Ecologic and Agronomic Aspects of *Agrostis Capillaris* L. – *Trisetum Flavescens* (L.) P. Beauv. Grassland Subtype

Ioan ROTAR^{1*}, Florin PĂCURAR¹, Anca PLEȘA¹, Roxana VIDICAN¹, Miklós NAGY¹

Faculty of Agriculture, UASMV Cluj-Napoca, Calea Mănăstur 3-5, Cluj-Napoca, Romania;

* corresponding author: rotarioan52@yahoo.fr

Bulletin USAMV series Agriculture 71(2)/2014
Print ISSN 1843-5246; Electronic ISSN 1843-5386
DOI 10.15835/buasvmcn-agr: 10842

Abstract

Grasslands in Apuseni Mountains are used in a traditional system and several types and subtypes of grasslands were described. Because of the current grassland management and the site conditions appeared certain grassland subtypes which need to be deepen characterized and their biodiversity and agronomic value needs to be maintain. The aim of the study was to characterize *Agrostis capillaris* L. – *Trisetum flavescens* (L.) P. Beauv. grassland subtype from both, ecological and agronomic point of view. The research was unfolded within Gârda de Sus commune, on Ghețari – Poiana Călineasa Plateau. For the floristic composition's study we used the Braun-Blanquet method. The phytocenosis *Agrostis capillaris* L. – *Trisetum flavescens* (L.) P. Beauv. has been identified in 37 sites. The sites were characterized from ecologic and agronomic point of view. This grassland subtype can be characterized as heliophytes, microtherm, mesophytes, moderate acidophilous, medium nitrophilous, medium resistant to mowing, medium resistant to stepping and medium resistant to grazing and endures an animal load of 0,81 – 1,00 LSU/ha.

Keywords: *ecological factors, grasslands, phytodiversity*

INTRODUCTION

Grasslands from *Festuca rubra* L. and *Agrostis capillaris* L. type in the Apuseni Mountains have evolved toward certain types and subtypes of grasslands (Gârda, 2010). One of them is *Agrostis capillaris* L. with *Trisetum flavescens* (L.) P. Beauv. The improvement of *Festuca rubra* L. and *Agrostis capillaris* L. grasslands' trophicity determines a powerful installation of *Trisetum flavescens* (L.) P. Beauv. species (Coldea *et al.*, 2012). In Europe, grasslands with *Trisetum flavescens* (L.) P. Beauv. have been located on the sites in the past, and were mowed two times per year and fertilized with manure (Ellenberg, 1996; Hutter *et al.*, 2002). From the typological classification's point of view, this phytocoenosis is not described as a type or subtype, not in the nemoral or in the boreal floor (Țucra *et al.*, 1979). The fact that *Agrostis capillaris* L. – *Trisetum flavescens* (L.) P. Beauv. phytocoenosis has been identified in many stations leads us to extend the study of these ecosystems. The aim of our study was to evaluate *Agrostis capillaris* L. -

Trisetum flavescens (L.) P. Beauv. grasslands, both from ecological and agronomic point of view.

MATERIALS AND METHODS

The research has been carried out in Gârda de Sus commune, between 2011-2012, where we established the study area, on Ghețari – Poiana Călineasa Plateau, because it constitutes a representative area for the traditional exploitation of resources. For floristic composition we used Braun-Blanquet method, applied on 25 m² area. Additionally, at the moment of performing the floristic relevee, by using the GPS device (Global Positioning System), data regarding the altitude (meters above sea level) and exposition (degrees 0 – 360°) of the relevee's research point. The distribution of identified grassland types and subtypes has been performed in several stages: marking the relevee number correspondent to the grassland on the orto-photoplan during the field activity; arranging the floristic relevees on grassland types and subtypes in Excel program; transposing these data in ArcView GIS 3.3

programme in order to generate the map of grassland types and subtypes' distribution and establishing the area occupied by them in the studied perimeter.

