INDICATIVE SPECIES FOR THE AGROCHEMICAL PROPERTIES OF MOUNTAIN GRASSLANDS SOIL FROM THE APUSENI NATURAL PARK (ROSCI 0002)

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Abstract

The establishment of the soil agrochemical conditions indicative species can give us valuable and quick information on the state of fertility or degradation in making decisions on the proper management of the grassy carpet of a permanent grassland. Studies on the soil-plant relationship in the Apuseni Natural Park on pastures located between 1060 and 1670 m altitude belonging to Habitat 6520 Mountain grasslands, were materialized by 55 floristic surveys accompanied by soil samples at 0-10 cm depth, which were analyzed and calculated statistically, establishing the indicator value of the species according to the Hundt method (1966) and Dufrêne - Legeandre method (1997). Indicative species and groups of species have been established for the agrochemical characteristics of the soils which continue to be used to develop the main measures for the improvement and use of the mountain grasslands grassy carpet, with the practice of ecological agriculture, biodiversity conservation and environmental protection.

Keywords: mountain grasslands, Habitat 6520, indicator species, soil agrochemical content.

INTRODUCTION

For the proper management of a grassland, it is not enough to have a unilateral knowledge of the floristic composition without its relation with the physical and chemical components of the soil.

In this sense, in the last half century, in our specialized literature, several older or newer works have appeared in the study of the soil-plant relationship with the concrete establishment of the indicator species (Lauer 1974, 1979; Maruşca 1982, 2001, 2010, 2016, 2017; Maruşca *et al.*, 2000, 2020; Bărbos *et al*. 2010).

These studies are particularly needed for the practice of organic farming, biodiversity conservation and the protection of pastoral landscapes.

It is necessary to continue and intensify such ecological studies, especially in the mountain area, an objective that aims at this paper.

MATERIAL AND METHOD

In July - August 2021, 55 floristic surveys were carried out, accompanied by soil samples from 0 - 10 cm depth from the pastures managed by the Apuseni Natural Park within a POIM Axis 4 project (2021 - 2022) SMIS Code 122643. After a first analysis on the phytodiversity and productivity of the 6520 habitat Mountain Grassland (Haifields) with the 5 constituent types (*Festuca rubra*, *F. rubra* with *Agrostis capillaris*, *F. rubra* with *Nardus stricta*, *N. stricta* with *F. rubra* and *N. stricta*)

(Maruşca *et al.* 2021) we move on to outlining some groups of indicator species for the agrochemical characterization of the soil.

The characterization of the reaction of the grassland soil and its content in different organic and inorganic materials was done according to current standards (Florea *et al.* 1987).

Graphic symbols were developed for suggestive presentation of soil agrochemical values (table 1 and 2).

Table 1

Soil reaction limits (pH in H2O) in soil
(after Florea et al. 1987)

Property	Symbol	pH ind.
Extremely acid	<<<	3,6 - 4,3
Strong acid	<<	4,4 - 5,0
Moderate acid	<	5,1 - 5,8
Weak acid	< =	5,9 - 6,8
Neutral	< = >	6,9 - 7,2

Table 2

Agrochemical content limits
(after Florea et al. 1987)

Propriety	Symbol	Soil content (0 - 10 cm)				
		SB me/100 g	Humus %	P_{AL} mg/kg	K_{AL} mg/kg	Al^{3+} me/100g
Extremely low	<<<	< 4	< 1,1	-	-	< 0,3
Very low	<<	4-7	1,2-2,2	< 9	< 66	0,4-0,8
Low	<	8-15	2,3-5,5	9-18	66-130	0,9-2,0
Medium	< = >	16-25	5,6-8,5	19-36	131-200	2,1-4,0
High	>	26-35	8,6-11,9	37-72	201-300	4,1-6,5
Very high	>>	36-60	12,0-24,0	> 72	> 300	6,6-10,0
Extremely high	>>>	> 60	> 24,1	-	-	> 10,1

Identifying characteristic or indicator species is a traditional activity in ecology and biogeography. Diagnostic species are those that occur frequently in a vegetation unit, thus being useful in the field recognition of that unit (type of herbaceous carpet, plant association, etc.). The measure of the association degree between a species and a vegetation unit (survey group) in relation to the agrochemical elements of the soil, is called fidelity.

