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Research Article

THE INITIAL GROWTH AND DEVELOPMENT OF POA PRATENSIS UNDER THE ALLELOPATHIC INFLUENCE OF TARAXACUM OFFICINALE

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ABSTRACT
This experiment was carried out in laboratory conditions. The aim of this work was estimating allelopathic potential of *Taraxacum officinale* on seeds germination and initial growth of *Poa pratensis*. In the experiment different concentration of soil's and plant's water solution obtained from common dandelion were employed. The inhibition of germination energy of *Poa pratensis* under the influence of plant extracts produced from roots and leaves of *Taraxacum officinale* was found. Germination availability was inhibited in a higher degree by extracts prepared from the leaves than the roots of *Taraxacum officinale*. Higher concentrations of all solutions of both the soil and the plant inhibited the length of seending of *Poa pratensis.*

Keywords: allelopathy, germination, plant's and soil's concentration.

INTRODUCTION

In plant communities, as in the natural grassland, get the predominance of these species which are particularly well adapted to the suitable environmental conditions e.g., drought, the excess of moisture or to the shortage of nutritive components. The botanical composition of natural ecosystems in the large measure can be consider as the result of varied competitive relations, which should also play the important role with the occurrence of allelopathic influences.

According to [Rogalski 2004] allelopathy is the process consisting of slow or stimulating the development of one plant by another. It happens as the result of secretion by them to the environment of various chemicals, which have allelopathic proprieties. These chemicals in high concentrations can act as the inhibitors of growth and development of plant, however, in low concentrations they can be the stimulants of these processes. One of the causes of the meadow sward degradation are the allelopatical substances secreted to the soil by some species of plants. These substances are called allelocompounds. They can be relieved to the environment through evaporating and leaching from the underground parts and by the exudation from the root system or in the process of decomposing of the organic matter [Einhelling 1995; Emeteiro *et al*., 2003; Cha –He *et al*., 2011].

The source of the allelopatical substances are the plants of various species and different organs [Lipińska and Harkot, 2007; Hozayn *et al*., 2011; Chuan *et al.,* 2011; Hanwen *et al.,*2011].

They are in aboveground parts (generative and vegetative) and underground parts of plants both alive and dead, which are on the surface of the soil, and also in the soil [Gill and Sandhu, 1994]. Many allelopatical compounds in the aboveground parts of plants (leaves, stems, flowers) dissolve in water; this is why they can be washed by rain, fog or the drops of dew [Beyschlag, *et al*., 1996; Puntam and Tang, 1986; Sahoo *et al.,* 2011; Mennan *et al.,* 2011].

The important source of relationships for allelopatical compounds is also the substances from plant residues. The specific products of the secondary metabolism of plants are secreted by root systems of many species of meadow plants, which have allelopatical proprieties; this is why they can influence the development of plants growing in their environment.

According to many authors [Harkot and Lipińska, 1997] high allelopatical activity among others have *Elymus repens, Festuca rubra, Festuca arundinacea, Bromus inermis, Bromus hordeaceus,* and also *Plantiago lanceolata, Achilea millefolium and Hieracium pilosella*. These plants negatively affected germination and growth of different plants.

The common dandelion (*Taraxacum officinale* F.H. Wigg) is perennial plant witch propagates often in a very large quantity in the sward of natural meadows. This species expands, enlarging of this populations very quickly. The literature lacks the data relating to influences of the common dandelion on plants growing in their neighborhood. Neither is it known why this species creates large clusters. It may compete with different plants through the allelopatic influence.

So, the aim of this work was the testing of the influence of water extracts from leaves and from roots of common dandelion (*Taraxacum officinale*) as well as soil extracts from the rizosphere of this species on the germination of the seeds and the initial growth of Kentucky – bluegrass *(Poa pratensis*).

MATERIAL AND METHODS

The investigative material were leaves and roots of *Taraxacum officinale* and soil coming from the rizosphere of this species. The samples of the material were taken in October 2006 from a natural meadow community, where the large quantity of *Taraxacum officinale* stepped out. The obtained plants and soil material after drying in laboratory temperature and crumbling, it was used to preparing water extracts. For this aim the samples of leaves and roots were prepared with the mass about 25, 50 and 75 g and the samples of soil with the mass about 500, 1000 and 1500 g. The weighed material was placed in Erlenmeyer flask and filled with distilled water in the following quantity:

- 500 cm^3 – leaves or roots,
- 1000 cm^3 – the soil.

