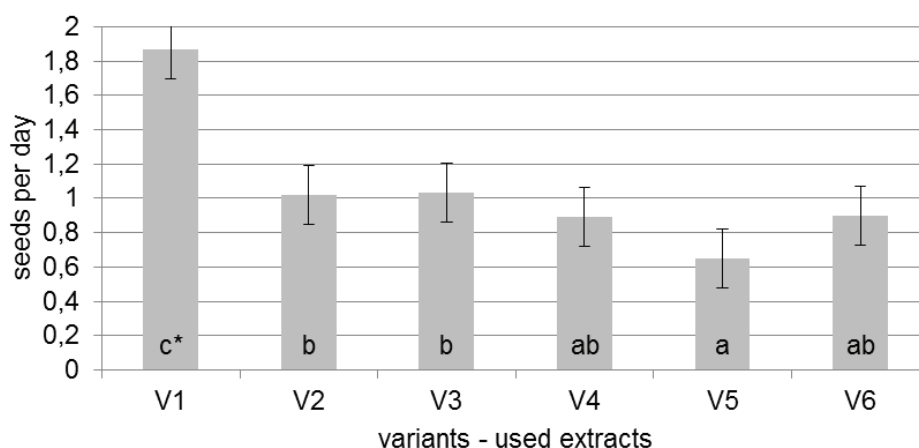
The total germinability of *Poa annua* L. seeds is showed in Tab. I.

Used aqueous extracts had a statistically significant effect ( $p = 0.000$ ) on germination of *Poa annua* L. The lowest germinability was recorded in variant 5 ( $27.3 \pm 7.1\%$ ) – germination of seeds in the leachate from *Poa pratensis* L. The highest number

I: Germination dynamics of *Poa annua* L. seeds (%)

Variant (used extract)	Number of germinated seeds on						Total germinability (%)
	7 <sup>th</sup>	14 <sup>th</sup>	21 <sup>st</sup>	28 <sup>th</sup>	35 <sup>th</sup>	42 <sup>nd</sup>	
	day from establishment of experiment						
V1 – distilled water (control)	2.7	43.7	78.0	78.0	78.3	78.3	78.3 ± 2.8 c*
V2 – <i>Lolium perenne</i>	0	21.7	38.7	42.7	42.77	42.77	42.7 ± 0.7 b
V3 – <i>Festuca rubra</i>	0	18.0	42.7	43.3	43.3	43.3	43.3 ± 0.7 b
V4 – <i>Festuca arundinacea</i>	2.0	32.0	36.0	36.7	37.3	37.3	37.3 ± 2.1 ab
V5 – <i>Poa pratensis</i>	3.3	25.0	26.0	27.0	27.3	27.3	27.3 ± 7.1 a
V6 – <i>Poa annua</i>	3.7	33.4	36.0	37.0	37.77	37.77	37.7 ± 0.7 ab

\* Different letters indices significant differences between variants (Fischer LSD test,  $\alpha = 0.05$ ,  $n = 3$ )

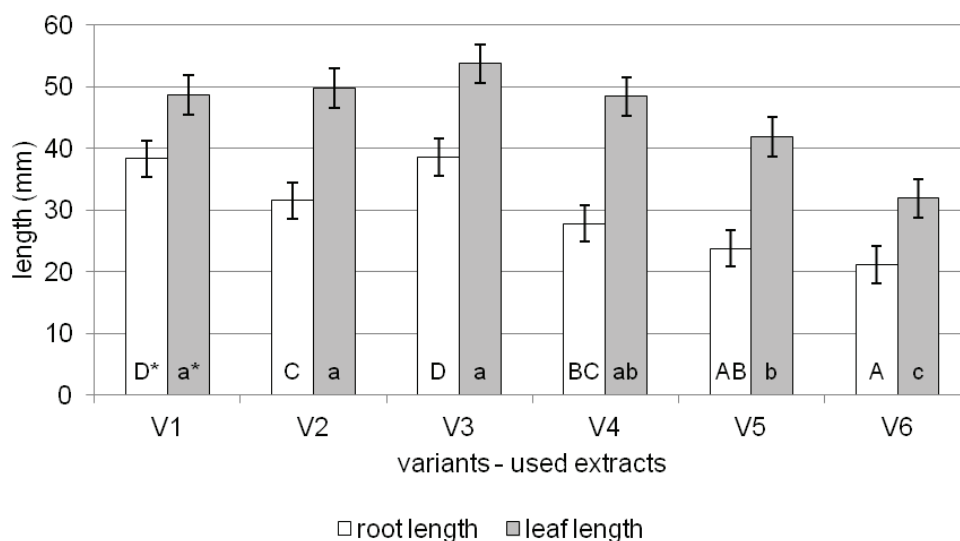


1: Rate of *Poa annua* L. seeds germination (seeds per day)

Variants: V1 – control; V2 – *Lolium perenne*; V3 – *Festuca rubra*; V4 – *Festuca arundinacea*; V5 – *Poa pratensis*; V6 – *Poa annua*

\* Different letters indices significant differences between variants (Fischer LSD test,  $\alpha = 0.05$ ,  $n = 3$ );