A first analysis was on the degree of participation in the grassy carpet of the dominant and codominant species (*Festuca rubra, Agrostis capillaris, Nardus stricta* and *Deschampsia caestitosa*) depending on the main agrochemical characteristics of the soil.

The fidelity of the participation in the grassy carpet of the 4 species according to the agrochemical characteristics of the soil was calculated statistically according to the Hundt method (1966) which refers only to the presence of species. In some doctoral theses, in addition to the presence, this method was completed with the degree of participation of the species depending on the agrochemical parameters of the soil (Lauer 1974, 1979; Maruşca 1981, 2010).

One of the most widely used statistical indices for expressing fidelity is the Dufrêne-Legendre indicator value (IndVal) (Dufrêne et Legendre 1997). To calculate this value, it is first necessary to classify the surveys, respectively to divide the data set into homogeneous groups. In this paper, the agrochemical elements of the soil (pH, SB, humus, phosphorus, potassium and exchangeable aluminum) from each survey are used as criteria for analyzing the indicative value of the species in a number of 55 surveys.

The Dufrêne-Legendre indicator value is defined as the product of the relative abundance and relative frequency of the species in the survey group for each agrochemical property limit:

$$IndVal = 100 \cdot (Ar \cdot Fr)$$

where: Ar - relative abundance, calculated as the ratio between the average abundance of the species in the target survey group (range of the agrochemical element) and the sum of the species' abundances in the whole data set; Fr - the relative frequency of the species in the target range.

Using the values of presence-absence and participation of the species in each survey analyzed in relation to the analyzed agrochemical elements, this index can be written in the form:

$$IndVal = 100 \, x \, \frac{(\frac{a_1}{N_1})}{(\frac{a_1}{N_1} + \frac{a_2}{N_2} + \frac{a_3}{N_3} + \cdots + \frac{a_P}{N_p})} \, x \, \frac{n_1}{N_1}$$

where: N_1 - N_p = number of readings for each range of the agrochemical element to which fidelity is determined,

n_1 = number of occurrences of the species in each range of analyzed agrochemical element;

a1 - ap = sum of the participations in each range of the analyzed agrochemical element.

The range of variation is between 0 and 100.

RESULTS AND DISCUSSION

After the statistical calculations and the graphical representation of the main dominant species according to the Hundt method (1966) improved by Lauer (1974), the degree of their participation according to the agrochemical characteristics of the soils stood out (figure 1).

- *Festuca rubra* prefers weakly acidic soils, with a high and very high content in bases (SB), humus and phosphorus (P), medium in potassium (K) and extremely low in aluminum (Al);

- *Agrostis capillaris* has a maximum participation in the grassy carpet on moderately acid soils with a low content in SB, very high in humus, P and K, and low in Al;

- *Deschampsia caespitosa* settles mainly on moderately acidic soils, very low in SB, high in P, medium in K and high in Al;

- *Nardus stricta* dominates very strong acid soils with a very low SB content, extremely high in Humus, medium in P, high in K, very and extremely high in Al mobile toxic to other plants.

The echodiagram of *Nardus stricta* from the Apuseni Natural Park with the Bihor, Vlădeasa and Gilău Mountains is very similar to that of the nardets from Braşov County with the Făgăraş, Bucegi, Perşani, Ciucaş and Bârsei Mountains (Maruşca 1982, 2010) and from the Maramureş Mountains).

Applying the method of combined statistical analysis of relative frequency and relative abundance Dufrêne-Legendre (1997) resulted in several echodiagrams suggestive of all 18 major species in Habitat 6520 (figure 2).

At a first analysis, the Dufrêne-Legendre value indices (Ind Val DL) for the species considered are extremely different, from 0 to 85%.

From the group of indicator species were considered only those that had a peak Dufrêne-Legendre IndVal equal to or greater than 30%, as a minimum threshold and otherwise without notable representations at the other ranges of agrochemical values.

