ASSESSMENTS ON THE PRODUCTIVITY OF GRASSLANDS LOCATED IN THE SUBCARPATHIC AREA OF OLTENIA, ACORDING TO THE MOISTURE REGIME EXPRESSED BY VEGETATION

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Abstract. *The Sub-Carpathian area of Oltenia is comprised between the Oltenia and Tismana Valleys, being located at the foot of the Parâng and Vâlcan Mountains and comprising Târgu Jiu - Câmpu Mare intracoline depression. The permanent grasslands found in this area comprise altitudes between 200-680 m altitude, generally on flat lands or slopes of up to 35 degrees, on soils with a pH of 5.2-6.8 and a high biodiversity, with an average of 152 plant species in a phytosociological association. From the geobotanical point of view, these grasslands are included mainly into 3 large classes: Molinio - Juncetea (mesohygrophile grasslands), Arrhenatheretea (mesophilic grasslands) and Festuco - Brometea (xerophile and xeromesophile grasslands), which expressed in decreasing order the humidity as a factor influencing their vegetation. Comparing the meso-hygrophile with the mesophile grasslands, we observe that the indices of pastoral value are almost identical for both grasslands, reaching values between 63.3-63.5 with the highest values in the association Festucetum pratensis (71) and the lowest in Agrostetum canini (52). On the xerophile and mesoxerophile grasslands the pastoral value is 33, almost half compared to the previous vegetation classes. The green mass production recorded by mesophile grasslands is on average 11.3 t/ha while the xerophile and xeromesophile ones reached green mass productions of 6.35 t/ha, a value lower with 44%. The loading with animals reached approx. 0.95 LU/ha on grasslands with better humidity and 0.53 LU/ha in areas with moisture deficit. The assessment of grassland productivity will be further used to establish the optimal grazing capacity, environmental production and biodiversity conservation.*

Keywords: permanent grasslands, production assessments, pastoral value, grazing capacity

1. Introduction

Grassland productivity has become a basic indicator for the preparation of pastoral arrangements [2, 3].

From a practical point of view, the methods used for determining or evaluating the productivity of grasslands are quite difficult to be applied in field conditions comprising protected areas [7]. Therefore, a new method for evaluating the productivity of grasslands was used in this study, a method based on the floristic survey and forage phytomass indices [4, 2].

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The present manuscript aims to assess the productivity of a grassland located in the Sub-Carpathian area of Oltenia, using these new methods.

2. Materials and methods

In order to perform the productivity assessments for the grassland studied in this research paper, we used the floristic surveys of these grasslands found in the paper "Grasslands from Sub-Carpathian area of Oltenia", Cap. 3.2 *Vegetation*, edited by Păun M., Popescu Gh. and Zaharia I., under the coordination of Pavel C. from the University from Craiova [6].

The main associations of grassland plants identified in the Oltenia Carpathian are framed in a Phytocoenology system as follows:

The vegetation of meso-hygrophile grasslands

Class *MOLINIO* - JUNCETEA, Br-Bl. 1949, 1951
Ord. *MOLINIETALIA,*, Koch 1926
Al . *Agrostion stoloniferae,* (Soó 1933)
1. As. *Agrostetum caninae* Harg. 1942
2. As. Agrostetum stoloniferae (Ujvarosi 1941)
3. As. *Alopecuretum pratensis,* Nowinski 1928
4. As. *Festucetum pratensis,* Soó 1938
5. As. *Poetum silvicolae oltenicum*, Buia, Păun, Safta et Pop 1959

The vegetation of mesophile grasslands

Class *ARRHENATHERETEA,* Br.-Bl. 1947
Ord. *ARRHENATHERETALIA,* Pawl. 1928
Al. *Arrhenatherion elatioris,* Br. – Bl. 1925, Pawl.1928
6. As. *Poetum pratensis*, Răv., Căzăc. et Turenschi 1956
Al. *Cynosurion cristati*, Br-Bl et Tx. 1943
7. As. *Festuco - Agrostetum*, Horv. 1951
8. As. *Agrostetum tenuis*, Szafer, Pawl., Kulcz. 1923
9. As. *Lolietum perennis*, Safta 1943

The vegetation of xerophile and xeromesophile grasslands

Clasa *FESTUCO – BROMETEA,* Br.-Bl. 1943
Ord. *BROMETALIA ERECTI*, Br.-Bl. 1936
Al. *Bromion*, Br-Bl 1925
10. As. *Ventenata dubia - Xeranthemum foetidum*, Borza 1950
Ord. *FESTUCETALIA VALESIACAE*
Al. ***Festucion rupicolae***, Soó 1964
11. As. *Botriochloetum ischaemi*, Krist 1937
12. As. *Medicagini - Festucetum valesiacae,*Wagner 1940
13. As. *Chrysopogonetum grylli oltenicum*, Buia, Păun, Safta et Pop 1959
Ord. *BRACHYPODIO - CHRYSOPOGONETALIA,* (H-ic 1958) Boșcaiu 1970
Al. *Danthonio - Brachipodion,* Boșcaiu 1970
14. As. *Festuco (rubrae) - Danthonietum,* Csűrős, Pop, Hodișan, Csűrős - Kapt. 1958

In addition to the stationary conditions (relief, altitude), the description of grassland associations also includes data related to soil reaction and some assessments on forage production.