Prepared samples were left in laboratory temperature for 24 hours. The received extract was filtered into a flask, and then it was used for the performance of biotests. While duration of the experience, extracts were kept in the refrigerator. It was applied the most often used biotest with germination. *Poa pratensis* was the tested plant. In this aim on Petri plate with a diameter of 15 cm, two layers of the filterpaper were laid out with 25 seeds, they were watered every three days. It was watered with 5 cm^3 of one prepared extracts. On the remaining days it was watered with distilled water. The experiment was carried out in three replicants with the control object (distilled water).

Following combinations were applied in this experiment:

1. control (distilled water),
2. water extracts from leaves – 25, 50 and 75 g of leaves,
3. water extracts from roots – 25, 50 and 75 g of roots,
4. water extracts from the soil – 500, 1000 and 1500 g of the soil.

Energy and the ability of seeds germination of this plant were estimated. The measurement of the energy of germination was done after 10 days from the date of the experiment foundation, however, the germination ability after 28 days from this date. Moreover, three times in the three-days' interval the lengths of leaf sheaths and the leaf length and once was measured the root length of this plant were estimated. The first measurement of the length of leaf sheath and the leaves length of *Poa pratensis* was conducted the next day after the estimation of the germination ability. During the last measurement the roots length of this plant was also measured.

The variation analysis was used for the statistical assessment of the results for one factor analyses. Significance of the means characterizing the investigated factor was estimated by the Tukey test for the level of significance $\alpha \leq 0.05$.

RESULTS AND DISCUSSION

Germination energy

In the biological estimation of grasses species the important parameter is the germination energy.

Water extracts both the plant's as and soil's obtained from *Taraxacum officinale* in the studied ranges significantly influenced the number of seeds germinated of *Poa pratenssis*.

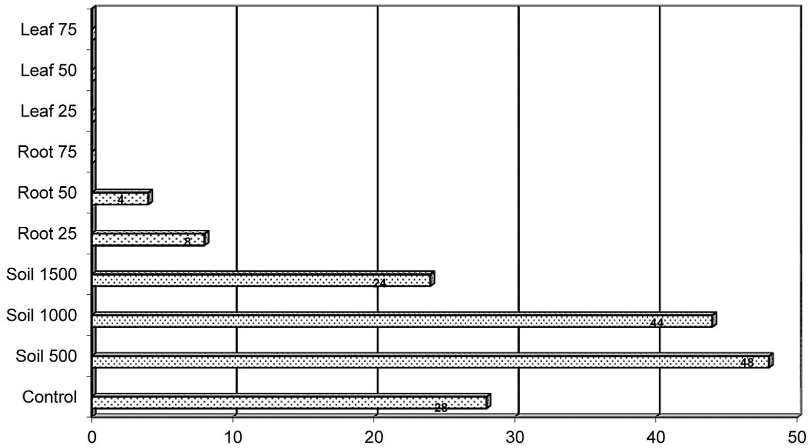

Figure 1. The germination energy of the seeds of *Poa pratensis* (in %) in dependence on various concentrations of studied extracts

The significant influence of soil extracts was observed in germination of Poa pratensis. Decidedly more seeds of this plant germinated, when they were watered with soil extracts in the relation to seeds watered with the extracts from roots, or with the extracts from leaves (Figure 1). Germination energy of *Poa pratensis* in objects watered with water extracts from the soil by the highest concentration (24%) was similar as in control conditions (28%), but in the presence of soil extracts with the lower concentration, reached decidedly higher values suitably 48% and 44%. Seeds germination of this plant, however the most strongly was blocked by extracts from leaves of *Taraxacum officinale*. No germinated seeds was observed in this case. Similar results got Harkot and Lipińska [2005] in their investigations relating *Poa pratensis*, where larger allelopathic activity showed the substances liberated from decomposed leaves than from decomposed roots of this species. Also in investigations of Wardle et al. (1996) was showed the inhibitory influence of water extracts from leaves of *Festuca arundinacea* on seeds germination of *Lotus corniculatus* and *Trifolium pratense*.