A fairly large amount of data on indicator species for soil agrochemical content in Habitat 6520 is summarized in table 3.
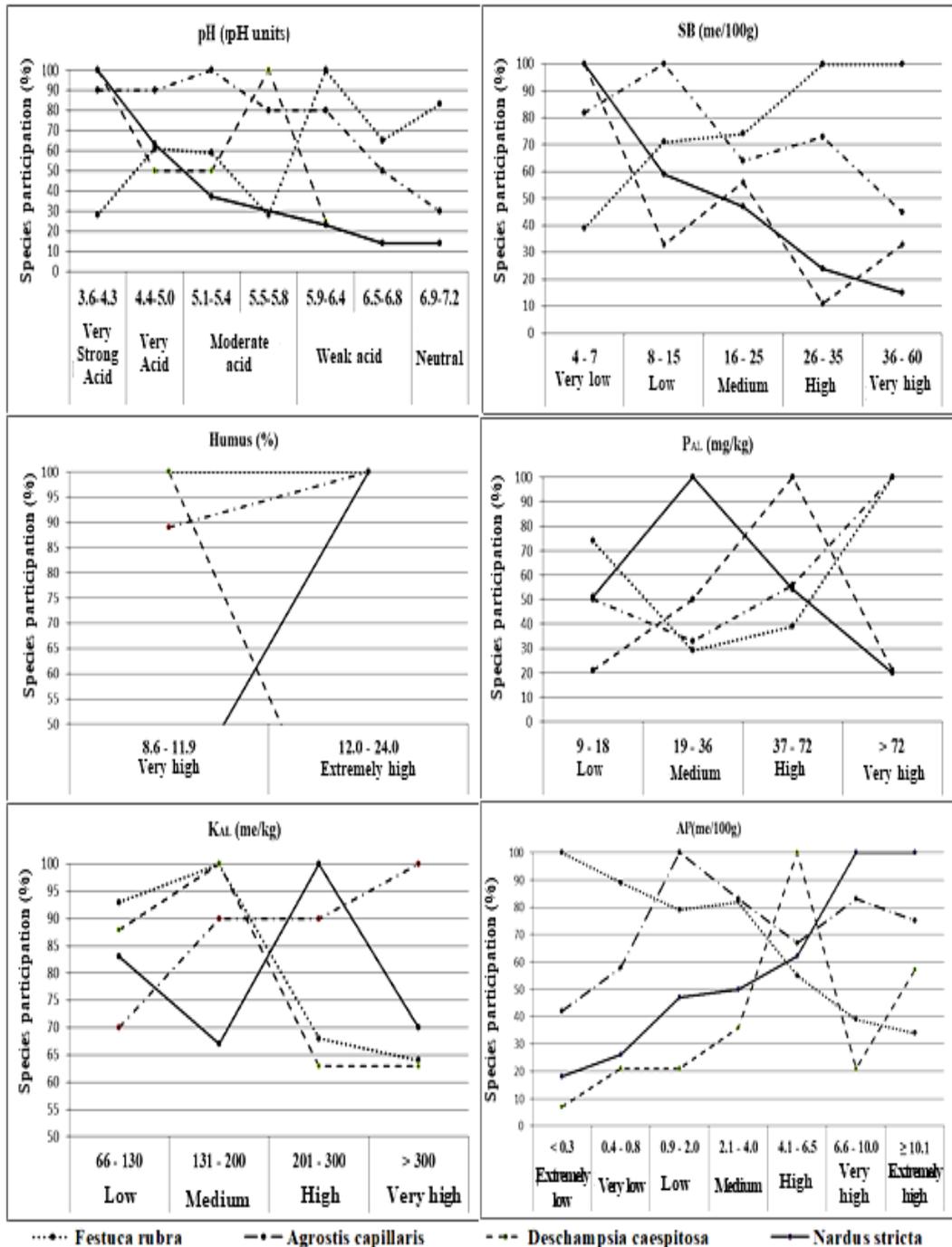
Figure 1 Echodiagrams of the main dominant and codominant species of Habitat 