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Research Article

THE ALLELOPATHIC INFLUENCE OF *TARAXACUM OFFICINALE* ON THE INITIAL GROWTH AND DEVELOPMENT OF *FESTUCA RUBRA* L.

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ABSTRACT
Common dandelion (*Taraxacum officinale* F.H. Wigg) is perennial plant often stepping out in very large quantity in the sward of natural meadows. This species expands, enlarging its population very quickly. In the literature there is the lack of data related to influences of the common dandelion on plants growing in it's neighbourhood. It is also unknown why this species creates large clusters. It may compete with different plants through the allelopatic influence. Therefore, the aim of this work was to test of the influence of water extracts from leaves and from the roots of common dandelion (*Taraxacum officinale*) as well as soil extracts from the radicular layer of this species on the germination of the seeds and the initial growth of Red fescue (*Festuca rubra* L.). The investigative material came from leaves and roots of *Taraxacum officinale* and soil coming from the radicular layer of this species. It was applied most often in biotest experiments on germination. Red fescue was the tested plant. The germination energy of red fescue was the most braked through the plant extracts prepared from roots and leaves of *Taraxacum officinale*.

Keywords: common dandelion, red fescue, allelopathy.

INTRODUCTION

In plant communities, such as natural grassland, predominance of these species which are particularly well adapted to the suitable environmental conditions occurs e.g., drought, excess of moisture or to the shortage of nutritive components. The botanical composition of natural ecosystems can be largely considered as the result of varied competitive relations [Callaway et al., 2005; Goslee et al., 2001; Ridenour et al., 2001; Weidenhamer 2006]. One may also encounter the occurrence of allelopathic influences [Basis et al., 2003; Spyreas et al., 2001).

According to many authors [Oleszek 1996], allelopathy is the process consisting of slowed down or stimulated development of one plant by another one. It happens as the result of the secretion of various chemicals, which have allelopathic proprieties, to the environment. These chemicals in high concentrations can act as inhibitors of growth and development, however in low concentrations they can be the stimulants of these processes [Inderjit and Duke 2003; Rene et al., 2004].

One of the reasons for meadow sward degradation is the allelopatical substances secreted to the soil by some species of plants. These substances are called allelocompounds [Perry et al., 1005; Birkett et al., 2001; Sinkonen 2003]. They can be released to the environment through evaporating and leaching from the underground parts and by the exudation from the root system or in the process of the decompose of the organic matter [Einhelling 1995a, 1995 b].

Plants of various species and their different organs are the source of the allelopatical substances [Lipińska and Harkot 2007]. They are in aboveground parts (generative and vegetative) and underground plants both alive and dead, which are on the surface of soil, and also in the soil [Bertin et al., 2003]. Many allelopatical compounds in aboveground parts of plants (letter, stems, flowers) dissolve in water, therefore, they can be washed by rain, fog or drops of dew [Beyschlag et al., 1996]. The important source of relationships allelopatical compounds is also decomposing plant residues [Pratley et al., 2000]. Specific products of the secondary metabolism of plants are secreted by root systems of many species of meadow plants, which have allelopatical proprieties that is why they can influence on the development of plants growing in their environment [Suman et.al., 2002; Callaway et. al 2000; Julita et.al.,2002].

According to many authors [Harkot and Lipińska 1997] high allelopatical activity among others are demonstrated by such species as: *Elymus repens, Festuca rubra, Festuca arundinacea, Bromus inermis*, *Bromus hordeaceus*, and also *Plantiago lanceolata, Achilea millefolium* and *Hieracium pilosella.* These plants affect negatively the germination and growth of different plants.

Common dandelion (*Taraxacum officinale* F.H. Wigg) is perennial plant often stepping out in very large quantity in the sward of natural meadows. This species expands, enlarging its population very quickly. In the literature there is the lack of data relating to influences of common dandelion on plants growing in its neighborhood. It is also unknown, why this species creates large clusters. It may compete with different plants through the allelopatic influence.