Plants demands for the ecological factors (light, temperature, soil's moisture, soil's pH and the soil's mineral nitrogen quantity) have been embodied by species' indicator values (from 1 to 9) by Ellenberg (1952, 1992), upgraded by the Federal Agency of Nature Conservation Germany (Bundesamt für Naturschutz – www.floraweb.de), and adapted to the conditions of our country by Kovács (1979).

Plants resistance against mechanical disturbances, such as: mowing, stepping and grazing were embodied through indicator values (from 1 to 9) by Dierschke and Briemle (2002). Then, after Dierschke and Briemle (2002), the land-use manner's interpretation and framing into intensification classes were performed.

Taking into account the environmental factors and plant resistance on mechanical disturbances, the species were classified into specific categories in function of the environmental or disturbing factor, following the number of species in category and the coverage of the category. In most of cases, the coverage of a specific category can provide more accurate information than the number of species (Cristea *et al.*, 2004). In a similar manner, the number of species in a given category is related to the total number of species in categories, without the indifferent and uncertain species. To determine the grassland's pastoral value we used the specific index of quality on a scale of 1-5 by Kovacs, 1979.

As phyto-sociological indexes, the mean abundance-dominance, the Shannon-Wiener index and the constancy have been calculated. The classification of the the grasslands in different types and subtypes was made after Țucra *et al.*, 1979.

RESULTS AND DISCUSSIONS

Agrostis capillaris L. – *Trisetum flavescens* (L.) P. Beauv. phytocoenosis was identified in 37 stations, which means a significant share (9%) of the total studied grasslands. These grasslands are used only by mowing. In our study area this grassland subtype is found at altitudes between 1070 and 1337 m and occupies approximately 60 ha (Fig.1). Usually it spreads from plain lands to slopes with an angle up to 40°, most of the relieves

being found on slopes of 10°. In general, this grassland is located on all of the expositions, but most commonly (35% of stations) on eastern to southern exposition (95 - 180°).

Woody vegetation average cover (Tab. 1) is 4.46%. The medium coverage of stumps is 0.88% and the rocks have 0.43 %. Stones have a coverage of 1.08% and the molehills have a low average coverage of 1.95%. Overall medium coverage of the herbaceous vegetation is 95.92%.

Fig. 1. Distribution of areas with the grassland subtype *Agrostis capillaris* L. – *Trisetum flavescens* (L.) P. Beauv. on Ghețari – Poiana Călineasa Plateau

The floristic composition of *Agrostis capillaris* L. – *Trisetum flavescens* (L.) P. Beauv. varies significantly depending on the station. *Poaceae* sp. are present with a mean abundance-dominance (MAD) of 48.4% (Tab. 1). *Agrostis capillaris* L. species appears with a MAD of 24.66% and *Trisetum flavescens* (L.) P. Beauv. with 16.32%. The dominant species, from *Poaceae*, specific for this subtype of grasslands are: *Agrostis capillaris* L., *Festuca rubra* L. and *Trisetum flavescens* (L.) P. Beauv. (K = V) followed by the indicator species

Tab. 1. Stand conditions, species composition and assessment of the *Agrostis capillaris* L.- *Trisetum flavescens* (L.) P. Beauv. subtype