6520, in relation to the agrochemical characteristics of the soil
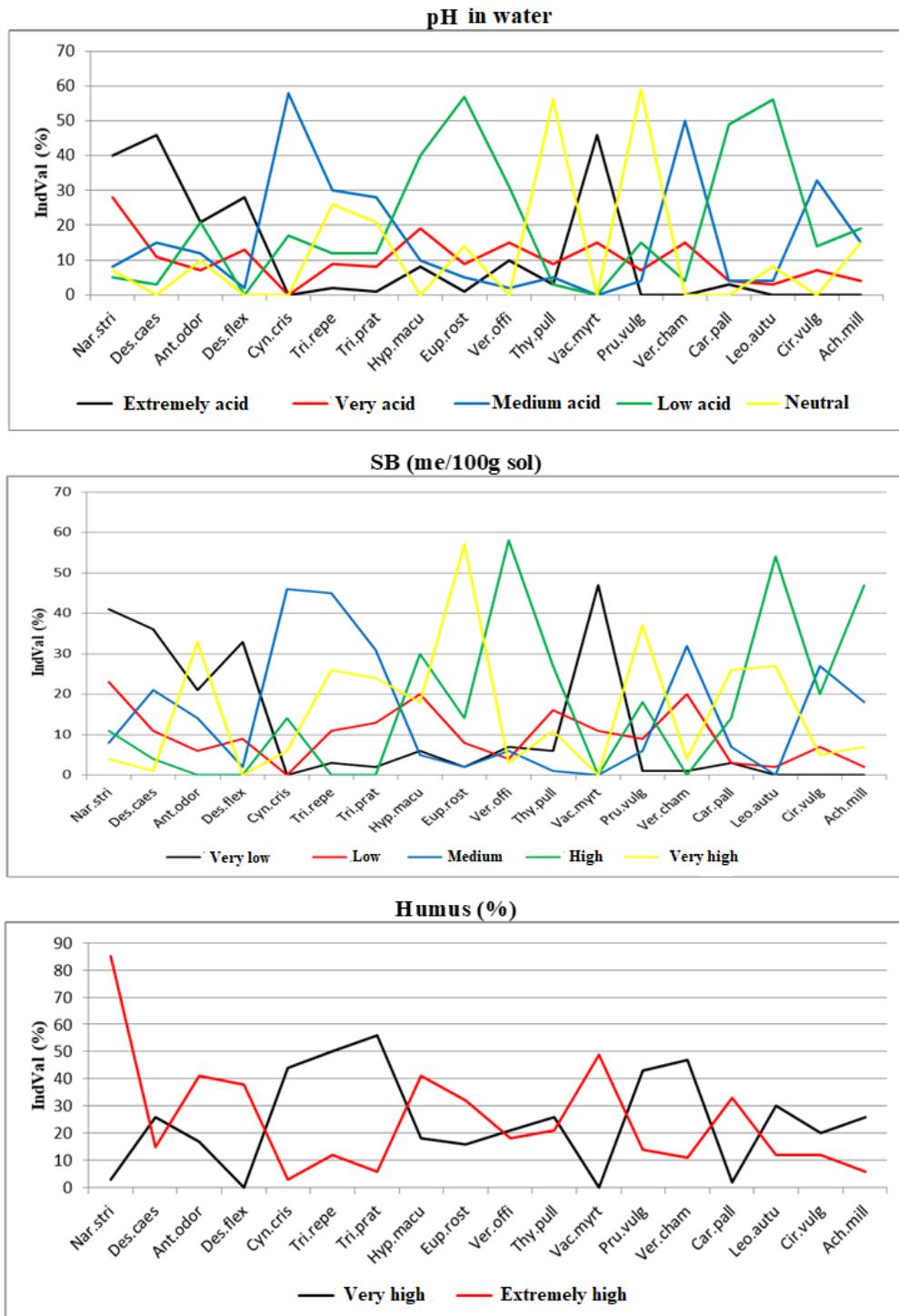
Figure 2 Indicative value (Dufrêne-Legendre) of the main species in Habitat 6520 in relation to the agrochemical characteristics of the soil