Ability germination

Water solutions from soil and root in the studied ranges of concentrations significantly influenced on the germination ability of *Poa pratensis*.

The germination ability of *Poa pratensis* seeds was very high on the object watered with soil extract by the smallest concentration (60%). With the increasing of the soil extracts concentrations (Figure 2), the germination ability of *Poa pratensis* seeds systematically decreased, get the values suitably 48% and 32%. Similarly as in the case of the germination energy, the seeds of *Poa pratensis* showed decidedly smaller ability of germination, when they were watered with extracts from roots, both in the relation to soil extracts, and to the control object. The strongest allelopathic influence on the studied feature showed the extracts

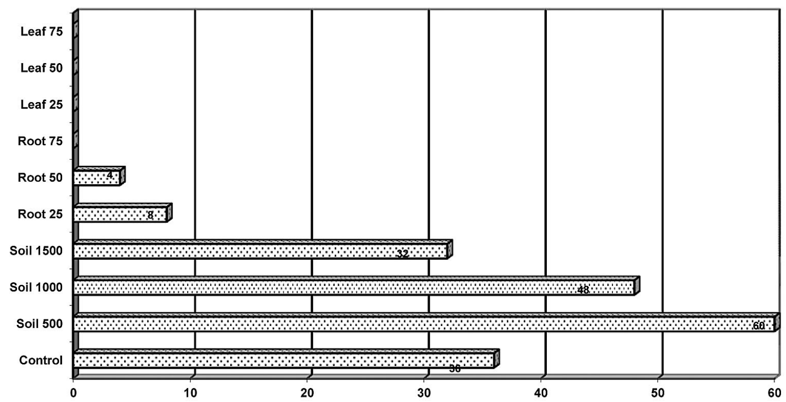

Figure 2. The germination ability of the seeds of *Poa pratensis* (in %) in dependence on various concentrations of the studied extracts

from leaves of Taraxacum officinale. On the objects watered with this extract no germinated any seeds of *Poa pratensis*.

Also Chuan *et al*. [2011] examined allelopathic effects of chili (*Capsicum annuum* L.), rice (*Oryza sativa* L.) and okra (*Abelmoschus esculentus* L.) extracts on germination and growth of goosegrass weed in laboratory bioassay. The most phytotoxic extract was chili leaves, followed by chili stem, which completely inhibited the germination of goose grass at 20 and 30 g L^{-1}, respectively. The chili leaf and stem extracts at 40 g L^{-1} inhibited the seedling growth of goose grass by 45 and 62%, respectively.

Stronger influence of plant's and soil's extracts on the energy of germination, than on germination ability of seeds of the tested plant was observed. Similar dependence relating seeds of *Poa pratensis* and *Bromus inermis* or spring barley in own investigations showed Lipińska and Harkot [1997] and Jaskulski [1997]. Also Jodełka *et al*. [2003] showed in their investigations the stronger influence of plant and soil extracts from *Hieracium pilosella* on energy than on the ability of germination of *Lolium perenne* L. and *Festuca rubra* L.

In bioassays Cha-He *et al.* [2011], investigated the residual effects of yellow top (*Flaveria bidentis*), a new invasive weed in China and its effects on test forage species for restoration of sites invaded by exotic weeds. The relative contributions of leaves and roots to the residual effects of yellow top were evaluated. They found that the sensitivity to yellow top residues was species dependent and there was no effect on the germination and initial growth of *Lolium perenne, Medicago sativa* and *Sorghum vulgare* × *S. sudanense hybrid*. Other species (*Lactuca indica, Trifolium repens* and *Euchlaena mexicana*) seedlings were more sensitive, but there was little influence on itself. The phytotoxic activity depended on the extract concentration and the extract sources. The yellow top root residues were more inhibitory than leaf, helping to explain its residual effects on the surrounding soil.

Biometrical parameters of Poa pratensis seedlings

In the conducted experience the influence of the tested concentrations of water solutions from plants and soils on the root length, leaf sheaths and leaf blades of the studied plant were showed.