I – indices mean  $\pm$  SD



2: Length (mm) of *Poa annua* L. roots and leaves

Variants: V1 – control; V2 – *Lolium perenne*; V3 – *Festuca rubra*; V4 – *Festuca arundinacea*; V5 – *Poa pratensis*; V6 – *Poa annua*

\* Different letters (A–D for root length; a–c for leaf length) indices significant differences between variants (Fischer LSD test,  $\alpha = 0.05$ ,  $n = 3$ ); I – indices mean  $\pm$  SD

of *Poa annua* L. seeds germinated in the control variant (V1) –  $78.3 \pm 2.8\%$ . In other water leachates germinated from  $37.3 \pm 2.1\%$  (V4) to  $43.3 \pm 0.7\%$  (V3) seeds of *Poa annua* L.

In case of the second evaluation characteristic – the rate of seed germination (Fig. 1) – was found out a similar trend as in total germinability.

The lowest rate of *Poa annua* L. seed germination was in extract from *Poa pratensis* L. (V5) –  $0.7 \pm 0.2$  seeds per day. Minimal (and non-significant) differences in germination rate were shown between the seeds of *Poa annua* L. germinated in the leachate from *Festuca arundinacea* Schreb. (V4) and *Poa annua* L. (V6) ( $0.9 \pm 0.05$  and  $0.9 \pm 0.02$  seeds per day, respectively) and in the leachate from *Lolium*

*perenne* L. (V2) and *Festuca rubra* L. (V3) ( $1.0 \pm 0.02$  and  $1.0 \pm 0.02$  seeds per day, respectively). The control variant (V1) was characterized by more than 80 % higher rate of *Poa annua* L. seed germination in comparison with other variants, and this difference was statistically significant ( $p = 0.001$ ). The results showed that aqueous extracts of turfgrasses reduced the total germinability and rate of germination of *Poa annua* L. seeds. Similarly, SVOBODOVÁ, MARTINEK (2010) found inhibition of germination rate and total germinability of *Deschampsia caespitosa* in the presence of some species of grass. It was confirmed the knowledge about allelopathic potential of grasses, which in its attempts reported by several authors (NARWAL, 1994; WARDLE

et al., 1996; LIPINSKA, HARKOT, 2005; KOVÁR, GREGOROVÁ, 2008).

Mutual comparison of the average plant height showed a positive but also negative influence of the plant leachates on growth rate, which is related to plant height (Fig. 2).

*Poa annua* L. plants were higher in leachate from *Lolium perenne* L. (49.8 mm; non-significantly) and in leachate from *Festuca rubra* L. (53.7 mm; significantly) in comparison with the control (48.6 mm). The average height of *Poa annua* L. in extract from *Festuca arundinacea* Schreb. was lower about 0.2 mm than in the control variant (non-significantly). Statistically significant difference in height of *Poa annua* L. plants was observed in leachate from *Poa pratensis* L. and *Poa annua* L. (about 6.7 mm and 16.7 mm less than control, respectively).

The effect of aqueous extracts was also reflected in the length of the roots of *Poa annua* L. (Fig. 2). Slightly longer roots had *Poa annua* L. grown in the extract from *Festuca rubra* L. (38.6 mm) than in distilled water (38.3 mm – control). In other variants showed inhibitory influence of leachates on the length of *Poa annua* L. roots and observed differences were statistically significant. The results can be seen the strongest inhibitory effect of water extract from the *Poa annua* L. on root growth of *Poa annua* L., and here may be considered autoinhibition of growth process. According to NARWAL (1994), the number of grass species showed allelopathic effects of their secretions, especially in the phase of seed germination and seedlings growth.

## SUMMARY

In a laboratory experiment was study the influence of water leachates from *Lolium perenne* L., *Festuca rubra* L., *Festuca arundinacea* Schreb., *Poa pratensis* L. and *Poa annua* L. on germination rate and total germinability of *Poa annua* seeds and its length of leaves and roots. The germination was realised in the growth chamber at a light and temperature conditions – day/night – 12/12 hr., 23/15 °C, rh 70%. Aqueous extracts significantly affected the total germinability and rate of germination of *Poa annua* L. seeds ( $p = 0.000$ ). The lowest germinability ( $27.3 \pm 7.1\%$ ) and the germination rate ( $0.7 \pm 0.2$  seed per day) had *Poa annua* L. germinated in extract from *Poa pratensis* L. Used extracts (except for the extract from *Festuca rubra* L.) had significantly inhibitory influence on root length of *Poa annua* L. in comparison with control. The results showed positive influence of *Lolium perenne* L. and *Festuca rubra* L. leachates (significantly) and negative influence of *Poa pratensis* L. and *Poa annua* L. leachates (non-significantly) on length of *Poa annua* L. leaves.

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#### Address

Ing. Peter Kovár, PhD., doc. Ing. Ľuboš Vozár, PhD., prof. Ing. Ján Jančovič, PhD., Department of grassland ecosystems and forage crops, Faculty of agrobiological and food resources, Slovak university of agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak republic, e-mail: Peter.Kovar@uniag.sk