P$_{AL}$ (mg/kg)

K$_{AL}$ (mg/kg)
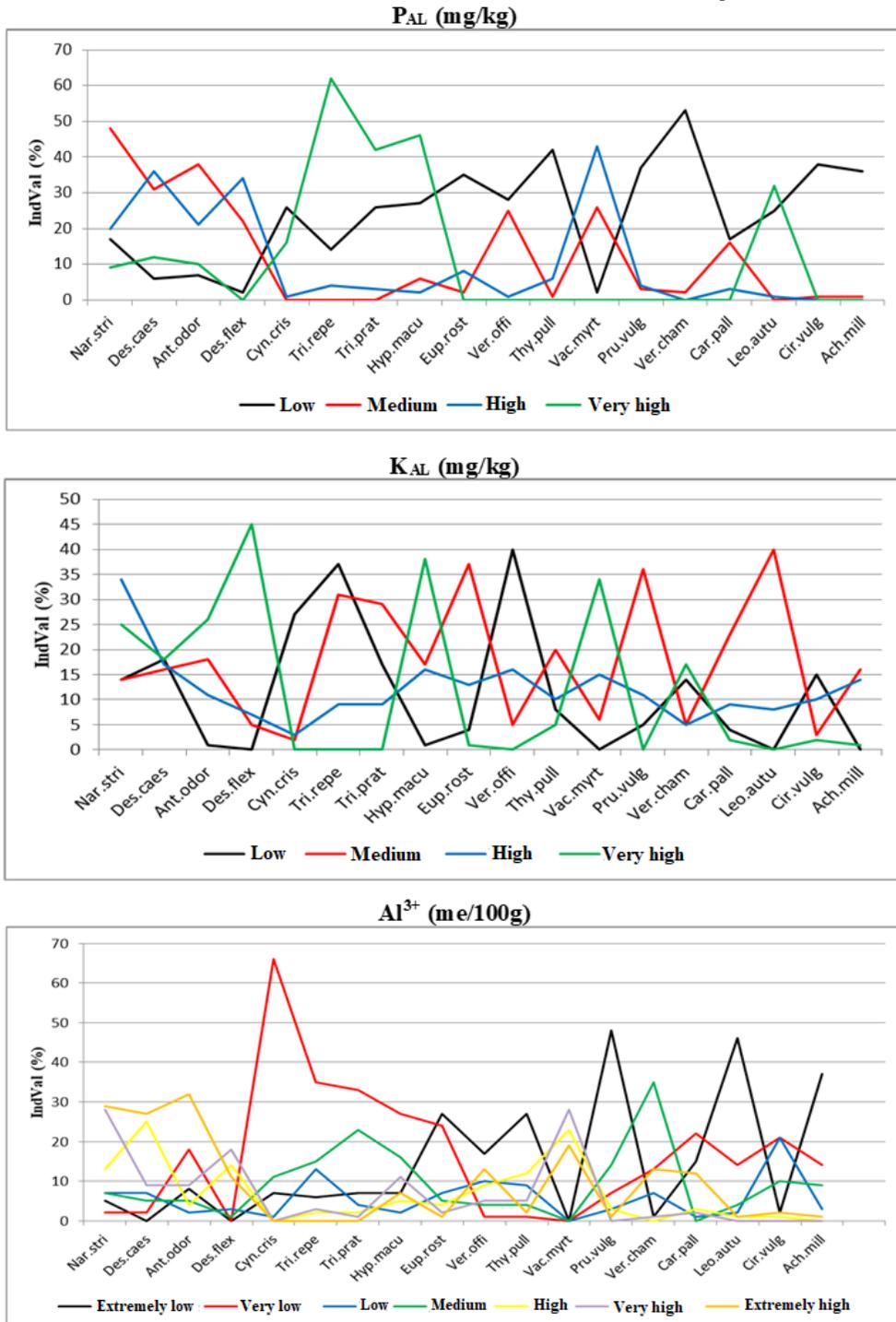

Al^{3+} (me/100g)

Figure 2 (continuation) Indicative value (Dufrêne-Legendre) of the main species in Habitat 6520 in relation to the agrochemical characteristics of the soil

Table 3

Indicative species for the agrochemical properties of meadow soil
Habitat 6520 in the Apuseni Natural Park

Species present in more than 15 of 55 surveys (no.)	pH ind	SB me/100 g	Humus %	P$_{AL}$ mg/kg	K$_{AL}$ mg/kg	Mobile aluminum me/100g
Poaceae						
Nardus stricta (48)	<<<	<<	>>>	.	.	>>>
Deschampsia caespitosa (38)	<<<	<<	.	.	.	>>>
Anthoxanthum odoratum (33)	.	.	>>>	< = >	.	.
Deschampsia flexuosa (20)	<<<	<<	>>>	.	>>	>>
Cynosurus cristatus (15)	<	< = >	>>	.	<	<<
Fabaceae						
Trifolium repens (28)	.	< = >	.	>>	<	<<
Trifolium pratense (23)	.	.	>>	.	< = >	<<
Other families						
Hypericum maculatum (35)	< =	.	.	.	>>	.
Euphorbia rostkoviane (26)	< =	>>	.	<	< = >	.
Veronica officinalis (26)	.	>	.	.	<	.
Thymus pullegioides (25)	< = >	.	.	<	.	.
Vaccinium myrtillus (24)	<<<	<<	>>>	.	>>	>>
Prunella vulgaris (23)	< = >	.	>>	<	< = >	<<<
Veronica chamaedrys (23)	.	< = >	>>	<	.	.
Carex pallescens (20)	< =	.	>>>	.	< = >	.
Leontodon autumnalis (18)	< =	>	.	.	< = >	<<<
Cirsium vulgare (16)	.	< = >	.	<	.	.
Achillea millefolium (15)	.	>	>>	<	.	<<<