So, the aim of this work was to test the influence of water extracts from leaves and from the roots of common dandelion (*Taraxacum officinale*) as well as soil extracts from the radicular layer of this species on the seeds germination and the initial growth of red fescue (*Festuca rubra* L. sensu lato).

MATERIALS AND METHODS

The investigative material came from leaves and roots of *Taraxacum officinale* and soil coming from the radicular layer of this species. The samples of the material were taken in October 2006 from the natural meadow community, in which the large quantity *Taraxacum officinale* stepped out. The plant and soil material after drying in room temperature and crumbling was used for preparing water extracts. For this purpose samples of leaves and root with the mass about 25, 50 and 75 grams and the samples of the soil with the mass about 500, 1000 and 1500 grams were prepared. The weighed out material was placed in Erlenmayer butts and flood with distilled water in the following quantity:

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

Prepared samples were left in the room's temperature for 24 hours. The received extract was infiltrated by filter-paper, and then use to the performance of biotests. During the whole experience, extracts were kept in a refrigerator. Most often experimented biotest with germination were applied. *Festuca rubra* was the tested plant. For this purposethe authors used Petry patern with the diameter 15 cm, lay out with two layers of filter-paper and placed 25 seeds, watering them every three days with 5 ml of one prepared extracts. In the next days, it was watered with distilled water. The experience was put in three replicants with the control object (distilled water).

Following combinations were applied in this experiment:

- control (distilled water)
- water extracts from leaves – (25, 50 and 75 g of leaves)
- water extracts from roots – (25, 50 and 75 g of roots)
- water extracts from the soil – (500, 1000 and 1500 g of the soil)

In the carried experiment the seeds germination of *Festuca rubra* was in room temperature in daylight.

Energy and the ability of seeds germination of this plant were estimated. The measurement of the energy of germination was done after 7 days from the date of the experiment foundation however the germination ability after 21 days from this date. Moreover, three times in the three-days' interval lengths of leaf sheaths and the leaves length of *Festuca rubra* were estimated and once was estimated the radicular lengths of this plants. First measurement of the length of leaf sheath and the leaves length of *Festuca rubra* was conducted the next day after the estimation of germination ability. During the last measurement the roots length of this plant was also measured.

Variation analysis was used in the statistical study of the results for one factors experiences. Significance of the differentiation the means characterizing the investigative factor was estimated by the Tukey'a test for the level of significance α ≤ 0,05.

RESULTS AND DISCUSSION

The germination energy of *Festuca rubra*

The significant parameter in the biological estimation of grasses species is germination energy of the seeds.

The results obtained in the work show that the germination energy of *Festuca rubra* seeds was differentiated in dependence on the kind of solution applied to watering of these seeds, as also on the mass of sample of plant and soil material used to preparing of extract (Table 1, 2, 3 and Figure 1).

The highest energy of germination was affirmed in the conditions of applying soil extracts (from 52 to 60%). Extracts from leaves the mostly braked the germination of seeds, and only single germination of seeds was observed after seven days from their sowing.

It should also be emphasized that generally all tested water extracts significantly reduced the energy of germination in the relation to the control.

The germination ability of *Festuca rubra* L.

The germination ability of *Festuca rubra* seeds was very high on the control object, where the value amounted to 96%. In the case of soil extracts (Figure 2) this ability in comparison with control object (96%) reached slightly lower values for the successive concentrations, getting suitably values 88%, 80% and 72%.

The germination ability of *Festuca rubra* seeds after applying water extracts from roots was considerably lower both in relation to the control object and to the soil extracts. The germination ability carried out respectively 36%, 16% and 12% in dependence on the applied increasing of concentrations of these solutions.