Ecological indexes				Agronomic indexes				Stand conditions	$\bar{x}$	K	Si	Si*%
								Altitude (m)	1187,03	-	-	-
								Slope (°)	10,22	-	-	-
								Exposition (°)	190,19	-	-	-
								Land use	1,00	-	-	-
								Wooden vegetation cover (%)	4,46	-	-	-
								Stubs (%)	0,88	-	-	-
								Rocks (%)	0,43	-	-	-
								Stones (%)	1,08	-	-	-
								Fallow molehills (%)	1,95	-	-	-
								Moss (%)	1,08	-	-	-
								General cover (%)	95,92	-	-	-
L	T	M	pH	N	MR	GR	STR	Species	MAD	K	Si	Si*%
-	-	-	-	-	-	-	-	Poaceae	48,04	-	-	-
7	x	x	4	4	6	5	5	<i>Agrostis capillaris</i> L.	24,66	V	3	73,99
x	x	x	5	x	7	5	5	<i>Anthoxanthum odoratum</i> L.	0,62	III	1	0,62
8	5	5	x	4	7	7	7	<i>Cynosurus cristatus</i> L.	0,42	III	3	1,26
7	x	5	x	6	8	4	6	<i>Dactylis glomerata</i> L.	0,35	II	5	1,76
8	x	6	x	6	6	4	6	<i>Festuca pratensis</i> Huds.	0,50	II	5	2,50
x	x	5	x	x	9	7	6	<i>Festuca rubra</i> L.	4,97	V	3	14,90
7	x	x	x	5	7	5	4	<i>Trisetum flavescens</i> (L.) P. Beauv.	16,32	V	4	65,27
-	-	-	-	-	-	-	-	Cyperaceae and Juncaceae	1,01	-	-	-
7	4	7	3	4	-	-	-	<i>Carex leporina</i> L.	0,01	I	x	0,00
7	4	x	4	4	4	5	5	<i>Carex pallescens</i> L.	0,01	I	x	0,00
2	5	5	6	5	-	-	-	<i>Carex sylvatica</i> Huds.	0,47	I	x	0,00
8	5	7	4	4	4	7	6	<i>Juncus effusus</i> L.	0,47	I	x	0,00
7	x	4	3	2	5	5	5	<i>Luzula campestris</i> (L.) DC.	0,05	I	x	0,00
-	-	-	-	-	-	-	-	Fabaceae	10,08	-	-	-
7	x	4	7	3	6	4	4	<i>Lotus corniculatus</i> L.	2,14	V	4	8,57
7	x	x	x	x	7	4	4	<i>Trifolium pratense</i> L.	2,38	V	4	9,51
8	x	5	6	6	8	8	8	<i>Trifolium repens</i> L.	4,30	IV	4	17,19
7	5	5	x	x	6	1	2	<i>Vicia cracca</i> L.	0,98	IV	2	1,96
-	-	-	-	-	-	-	-	Plants of OBF	45,15	-	-	-
5	5	4	7	3	7	4	5	<i>Achillea distans</i> Waldst. & Kit. ex Willd.	1,18	II	x	0,00
8	x	4	x	5	7	4	5	<i>Achillea millefolium</i> L.	0,47	III	2	0,95
6	4	5	6	6	-	-	-	<i>Alchemilla vulgaris</i> L.	10,47	V	2	20,93
6	4	6	8	5	3	7	3	<i>Astrantia major</i> L.	0,68	II	x	0,00
8	6	5	7	5	5	2	2	<i>Campanula patula</i> L.	0,30	III	x	0,00
8	4	5	x	6	6	6	6	<i>Carum carvi</i> L.	0,28	III	2	0,57
7	4	5	5	4	5	2	2	<i>Centaurea phrygia</i> L.	4,05	V	x	0,00
6	5	5	8	5	-	-	-	<i>Cirsium erisithales</i> (Jacq.) Scop.	0,51	II	x	0,00
6	5	6	7	x	5	9	3	<i>Colchicum autumnale</i> L.	7,89	IV	x	0,00
7	5	5	6	5	6	2	2	<i>Crepis biennis</i> L.	0,95	IV	x	0,00
6	x	x	x	4	5	6	5	<i>Euphrasia rostkoviana</i> Hayne	0,42	II	x	0,00
8	x	6	3	2	3	3	3	<i>Hypericum maculatum</i> Crantz	1,36	IV	x	0,00
7	x	5	5	5	7	7	7	<i>Leontodon autumnalis</i> L.	1,44	III	1	1,44
7	x	4	x	3	6	3	4	<i>Leucanthemum vulgare</i> Lam.	0,82	IV	1	0,82
7	x	6	7	7	5	3	2	<i>Pimpinella major</i> (L.) Huds.	1,16	IV	1	1,16
6	x	x	x	x	7	6	6	<i>Plantago lanceolata</i> L.	0,38	III	2	0,76
7	x	4	7	3	4	8	8	<i>Plantago media</i> L.	0,34	III	1	0,34
8	6	3	8	2	4	4	4	<i>Polygala comosa</i> Schkuhr	0,12	II	x	0,00
6	x	x	x	2	8	4	5	<i>Potentilla erecta</i> (L.) Raeusch.	0,38	II	1	0,38
8	6	3	7	3	6	5	4	<i>Ranunculus bulbosus</i> L.	0,59	III	x	0,00
7	5	x	x	3	5	8	3	<i>Rhinanthus minor</i> L.	1,49	IV	x	0,00
8	x	x	x	6	6	4	2	<i>Rumex acetosa</i> L.	1,78	IV	x	0,00
8	5	3	8	3	5	3	4	<i>Scabiosa columbaria</i> L.	0,31	II	x	0,00
6	x	4	4	3	4	5	5	<i>Stellaria graminea</i> L.	0,24	III	x	0,00
7	6	8	x	8	6	4	4	<i>Symphytum officinale</i> L.	0,11	II	1	0,11
7	x	5	x	7	8	7	7	<i>Taraxacum officinale</i> F.H.Wigg	1,74	IV	2	3,49
8	x	4	x	1	4	4	4	<i>Thymus pulegioides</i> L.	0,11	II	x	0,00
9	3	7	6	5	5	7	2	<i>Trollius europaeus</i> L.	1,69	II	x	0,00
7	4	x	7	6	3	7	2	<i>Veratrum album</i> L.	0,70	II	x	0,00
6	x	5	x	x	7	6	6	<i>Veronica chamaedrys</i> L.	0,45	II	x	0,00
7	x	4	3	2	4	2	2	<i>Viola canina</i> L.	0,12	II	x	0,00
5	5	x	x	x	5	4	4	<i>Viola tricolor</i> L.	0,14	II	x	0,00
-	-	-	-	-	-	-	-	Σ	-	-	-	229,63
-	-	-	-	-	-	-	-	P _v	-	-	-	2,29
-	-	-	-	-	-	-	-	Assessment mark	-	-	-	50

