

Allelopathic inhibitory effect of *Pteridium aquilinum* (L.) Kuhn on germination of *Festuca arundinacea* Schreb. and *Trifolium pratense* L.

Hrvoje KUTNJAK, Josip LETO, Maja ŠĆEPANOVIĆ, Krešimir BOŠNJAK, Goran PERČULIJA, Damir KLJUČEVIĆ, Mladen KNEŽEVIĆ, Marina VRANIĆ

University of Zagreb, Faculty of Agriculture, Svetošimunska cesta 25, 10000 Zagreb, Croatia, (e-mail: hkutnjak@agr.hr)

Abstract

Significant areas of land formerly used in Lika, due to cessation of agricultural production are covered with bracken (*Pteridium aquilinum* (L.) Kuhn.), opening the way for vegetation succession to the forest stage. The aim of this study was to determine the competitiveness of two forage crops in these areas with the aim of suppressing and crowding out bracken. The experiment was performed *in vitro* in which the seeds of tall fescue (*Festuca arundinacea* Schreb.) and red clover (*Trifolium pratense* L.) were treated with extract of bracken, *Pteridium aquilinum*. We measured the number of germinated seeds and the length of plumule and radicle. The results show a decrease in germination of red clover for 2%, respectively tall fescue by 31%. Radicle length in red clover was reduced by 33.1%, while the reduction in length at tall fescue was 66.7% for radicle and 51.1% for plumule. This study confirmed allelopathic inhibitory effect of bracken extract on red clover and tall fescue germination and primary development. The data suggest a potentially large losses in efforts of introduction of these crops through sowing on bracken fields, which especially applies to tall fescue.

Key words: allelopathy, agriculture restoration, bracken, *Pteridium aquilinum*, *Festuca arundinacea*, *Trifolium pratense*

Alelopatski inhibicijski utjecaj bujadi (*Pteridium aquilinum* (L.) Kuhn) na klijavost trskolike vlasulje (*Festuca arundinacea* Schreb.) i crvene djeteline (*Trifolium pratense* L.)

Sažetak

Uslijed smanjenja i obustave poljoprivredne proizvodnje u Lici značajan dio nekad korištenih površina, zauzela je bujad (*Pteridium aquilinum* (L.) Kuhn.) tvoreći bujadnice, čime je na tom prostoru otvoren put vegetacijskoj sukcesiji prema šumi. Cilj ovog istraživanja bio je utvrditi potencijalnu kompetitivnost dviju krmnih kultura na takvim prostorima, a u cilju potiskivanja i iskorjenjivanja bujadi. Pokus je proveden *in vitro*, gdje je sjeme trskolike vlasulje (*Festuca arundinacea* Schreb.) i crvene djeteline (*Trifolium pratense* L.) tretirano ekstraktom bujadi. Mjeren je broj iskljicalih sjemenki te dužine klica i korijenaka. Rezultati pokazuju kako se u tretmanu ekstraktom bujadi smanjuje klijavost crvene djeteline za 2%, a kod trskolike vlasulje za 31%. Dužina korijenka kod crvene djeteline bila je smanjena za 33,1% dok je redukcija kod trskolike vlasulje iznosila 66,7% za korijenak, odnosno 51,1% za klicu. Ovo istraživanje je potvrdilo alelopatski inhibicijski utjecaj ekstrakta paprati na klijavost i primarni razvoj crvene djeteline i trskolike vlasulje. Dobiveni podaci sugeriraju na potencijalne velike gubitke uslijed

usijavanja navedenih krmnih kultura na bujadištima, što se posebno odnosi na trstikastu vlasulju.

Ključne riječi: alelopatija, obnova poljoprivredne proizvodnje, bujad, *Pteridium aquilinum*, *Festuca arundinacea*, *Trifolium pratense*

Introduction

Large areas in Lika (Croatia) of nearly 200 km² are occupied by bracken habitats or stands dominated with common bracken (*Pteridium aquilinum* (L.) Kuhn). From the past century, especially within the last 20 years, livestock production practice in these areas has been significantly decreased and somewhere fully suspended. In the past, bracken was collected and used for a livestock litter. Gradual field work abandonment in these areas induced vegetation succession through the emergence of pioneer tree species such as aspen (*Populus tremula*), birch (*Betula verrucosa*), which opened the path of development towards the forest (Topic & Vukelic, 2009). Bracken fields rehabilitation and their return to agricultural production is not a simple process for a number of factors. Brackens build dense canopy which overshadow the ground and has a strong and deep rhizome which is difficult to eradicate. In addition to the fern-toxic in animal nutrition (Cooper-Driver, 1976; Pamukcu et al., 1978), it also contains a number of allelochemicals which have strong allelopathic effect on other plants (Gliessman, 1976). Recent research focused on rooting out brackens showed that it is possible to eradicate brackens, if mowing is performed at least twice a year with application of herbicides and by resowing with competing species (Petrov & Marrs 1999, Marrs & Watt, 2006). We conducted this survey on this track with an aim to determine the potential of two forage crops: red clover (*Trifolium pratense* L.) and tall fescue (*Festuca arundinacea* Schreb.), have for sowing in the areas dominated by bracken.