However, the studied feature had the lowest values after applying water extracts from leaves of *Taraxacum officinale* (from 1 to 40%), what can testify to their big allelopathy influence. It should be noticed, that water extracts both from the soil and from the plants (leaves, roots) significantly reduced germination ability of *Festuca rubra* seeds in relation to the control object (Table 1, 2, 3). Also stronger influence of all the applied water solutions was observed on the energy of

Table 1. Influence of the water solution of the soil extract on initial growth and development of *Festuca rubra*

Studied feature	Control	Mass of the sample (g)		
		500	1000	1500
Germination energy	64a	60ab	56bc	52c
Germination ability	96a	88b	80c	72d
Length of the leaf [mm]	42a	52b	45a	40a
Length of the sheath [mm]	7a	9a	9a	8a
Length of radicle [mm]	25a	21ab	20ab	16b

Comment: Means in lines estimated with the same letters do not differ significantly.

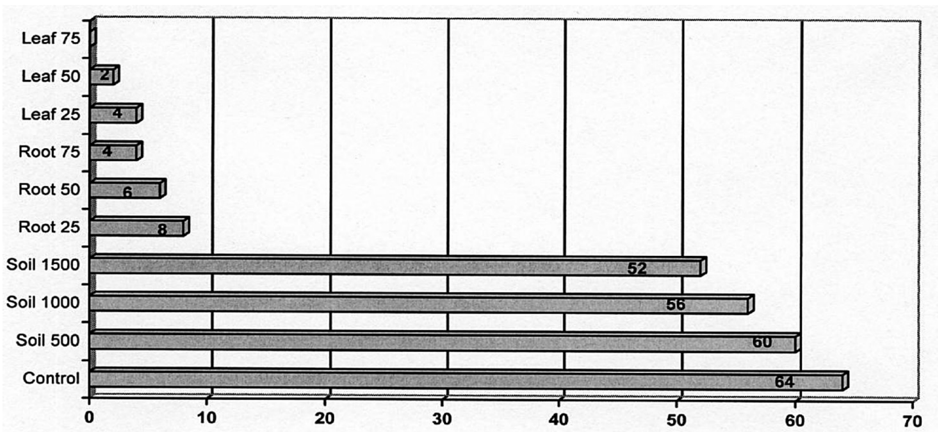

Figure 1. The germination energy of seeds of *Festuca rubra* L. in dependence on various concentrations of studied extracts

Table 2. Influence of the water solution of the extract from *Taraxacum officinale* roots on initial growth and development of *Festuca rubra*

Studied feature	Control	Mass of the sample (g)		
		25	50	75
Germination energy	64a	8b	6b	4b
Germination ability	96a	36b	16c	12c
Length of the leaf [mm]	42ab	48b	42a	36a
Length of the sheath [mm]	7a	13a	12a	7a
Length of radicle [mm]	25a	6b	3bc	2c

Comment: Means in lines estimated with the same letters do not differ significantly.

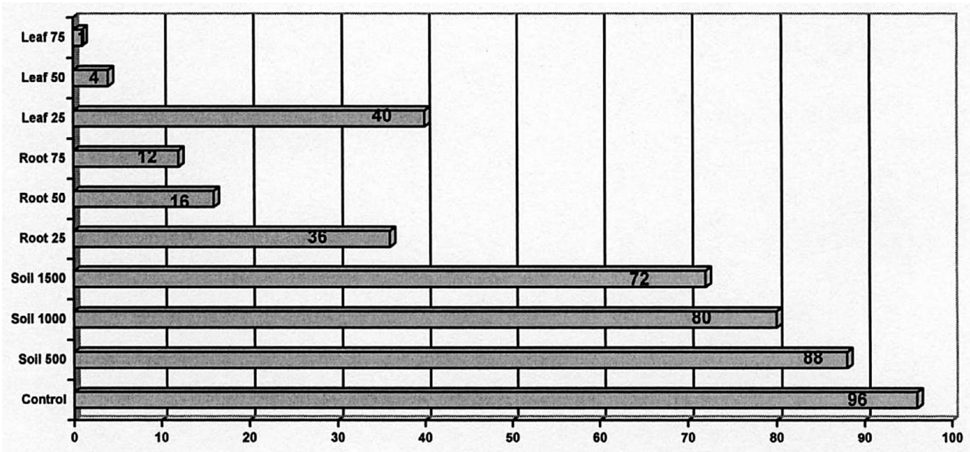

Figure 2. The germination ability of seeds *Festuca rubra* L. in dependence on various concentrations of studied extracts

germination than on the germination ability of *Festuca rubra*.