$\bar{x}$ - media; K - Constancy; Si - specific index of quality; L - light, T - Temperature, M - Moisture, pH - Reaction, N - Nitrogen, MR - Resistant to mowing, GR - Resistant to grazing, STR - Resistant to stepping, MAD - Medium abundance-dominance, Σ - Amount of Si*%, P_v - Pastoral value.

like *Anthoxanthum odoratum* L. și *Cynosurus cristatus* L. (K = III) and accessory species as *Festuca pratensis* Huds., *Dactylis glomerata* L. (K = II). Other species which appears in this subtype of grassland accidentally, determined by completely isolated conditions, are called accidental species: *Deschampsia flexuosa* (L.) Beauv., *Elymus repens* (L.) Gould, *Phleum montanum* K. Koch, *Phleum pratense* L., *Poa trivialis* L. etc.

Species from *Cyperaceae* and *Juncaceae* have a very reduced cover, with a MAD of 1.01% (Tab. 1), in many of the cases are missing from the canopy. Species from these botanical families are: *Carex leporina* L. (0,01 %), *Carex pallescens* L. (0,01 %), *Carex sylvatica* Huds. (0,47 %), *Juncus effusus* L. (0,47 %) și *Luzula campestris* (L.) DC. (0,05 %), all of them are considered accidental species (K = I).

Species from *Fabaceae* (tab. 1) are present with a MAD of 10.8%. The dominant species of this family (K = V) are *Trifolium pratense* L. and *Lotus corniculatus* L., followed by the frequent species like (K = IV) – *Trifolium repens* L. și *Vicia cracca* L.

