

SOIL ASSESSMENT BASED ON BOTANICAL COMPOSITION ON HABITATS OF AUTOCHTHONOUS POPULATIONS OF RED CLOVER (*Trifolium pratense* L.)

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Abstract: Plant species which grow at particular habitats may point out at specific abiotic characteristics of these habitats. There is a need for a more generic approach to link soil and vegetation responses. An alternative approach is to use Ellenberg indicator values as a means of assessing the likely competitive advantage between different species as projected by dynamic soil models. The way of utilization and maintenance, and different environmental influences change the specific soil conditions at their locations by human-induced and natural stresses. Different ecotypes of red clover registered at surveyed locations are adapting to such environmental changes, and may represent the breeding pool for red clover breeding to abiotic stresses.

Keywords: red clover, Ellenberg indicator value, soil assesment

Introduction

Red clover (*Trifolium pratense* L.) is forage legume important for livestock feeding. Except in arable land, red clover may be found at meadow and ruderal habitats (Dujmović Purgar, 2006). In view of climatic and relief variability of the territory of Croatia, different ecotypes of red clover have been developed. Considering high adaptability of red clover, it may grow in wide range of soil and environmental conditions (Frame et al., 1998). Soils worldwide are subjected to increasing degrees of physical, chemical and biological, natural or human-induced stresses (Várallyay, 2007). As habitat conditions are being changed, botanic composition which point out at specific abiotic characteristics of habitat, changes as well (Ellenberg, 1974; Knežević et al., 2007). There is a need for more generic approach to link soil and vegetation responses. An alternative approach is to use Ellenberg indicator values as a mean of assessing the likely competitive advantage between different species as projected by dynamic soil models (Canham et al., 2003). The adaptability of newly created red clover varieties is a trait increasingly taken into account today. The objective of this research is to find out the specific abiotic characteristics of the habitats of autochthonous red clover populations in order to utilize these populations in breeding programs to tolerance to specific abiotic stresses.

Materials and methods

Eleven locations of autochthonous populations of red clover were surveyed in north-western Croatia (NW Croatia). Two types of habitats, meadow and ruderal, were registered on these locations. Surveillance of botanic composition, soil type, altitude, exposition and terrain inclination was carried out at these locations during 2007 (Table 1). Abiotic characteristics of locations [soil humidity (F), soil reaction (R), nitrogen supplies (N)] were determined on the basis of botanical composition, by Ellenberg indicator value (Ellenberg, 1974).

Table 1. Description of locations of red clover in the territory of NW Croatia

Location	Habitats	No of species	Altitude (m)	Exposition	Inclination (%)	Soil type
Sava (SA)	meadow	31	107	S	0	alluvial
Dugo Selo (DU)	ruderal	16	106	SW	5	loam
Zlatar Bistrica (ZL)	meadow	37	180	SW	10	loam
Celje (CE)	ruderal	27	160	SW	0	organic
Presečno (PR)	meadow	32	184	W	10	sandy loam
Kumrovec (KU)	meadow	32	234	S-SE	5	loam
Sošice (SO)	meadow	26	560	SE	5	loam
Drmići (DR)	meadow	33	538	W	40	loam
Stojdraga (ST)	ruderal	17	490	W	10	loam
Bedekovčina (BE)	meadow	20	219	E	10	loam
Krapinske toplice (KR)	ruderal	18	164	W	50	loam

The principal coordinate analysis (PCA) was applied in order to form and correlate groups of autochthonous red clover populations, regarding abiotic characteristics of their habitats. Ellenberg indicator values (e) were standardized as $y_e = \frac{(x_e - \bar{x}_e)}{sd_{x_e}}$, with

x_e the e -th character of Ellenberg indicator values before standardisation ($e = 1 \dots E$, $E = 3$), y_e the standardized character, \bar{x}_e the mean of x_e and sd_{x_e} the standard deviation of x_e . Euclidean distance between locations L ($L = 11$) i and j , d_{ij}^e , was defined by

$$d_{ij}^e = \frac{\sqrt{\sum_{e=1}^E (y_{ie} - y_{je})^2}}{8E} \quad (\text{Roldan-Ruiz et al, 2001.}).$$

The normalizing constant $8E$ ($= 24$)

brings the d_{ij}^e on the scale from 0 to 1. The 3D principal coordinate analyze (PCA) carried out using SAS/Stat software (V9.1).