Legend: <<< extremely low; << very low; < low; < = > medium (neutral); > high;
>> very high; >>> extremely high

After getting acquainted with the significance of the symbols for assessing the agrochemical properties of the soil presented in Tables 1 and 2, we proceed to assess the indicative value of each species in Table 3 and the composition of ecological groups.

Thus, *Nardus stricta* indicates very strongly acidic soils (pH 3.6-4.3) with a very small amount of bases (4-7 me/100 g), extremely high humus content (> 24.1%) and the same. for mobile aluminum (> 10.1 me/100g). *Deschampsia caespitosa, D. flexuosa* and *Vaccinium myrtillus* are also part of this group as indicators of extreme negative conditions for growth and development.

Indicative species for a very low mobile aluminum content (Al3 + 0.4-0.8 me/100 g) are *Cynosurus cristatus, Trifolium repens* and *T. pratense* which are also very good forage plants.

A low phosphorus content (P 3-18 mg/kg) as a very important element in plant nutrition is represented by the ecological group *Achillea millefolium, Cirsium vulgare, Euprasia rostkoviana, Prunella vulgaris, Thymus pullegioides* and *Veronica chamaedrys*, medium in phosphorus

(19- 36 mg/kg) *Anthoxanthum odoratum* and very large (> 72) Trifolium repens.

For an average potassium content (K 151-200 mg/kg), an ecological group of *Carex pallescens, Euphrasia rostkoviana, Leontodon autumnalis, Prunella vulgaris* and *Trifolium pratense* was also outlined, with a very high content (KAL> 300 mg/kg). *Hypericum maculatum* and *Vaccinium myrtillus* species.

In general, the species from the habitat 6520 (Mountain grasslands) located between 1061 m to 1672 m altitude in the Apuseni Natural Park, have a very high humus content (12-24%) and above this limit, due to the accumulation of excess organic matter in acidic soil reaction conditions and low temperatures.

CONCLUSIONS

The permanent grasslands from the Apuseni Natural Park, belonging to Habitat 6520 (Mountain grasslands) used for grazing with animals, contain numerous species indicative of the agrochemical characteristics of the soil.

The group of species consisting of *Nardus stricta, Deschampsia caespitosa, D. flexuosa* and *Vaccinium myrtillus* indicate very strong acid soils, which need to be finely calcified to improve the grass carpet.

The group of species consisting of *Achillea millefolium, Cirsium vulgare, Euphrasia*

Under these conditions, in addition to a very low base amount indicator group (SB 4-7 mg/100 g) mentioned above, a medium group (SB 16-25) was formed consisting of *Cynosurus cristatus, Trifolium repens, Cirsium vulgare* and *Veronica chamaedrys*.

It can be noted that one of the 18 species analyzed may be indicative of 2 to 5 agrochemical characteristics of the soil.

The data obtained on the indicator species for the agrochemical characteristics of the soil serve to a more intimate knowledge of the soil-plant relationship, are the basis for making decisions for the improvement and use of grasslands, conservation of biodiversity and pastoral landscapes.

rostkoviana, Prunella vulgaris, Thymus pullegioides and *Veronica chamaedrys*, indicates soils with a low phosphorus content, a very necessary element for normal plant nutrition, especially of atmospheric N-fixing legumes, being necessary to apply phosphorus fertilizers.

The group of species *Cynosurus cristatus, Trifolium pratense, T. repens, Achillea millefolium, Leontodon autumnalis* and *Prunella vulgaris* indicate a low to very low content of mobile aluminum in the soil, which allows the development of valuable forage species from spontaneous flora or sown varieties.

The setting of indicator species for the grasslands agrochemical soil characteristics can bring important savings with chemical analysis and the application of a precision cultivation depending on the floristic composition of the grass carpet.

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