Plants from other botanical families (OBF) are present with a MAD of 45.15%. OBF species with significant presence are *Alchemilla vulgaris* L. (10.47%), *Centaurea phrygia* L. (4.05%), *Colchicum autumnale* L. (7.89%). The dominant species from OBF of the *Agrostis capillaris* L. – *Trisetum flavescens* (L.) P. Beauv. subtype are *Alchemilla vulgaris* L. and *Centaurea phrygia* L. (K = V), followed by frequent species (K = IV) like *Colchicum autumnale* L., *Crepis biennis* L., *Hypericum maculatum* Crantz, *Leucanthemum vulgare* Lam., *Pimpinella major* (L.) Huds., *Rhinanthus minor* L., *Rumex acetosa* L. and *Taraxacum officinale* F.H.Wigg. The indicator species of this group are (K = III) *Achillea millefolium* L., *Campanula patula* L., *Carum carvi*

L., *Leontodon autumnalis* L., *Plantago lanceolata* L., *Plantago media* L., *Stellaria graminea* L., etc. Accessory species (K = II) are: *Achillea distans* Waldst. & Kit. ex Willd., *Astrantia major* L., *Cirsium erisithales* (Jacq.) Scop., *Euphrasia rostkoviana* Hayne, *Polygala comosa* Schkuhr, *Potentilla erecta* (L.) Raeusch., etc. Accidental species determined by certain factors in isolated station are: *Arnica montana* L., *Arabis hirsuta* (L.) Scop., *Campanula serrata* (Kit. ex Schult.) Hendrych, *Carlina acaulis* L., *Centaurea mollis* Waldst. et Kit., *Doronicum orientale* Hoffm., *Euphorbia carniolica* Jacq., *Fragaria vesca* L., *Filipendula ulmaria* (L.) Maxim., *Gentianella lutescens* (Velen.) J. Holub, *Gymnadenia conopsea* (L.) R. Br., *Hieracium pilosella* L., *Linaria vulgaris* Mill., *Primula veris* L., *Prunella vulgaris* L. etc.

Regarding the distribution of species in constancy classes, it is noted that 56 species are accidental, 10 species are indicators, 10 species are frequent and 7 species are dominant (fig. 2). There is a decrease in the number of species from the lower frequency classes to the higher classes. The trend is easily predictable and obvious, given the conditions when the biotop's limited resources maintain the abundance of most of the species at a relatively low level in behalf of dominant species and good competitors. This fact has been found by Cristea et al. (2004). The core of phytocoenosis consists of species from classes IV and V, total of 17 species.

The floristic diversity of this subtype is highlighted by the average value of Shannon – Wiener index of 2.32. The average number of species per 25 m² is 27.73.

Regarding the agronomic value of grasslands, this is within the 6th grade – grassland's category is medium and endures a load of 0.81 to 1.00 LSU/ha.

Fig. 2. Distribution on constancy classes of *Agrostis capillaris* L.- *Trisetum flavescens* (L.) P. Beauv. subtype's species

Within this subtype 72 heliophytes species, 18 meso-heliophytes, 5 extremely-heliophytes and one heliophobous species are distinguished (Tab. 2). The same hierarchy is maintained when considering the cover of the species' classes and we can say that this subtype has a heliophytes character.

Regarding the special requirements for temperature of the species, we found out that 37 species are mesotherm and 10 are microtherme. The other categories are not represented and 52 species are indifferent to temperature (Tab. 2). Even though 69.19% is represented by the coverage of indifferent species for temperature, we state that this subtype has a character microtherme, because the microtherme species have a coverage of 18.23%.

Regarding the requirement for moisture of the plants we observed that 38 species are mesophytes, 33 mesoxerophiles and 12 mesohygrophilic (Tab. 2). The same hierarchy is maintained when considering species cover and we can say that the subtype has a mesophytes character (44.54% coverage).