Results and discussion

Ellenberg indicator values of surveyed locations were determined on the basis of their botanical composition, while Centerini et al. (2007) studied and evaluated soil parameters and botanical composition separately.

In total, 105 plant taxa were registered on locations of autochthonous red clover populations. Plant taxa were the least numerous at the location DU (16), and the most numerous at the location ZL (37). Sinkovič (2006) records 20 species in average at one location.

On the basis of plant taxa registered at the area under surveillance, the mean values for soil humidity (F) point out the prevailing of indicating plants of humid habitats (F=5). Analysis of indicating values for soil reaction (R) point out the domination of moderately acid to moderately alkaline soils (R=6), and is in accordance to Vrbek (2000). Considering the nitrogen supply, the most abundant plant species are those indicating the habitats moderately supplied with nitrogen (N=6).

On the basis of Ellenberg indicator values, locations are clustered into six groups: (1.) KU and PR, (2.) ST, SO, BE and KR, (3.) SA and DU, (4.) ZL, (5.) DR and (6.) CE (Figure 1).

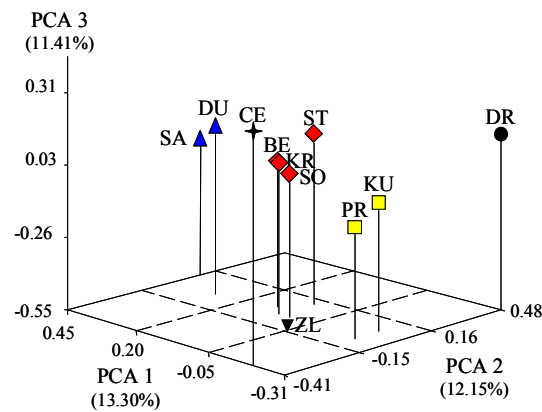


Figure 1. The 3D PCA of locations surveyed by Ellenberg indicator values

Although DR and CE have equal mean values for all parameters assessed (F=5, R=6, N=5), these locations are the most separated because they are geographically the most distant, and differentiate in altitude and soil type (Table 1). Both locations were used as arable land in the past. Today, the location DR is transformed in newly set meadow, while the location DR is fully neglected ruderal habitat.

The location ZL is separated from the other groups by the number of species, and differentiates in the phases of succession.

Locations BE and SO are grouped in the same group because they have the same mean values for F (F=5) and R (R=6). Recently, these locations were arable lands, but today they are naturally grassed.

Locations KR and ST are similar in the average value of nitrogen supply (N=6). Mentioned locations are ruderal habitats alongside the road, with the specificity in terrain inclination at the location KR, as visible from the mean value of soil humidity (F=4).

Locations SA and DU are similar in nitrogen supply (N=7). Location SA is meadow habitat, and DU is ruderal habitat, but the way of their maintenance and utilization is quite similar.

Locations PR and KU are clustering together due to similar mean values (F=6, R=6, N=5), and the same number of plant species. However, the location KU is completely neglected in comparison to the location PR.

The location DR and KU cluster together due to pH value of soil and nitrogen supply (R=6, N=5) and due to fact that these habitats were arable land in the past, and today are utilized as meadows. The only differentiations between DR and KU are manifested in the phases of succession.

Conclusions

The habitats at surveyed territory are mainly humid, with moderately acid to alkaline soil reaction, and moderately supplied with nitrogen.

The way of utilization and maintenance, and different environmental influences change specific soil conditions at particular locations, causing human-induced or natural stresses. Different ecotypes of red clover are adaptable to these changes. These ecotypes are registered together with characteristics of surveyed habitats and are representing the breeding pool for tolerance to specific abiotic stresses.

Acknowledgements

Results shown in this paper arise from the research project (Genetic variability of red clover and tolerance to abiotic stress), carried out by the support of The Ministry of Science, Education and Sports of The Republic of Croatia.

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