Biometric parameters of *Festuca rubra* L. seedlings

In the conducted experiment the measurements of the length of leaves, leaf sheaths and root's length of *Festuca rubra* were done.

In these investigations (Table 1) *Festuca rubra* developed the longest leaves under the influence of soil extracts, but the largest value – 52 mm – was obtained at the lowest concentration (500 grams of the soil/litre). With the increase of the concentrations of soil extracts, the seedlings developed slightly shorter leaves achieved the value 45 mm at the concentration 1000 grams of the soil/litre and 40 mm at the highest concentration. The strongest allelopathic influence on the studied feature was recorded for extracts from leaves (Table 3). Under their influence the length of leaves of *Festuca rubra* reached the lowest values, and by highest concentration the leaves did not develop. Similar tendency in the change of the length of leaves was affirmed under the influence of water extracts from roots of *Taraxacum officinale.*

Similarly to the case of the lengths of leaves, the studied solutions influenced the length of leaf sheaths of the tested grass. The results obtained in the work (Table 3) show, that the extracts from leaves influenced the most stopped the growth of leaf sheaths. Only under the influence of the applying lowest concentration of the extract from leaves, were leaf sheaths created, however they were short with the length of 3 mm. After using higher concentrations of extracts from leaves leaf sheaths did not create at all. extracts from the roots smallest allelopathic influence on the length of the leaf sheath (Table 2). In this case the longest sheaths were created, which reached the length suitably 13 mm, 12 mm and 7mm. The extracts from the soil showed slightly larger allelopathic influence on the length of leaf sheaths (Table 1), in the result of this, they were shorter at approximately 2,0 mm.

In the allelopathic influence of extracts from *Taraxacum officinale* their influence on the length of seedlings root's of *Festuca rubra* is also important. After applying the soil extract with the con-

Table 3. The influence of the water solution of the extract from leaves of *Taraxacum officinale* on initial growth and development of *Festuca rubra*

Studied feature	Control	Mass of the sample (g)		
		25	50	75
Germination energy	64a	4b	2b	0b
Germination ability	96a	40b	4c	1c
Length of the leaf [mm]	42a	27b	11c	0d
Length of the sheath [mm]	7a	3ab	0b	0b
Length of radicle [mm]	25a	1b	0b	0b

Comment: Means in lines estimated with the same letters do not differ significantly.

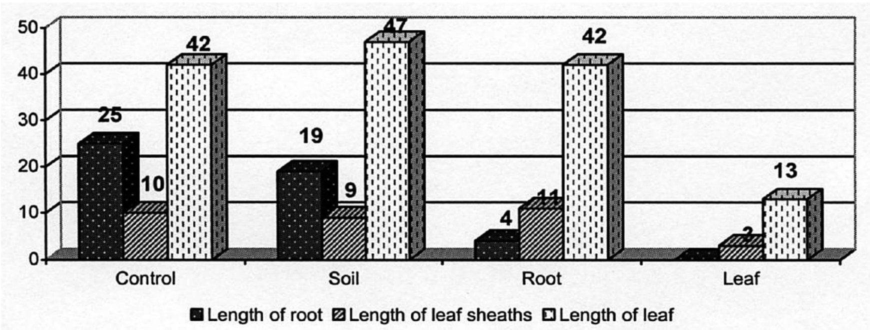

Figure 3. Length of studied parts of plants in regard to the kind of the applied extracts (mean for studied solutions)

centration of the solution 1500 grams of the soil/ litre *Festuca rubra* had the longest roots of 21 mm. Together with the growth of the concentrations especially the extracts from roots (Table 2) clear inhibitory influence on the studied feature in such considerable degree was observed(they were very short). However, the extracts from leaves, showed the strongest allelopathic influence (Table 3). Under their influence, only in the case of the lowest concentration were created the roots with length 1mm, however under the influence of remaining concentrations they did not create at all.