In canopy 24 neutrophilous species, 14 moderate acidophilous species, 13 alkaliphile species, 8 lightly acidophilous species and one strongly acidophilous species are present. The number of indifferent species to soil reaction is 38 (Tab. 3). Considering the coverage of species, we found out that the highest coverage have the moderate acidophilous species, followed by the lightly acidophilous species and neutrophilous with alkaliphile species. Thus, we can say that this subtype has a moderate acidophilous character. (Tab. 3)

Tab. 2. Classification of *Agrostis capillaris* L.– *Trisetum flavescens* (L.) P. Beauv. subtype's species depending on demand for light, temperature and moisture

Classes	Species no.	Light		Temperature			Moisture		
		Species by LI %	C %	Species no.	Species by TI %	C %	Species no.	Species by MI %	C %
1-2	1	1,01	0,47	0	0,00	0,00	0	0,00	0
3-4	0	0,00	0,00	10	10,10	18,23	33	33,33	7,71
5-6	18	18,18	23,16	37	37,37	16,88	38	38,38	44,53
7-8	72	72,73	72,97	0	0,00	0,00	12	12,12	2,58
9	5	5,05	1,98	0	0,00	0,00	0	0,00	0
x	3	3,03	5,72	52	52,53	69,19	16	16,16	49,48
Total	96	-	-	47	-	-	83	-	-

Note: C - species cover; LI - light index; TI - temperature index; MI - moisture index; The total was calculated without indifferent and uncertain species.

Tab. 3. Classification of *Agrostis capillaris* L.– *Trisetum flavescens* (L.) P. Beauv. subtype's species depending on demand for soil's pH

Classes	Soil's pH		
	Species no.	Species by pHI %	C %
1-2	1	1,01	0,01
3-4	14	14,14	27,34
5-6	8	8,08	23,99
7	24	24,24	15,29
8-9	13	13,13	2,04
x	38	38,38	35,42
u	1	1,01	0,20
Total	60	-	-

Note: C-species cover; pHI-pH index; u-uncertain; The total was calculated without indifferent and uncertain species.

The phytocoenosis of this subtype includes 29 moderate nitrophilous species, 26 medium nitrophilous species, 20 nitrophobic and 10 nitrophilous (Tab. 4). The highest coverage have the medium nitrophilous species (41.83%), followed by moderate nitrophilous species. Thus the subtype *Agrostis capillaris* L.- *Trisetum flavescens* (L.) P. Beauv. phytocoenosis has a medium nitrophilous character.

Regarding plant resistance to mowing, we found that 31 species are medium resistant, 29 are medium sensitive, 20 resistant and 2 extremely resistant. If we consider the coverage, it is found that the group of medium resistant species has the highest coverage (51.12%), followed by the resistant species (Tab. 4). Thus, we can state that the subtype has a medium resistant character on

mowing, being used in an extensive to medium intensive system.

Regarding stepping resistance we found that 34 species are medium sensitive, 23 medium resistant, 17 sensitive and 8 resistant (Tab. 5). When coverage percent is taken into account, it is found that the medium sensitive species and medium resistant species have about the same value (35.7%, respectively 35.81%), followed by sensitive species (12.40%) and resistant species (8.36%). Grassland has a medium sensitive character on stepping, which shows that stepping occurs only occasionally by agricultural machinery or once during a grazing cycle.

In *Agrostis capillaris* L.- *Trisetum flavescens* (L.) P. Beauv. phytocoenosis subtype 34 species are medium sensitive to grazing, 18 species medium

Tab. 4. Classification of *Agrostis capillaris* L.- *Trisetum flavescens* (L.) P. Beauv. subtype's species depending on demand for nitrogen and mowing suitability

Classes	Nitrogen			Mowing resistance		
	Species no.	Species by NI %	C %	Species no.	Species by MI %	C %
1-2	20	20,20	3,22	0	0,00	0,00
3-4	29	29,29	37,88	29	29,29	5,41
5-6	26	26,26	41,83	31	31,31	51,12
7-8	10	10,10	3,20	20	20,20	30,69
9	0	0,00	0,00	2	2,02	5,05
x	14	14,14	18,18	-	-	-
u	-	-	-	17	17,17	12,04
Total	85	-	-	82	-	-

Note: C-species cover; NI-nitrogen index; MI-mowing index; u-uncertain; The total was calculated without indifferent and uncertain species.