Materials and methods

Plant materials used in this study were the above-ground parts of bracken (*Pteridium aquilinum*), grass seeds of tall fescue (*Festuca arundinacea* cv. BARADISO) and red clover (*Trifolium pratense* cv. VESNA). Respective varieties of grass and clover were selected due to its current availability, but also because of the previously conducted research in Grassland Research Centre of Faculty of Agriculture. Fern extract was prepared for the treated seed of grass and clover. The concentration of applied bracken extract was adjusted with the previously determined yield of dry matter of brackenfields which was 10917 kg DM ha⁻¹, and is converted to the Petri dish surface of 7 cm in radius in which the experiment was implemented. The experiment was set in quadruplicate, where in every dish with a three layer cellulose paper sheet 25 seeds were topped with 10 ml of distilled water, in the control/blank group, while in the treatment group they were topped with 10 ml of aqueous bracken extract. They were all placed on germination in darkness at room temperature between 20 ° and 25 ° C. After 6 (*T. pratense*) and 7 days (*F. arundinacea*), dishes with the germinated seeds were scanned and the length of radicle and plumule was measured on rectified images using the software package ArcGIS 9 (ESRI).

Results and discussion

It was determined that the germination level of red clover in the treated group declined by 2% (from 100 to 98). Germination of tall fescue in control group was significantly lower at start with 61%, while in the treatment it was 42%, which marked a decline of 31% (Figure 1).

After 6 days, the radicle length of red clover in the control group varied between 6.1 and 85.5 mm, with the average of 55.3 mm; while in the treatment with the bracken extract, the radicle length range was between 9.3 and 68.9 mm with an average value of 37 mm which reduced the normal radicle length by 33.1%. The average length of tall fescue radicle in the control group after 7 days was 25.6 mm, while the average length of plumule was 21.9 mm. In the treated group of red clover, the average radicle length decreased to 8.5 mm, while the plumule was on average 10.7 mm long, so radicle was reduced by 66.7% and plumule by 51.1% (Table 1). In addition to reducing the length of radicle and plumule, changes were also recorded in their mutual length ratio, k:r (control) = 1:0.85, k:r (treatment) = 1:1.26, suggesting amplified depressing effect especially on the development of the root system.

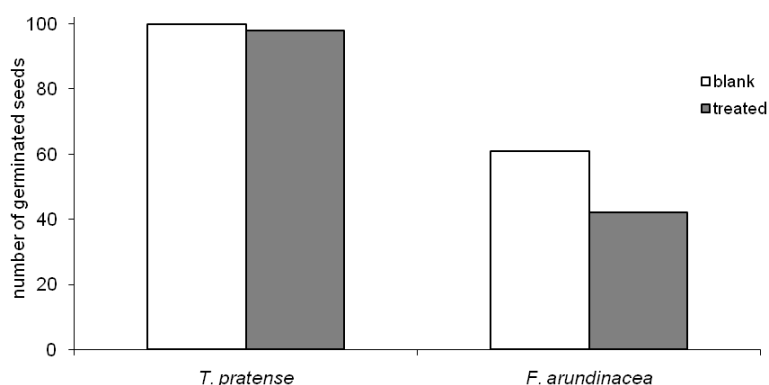


Figure 1. Decline in seed germination of red clover and tall fescue treated with bracken extract

Table 1. Differences in the length of plumule (p) and radicle (r) between the control group and treated groups, r (T), p (T), n - number of germinated seeds, SD - standard deviation

	Trifolium pratense		Festuca arundinacea			
	r	r(T)	r	r(T)	k	k(T)
n	100	98	61	42	61	42
average(mm)	55.3	37.0	25.6	8.5	21.9	10.7
SD	13.7	11.5	13.5	6.4	13.9	6.4

Conclusions

This study confirmed allelopathic inhibitory effect of bracken extract on germination and development of red clover and tall fescue. The data suggests potentially large losses in efforts of introduction of these crops through sowing on bracken fields, which especially applies to tall fescue.

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