The conducted investigations (Figure 3) show strong influence of plant extracts from leaves of Taraxacum officinale on initial growth and development of *Festuca rubra.* Slightly weaker allelopathic influence showed the extracts from the roots of this plant.

The inhibitory effect of allelocompounds [Harkot and Lipińska 1997] can already appear while imbibition of seeds. The disorders to which comes then, dealy the plants germination, break the growth of creation of the roots and cause their deformation and decay. Many cases of allelopathic influences of plants were already proved during the seeds germination. One of them is allelopatic influence of *Hieracium pilosella* L. on initial growth and development of *Lolium perenne* L. and *Festuca rubra* L. [Jodełka et al., 2003].

Extracts from leaves broke the germination of seeds most effectively, and only single germination of seeds was observed after seven days from their sowing. Investigations led by many authors (Harkot and Lipińska 1996) showed similar dependence in the case of *Poa pratensis*, where substances relived from decomposed leaves showed larger allelopatic activity, than the ones from decomposed roots of this species.

Stronger influence of the all applied water solutions was observed on the energy of germination than on the germination ability in *Festuca rubra*. Also definitely larger influence of water solutions (plant, soil and root's, secretions) on the germination energy than on the germination ability of *Bromus inermis* and *Poa pratensis* seeds was proved by many authors [Lipińska 2002; Harkot and Lipińska 1995].

Their investigations [Harkot and Lipińska 1996] proved that germination of *Dactylis glomerata* L. and *Phleum pratense* L. on the soil from under sward with *Poa pratensis* L. domination was indeed worse in comparison with germination on the control objects however germination of *Festuca rubra* were similar in all objects. The investigations conducted by the other authors

[Lipińska 2002] showed stronger influence of water extracts from the soil under the sward of *Lolium perenne* L. on the extension of the roots than on the length of seedlings of *Phleum pratense* L. and *Poa pratensis* L.

Conducted investigations show the strong influence of plant extracts from leaves of *Taraxacum officinale* on initial growth and development of *Festuca rubra.* Slightly weaker allelopathic influence was showed the extracts from the roots of this plant.

Some danger, connected with the interpretation of the importance of individual compounds in allelopathic affecting is the physico-chemical complexity of the soil, its ability to bind organic compounds, and the existence of the microorganisms which can transform individual plant products to more toxic compounds or to destroy them in such a degree that they will not show any activity in the relation to tissues of the higher plants [Bertin et al., 2003; Callaway et al., 2000]. So, the results of the influence of the soil on the germination, height of seedlings or length of radicula of the tested plants cannot be attributed exclusively to the proprieties of the allelopathic substance presented by Suman at al. [2002]. In field conditions, it is also allelopathic compounds that have influence on their interactions connected with various botanical compositions of various composition agrophytocenosis [Callaway et al., 2005; Weidenhamer 2006]. These effectis are so closed that the control of their influence is often symbolic. The results of experimental investigations cannot be transferred directly onto conditions existing in the nature. However, this does not change the fact that the phenomenon of allelopathy is one of several basic ecological factors, which create the conditions of environment [Basis et al., 2003; Inderjit and Duke 2003].

CONCLUSIONS

1. The germination energy of *Festuca rubra* independently on the applied soil or plant extract, underwent break together with the growth of the concentration of applied extracts prepared from *Taraxacum officinale.*
2. The higher concentrations of *Taraxacum officinale* secretions broke lengthening of the roots and the growth of the leaf sheath as well as the leaves of *Festuca rubra*.
3. On the all studied features the strongest allelopathic influence independently on the rare of the concentration of studied extracts, had the extract from the leaves of *Taraxacum officinale* in the contrast to the soil extract, which did not show such affecting.

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