The length of radicules

The longest roots *Poa Pratensis* developed on the objects watered with soil solutions (Table 1). The roots reached the largest length (13 mm) at the lowest concentration carrying out 500 g of the soil /litre. Together with the growth of the concentrations of soil extracts, seedlings developed somewhat shorter roots achieving suitably values 9mm and 7mm. Somewhat shorter roots, were observed in this plant, when it was watered with extracts from roots of *Taraxacum officinale*. Under these influence the ridicules length of *Poa pratensis* decreased together with the growth of the concentrations of these extracts, achieving responsible values 6 mm, 3 mm and 2 mm. However, in the case of watering the plant with extracts from leaves, the radicules of seeds weren't shaped at all. Together with the growth, both the concentration of soil and root solutions was observed their inhibitory influence on the radicules length of *Poa pratensis*. In these investigations also showed that together with decreasing of concentration of plant extracts got from dead leaves of *Poa pratensis* decrease their negative influence on lengthening of seedling radicules [Lipińska and Harkot 2000].

Last years, large interest was laid on investigations from the range of allelopathy between various plants existing on the grasslands. By Breazu *et al*. [1998] water extracts from remainder of *Trifolium repens* and *Medicago sativa* and *Dactylis glomerata, Festuca pratensis, Festuca arundinacea* and *Festuca rubra* brake partly, or at all the germination growth of root of *Trifolium repens*. In his investigations he also showed that soluble compounds from above-ground parts of

Table 1. The length of radicules of *Poa pratensis* (in mm) in dependence on the concentration of water extracts from soil's and plant's

The water solution from	Mass of the samples (g)						
	0	500	1000	1500	25	50	75
Soil	28a	48b	44c	24d	–	–	–
Leaf	28a	–	–	–	0b	0b	0b
Root	28a	–	–	–	24b	8c	4d

Comments: Mean in poems estimated with the same letters do not differ significantly.

Lolium perenne L. weakened the initial development of *Poa pratensis* [Harbone 1997].

Also in Hozayn *et al.* [2011] study the lentil varieties differed in responses to the incorporated sorghum and sunflower shoot residues. The sunflower residues at 12 and 24 g/pot decreased the seedling growth of lentil varieties more than sorghum residues.

But the study by Mennan *et al.* [2011] aimed to screen rice genotypes for allelopathic activity and to identify the potential parental lines for QTL analysis. Therefore, a total of 41 cultivars from germplasm collections in Turkey were evaluated for their allelopathic effects. Significant differences were found among the rice cultivars in their ability to reduce barnyard grass *(E. crus-galli*) root growth and root dry weight accumulation. Root length inhibition ranged from 0.7% to 38.8%, respectively. The "Marateli" and "Koral" cultivars inhibited the root length by 38.8% and 31.2%, respectively. However, "Arko", "Edirne", "Kirkpinar" and "Sumnu" stimulated the root length and dry weight than control. Rice tissue extracts had variability to inhibit the E. crus-galli germination, the "Marateli" leaf extracts were most inhibitory to germination.

Length of leaf sheaths

Similarly as in the case of the measurements of the root length, the length of leaf sheaths was shorter on objects watered with the extracts from roots in the relation to objects watered with the extracts from the soil (Table 2). Together with the growth of the concentrations of both extracts, their inhibitory influence was observed on the studied feature. The length of leaf sheaths on objects watered with the extracts from the soil was longer average about 3mm in relation to the ones, which were watered with extracts from roots. However, the largest allelopathic influence on the value of this feature showed the extracts from leaves of *Taraxacum officinale*. Leaf sheaths were not developed at all in the case of the use of these extracts without regard on their concentration.

Length of leaf blades

In the conducted experiment, the longest leaf blades developed *Poa pratensis* on objects watered with soil extracts but these values decreased together with the growth of the concentration of the applied extract (Table 3). Leaf blades reached the largest length (24 mm) by the lowest concentration of soil extract carrying out 500 g/litre. Extracts from roots of *Taraxacum officinale* showed a somewhat stronger allelopathic influence. On the objects watered with these extracts leaf blades were developed only by two lower concentrations of the extract, achieving values of 8mm and 4mm suitably. By the highest concentration of the root extract (75 g/0.5 litre) the leaves were not developed at all. Similarly, as in the case of the root length, or of the lengths of leaf sheaths, the strongest allelopathic affecting on the studied feature showed also the extracts from leaves of *Taraxacum officinale*. Leaf blades at all not were not developed under their influence.