Tab. 5. Classification of *Agrostis capillaris* L. - *Trisetum flavescens* (L.) P. Beauv. subtype's species depending on stepping and grazing suitability

Classes	Stepping resistance			Grazing resistance		
	Species no.	Species by STI %	C %	Species no.	Species by GI %	C %
1-2	17	17,17	12,40	11	11,11	6,79
3-4	34	34,34	35,70	34	34,34	14,51
5-6	23	23,23	35,81	18	18,18	44,30
7-8	8	8,08	8,36	18	18,18	18,78
9	0	0,00	0,00	1	1,01	7,89
u	17	17,17	12,04	17	17,17	12,0351
Total	82	-	-	82	-	-

Note: C-species cover; STI-stepping index; GI-grazing index; u-uncertain; The total was calculated without indifferent and uncertain species.

resistant, 18 resistant species, 11 sensitive and one extremely resistant species (Tab. 5). Considering the coverage, we can state that 44.3 % are medium resistant species, followed by resistant (18.78%), medium sensitive and sensitive species. In this case, the character of grassland is medium resistant to grazing, and we can conclude that the grassland is grazed 1-2 times per year.

CONCLUSION

The presence of *Agrostis capillaris* L.- *Trisetum flavescens* (L.) P. Beauv. grasslands in the study area in a high level is fully justified with their framing as subtype of *Festuca rubra* L. - *Agrostis capillaris* L. grassland type.

Agrostis capillaris L. – *Trisetum flavescens* (L.) P. Beauv. subtype can be characterized as heliophytes, microtherm, mesophytes, moderate acidophilous, medium nitrophilous, medium resistant to mowing, medium resistant to stepping and medium resistant to grazing.

Regarding grassland's agronomic value, this frames within the 6th class, the grassland category is medium and can support an animal load of 0,81 – 1,00 LSU/ha.

REFERENCES

1. Braun– Blanquet J. (1932). Plant Sociology, the study of plant communities, Ed. Mc-Graw – Hill Book Company, Inc. New – York and London, 31-33.
2. Coldea Gh., Oprea A., Sârbu I., Sirbu C., Ștefan N. (2012). Les associations Vegetales de Roumanie. Presa Universitară Clujeană, Cluj-Napoca.
3. Cristea V., Gafta D., Pedrotti F. (2004). Phytosociology. Presa Universitară Clujeană Printhouse.
4. Dierschke H., G. Briemle (2002). Kulturgrasland. Wiesen, Weiden und verwandte Staudenfluren, Ed. Verlag Eugen Ulmer GmbH & Co., Stuttgart, Germania, 31-33, 205-216.
5. Ellenberg H. (1952). Wiesen und Weiden und ihre standörtliche Bewertung, Ed. Ulmer, Stuttgart.
6. Ellenberg H., Weber H. E., Düll R., Wirth Werner V., Paulissen W. D. (1992). Zeigerwerte von Pflanzen in Mitteleuropa. - Scripta geobotanica 18.
7. Ellenberg H. (1996). Vegetation Mitteleuropas mit den Alpen in ökologischer, dynamischer und historischer Sicht. 5. Auflage. Stuttgart, Ulmer. 1096 S.
8. Gârda N. (2010). The study of some mountainous landscape elements (with special regard to grassland ecosystems in Gârda de Sus Commune, Apuseni Mountains. PhD Thesis, Faculty of Agriculture, USAMV Cluj-Napoca.
9. Huttler C.P., Briemle G., Fink C. (2002). Wiesen, Weiden und anderes Grünland. Hirzel. Germany.
10. Kovács J.A. (1979). Indicatorii biologici, ecologici și economici ai florei pajiștilor, Redacția de propagandă tehnică agricolă, 1-50.
11. Țuca I., Kovacs A.J., Roșu C., Ciubotaru C., Chifu T., Neacșu M., Bărbulescu C., Cardașol V., Popovici D., Simtea N., Motcă Gh., Dragu I., Spirescu M. (1987). Principalele tipuri de Pajiști din R.S. Romania, Ed. București.
12. *** www.floraweb.de