Table 2. Length of leaf sheaths of *Poa pratensis* (in mm) in dependence on the concentration of water soil and plant extracts

The water solution from	Mass of the samples (g)						
	0	500	1000	1500	25	50	75
Soil	36a	60d	48c	32b	–	–	–
Leaf	36a	–	–	–	0b	0b	0b
Root	36a	–	–	–	32b	8c	4d

Comments: Mean in poems estimated with the same letters do not differ significantly.

Table 3. Length of leaf blades of *Poa pratensis* (in mm) in dependence on the concentration of water soil and plant extracts

The water solution from	Mass of the samples (g)						
	0	500	1000	1500	25	50	75
Soil	10a	13b	9c	7c	–	–	–
Leaf	10a	–	–	–	0b	0b	0b
Root	10a	–	–	–	6b	3c	2c

Comments: Mean in poems estimated with the same letters do not differ significantly.

Hanwen *et al.* [2011] studied the allelopathic potential of *Eucalyptus dundasiion* in two important Australian weeds species: annual ryegrass (*Lolium rigidum Gaudin*) and barley grass (*Hordeum glaucum* Steud). Distillation of eucalyptus leaves yielded three bioactive fractions: essential oil fraction and the aqueous fractions A and B. These 3 – fractions inhibited the germination and seedling growth of annual ryegrass and barley grass.

The germination and seedling growth of barley grass were more sensitive than annual ryegrass to aqueous fraction A, and the germination of annual ryegrass was more sensitive than barley grass when exposed to fraction B. The phytotoxicity was concentration-dependent.

An interesting study was carried out by Sahoo *et al.* [2011]. In this study the effects of aqueous leaf extract of 5 home garden trees *Artocarpus heterophyllus* L., *Mangifera indica* L., *Areca catechu* L., *Citrus indica* Tanaka and *Tamarindus indica* L. were studied on the germination, shoot length and root length of 5 food crops *Capsicum annum* L. (Chilli), *Glycine max* (L.) Merr. (Soybean), *Zea mays* L. (Maize), *Oryza sativa* L. (Rice), and *Abelmoschus esculentus* (L.) Moench (Lady's finger). Most of the food crops, except paddy, were inhibited by *Tamarindus* leaf extract and hence, are incompatible. Soybean was also sensitive to *Artocarpus* extracts, while germination and growth of lady's finger was inhibited by all tree species, except *Artocarpus*. Paddy was resistant to allelopathic effects of all tree species.

About biodensity and the stability of natural grasslands being many-species assemblages decide allelopathic influence of higher plants. The knowledge of interaction (negative or positive) of one plant on the growth and development of other plants can be useful in composing of pasture and meadow mixtures. However, you should pay attention to the special complexity of interaction of plants in the assemblages of grasslands. The control of this influence can be often symbolic because of his complexity. The results of one experimental investigations not should be, therefore, transfered directly onto the existing conditions in the nature. However, you should be aware that the allelopathi phenomenon is one of ecological factors forming the conditions of development of plants fulfilling the function of the limiting factor [Basis *et al.* 2003; Inderjit and Duke 2003; Rindenour and Callaway 2001].

CONCLUSION

1. Germination energy of *Poa pratensis* was the most braked through the plant extracts prepared from roots and leaves of *Taraxacum officinale.*
2. The germination ability of seeds of *Poa pratensis* was the highest in objects, where soil extracts were applied, however, the value of this feature was braked by extracts prepared from plant extracts in the higher degree from leaves of *Taraxacum officinale* than from roots. Higher concentrations, both soil solutions and plant's, affected as inhibitory both on the root growth, as and the growth of the leaf sheath and leaves of *Poa pratensis.*
3. The results of the studied parameters can confirm allelopathic influence of *Taraxacum officinale* on the growth and development of *Poa pratensis*, and especially extracts prepared from leaves.

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