Grouping the associations according to the vegetation classes that correspond also to humidity conditions have been very helpful in establishing grassland productivity.

Furthermore, we were able to determine more precisely the ecological and humidity indices for these associations are after [1], improved by [7] and [4]:

1 and 2 = very dry (xerophilous);
3 and 4 = dry (mesoxerophilous);
5 and 6 = moderate moisture (mesophilous);
7 and 8 = moisture (mesohigrophilous);
9 = moisture wet (hygrophilous);
10 = flooded (ultrahigrophilous).

The productivity assessments were performed according to the method proposed by [5], with an example provided also in the present Annals of the Romanian Academy of Scientists [2], therefore we won't describe it again.

3. Results and Discussions

First we performed a synthesis of the seasonal conditions including the number of species (phytodiversity), components of each plant association of grassland (Table 1).

The grasslands found in the studied area are located at attitudes between 200-680 m, on a flat or sloping terrain with an inclination of up to 35 degrees.

The soil reaction is moderately acidic to neutral with a pH ranging between 5.2 and 6.8.

These grasslands are very rich in plant species, comprising an average of 152 taxa, with differences ranging from a minimum of 87 plant species found on the association *Alopecuretum pratensis*, and a maximum of 212 plant species found on the *Agrostetum tennuis* association.

Table 1) General data comprising the natural conditions and phytodiversity of the studied grasslands.

No.	*Phytosociologycal association*	*Altitude (m)*	*Relief*	*Soil reaction (pH)*	*No. of species*
The vegetation of the mesohigrophile grasslands					
1.	*Agrostetum caninae*	250-450	Flat	5.2-5.5	111
2.	*Agrostetum stoloniferae*	200-400	Flat	6.0-6.6	156
3.	*Alopecuretum pratensis*	200-350	Flat		87
4.	*Festucetum pratensis*	200-450	Flat		159
5.	*Poetum silvicolae oltenicum*	200-300	Flat		130
The vegetation of mesophile grasslands					
6.	*Poetum pratensis*	200-350	Flat	5.8-6.1	95
7.	*Festuco - Agrostetum*	250-680	Slope	5.2-5.8	148
8.	*Agrostetum tenuis*	200-600	Slope		212
9.	*Lolietum perennis*	200-600	Flat		125
The vegetation of xerophile and xeromesophile grasslands					
10.	*Ventenata dubia - Xeranthemum foetidum*	300-500	Slope		108
11.	*Botriochloetum ischaemi*	265-520	$5 - 35^0$	5.3-6.0	168
12.	*Medicagini - Festucetum valesiacae*	200-600	Slope		189
13.	*Chrysopogonetum grylli oltenicum*	200-450	Slope	5.4-5.6	164
14.	*Festuco (rubrae) - Danthonietum*	260-530	Slope	6.1-6.8	138
	AVERAGE	200-680	All	5.2-6.8	152

Source: Own results.

Our results concerning grassland productivity highlighted quite big differences among the studied grasslands associations considering the humidity factor (Table 2).

The mesohigrophile grasslands recorded ecological soil moisture indices with values ranging from 5.4 found in As. *Festucetum pratensis* up to 6.5 in As. *Alopecuretum pratensis*. The pastoral value recorded values between 52.2 in *Agrostetum canina* and 71 in *Festucetum pratensis*.

Forage green mass production (GM) recorded values ranging from 7.8 t/ha up to 14.22 t/ha for the same associations, which allow an optimal loading with animals between 0.65 and 1.18 units of livestock (LU) per hectare, in a 185-day grazing season.

The mesophile grasslands recorded ecological humidity indices ranging from 4.2 in *Agrostetum tenuis* up to 5.2 in *Poetum pratensis*.

The pastoral value (PV) reached values between 56.9 and 69.9 in the same associations as before.

Table 2) The indices for grasslands humidity and optimal loading with animals divided according to the phytosociologycal associations

No.	*Phytosociologycal association*	*Humidity factor (indices)*	*Pastoral value*		*GM (t/ha)*	*LU/ha*	*%*	*Evaluation*
			Ind.	*%*				
The vegetation of the mesohigrophile grasslands								
1.	*Agrostetum caninae*	6.0	52.2	99	7.80	0.65	81	Average
2.	*Agrostetum stoloniferae*	5.8	63.1	120	11.54	0.96	112	Mediocre
3.	*Alopecuretum pratensis*	6.5	67.8	129	13.01	1.08	135	Mediocre
4.	*Festucetum pratensis*	5.4	71.0	135	14.22	1.18	147	Good
5.	*Poetum silvicolae oltenicum*	0.1	63.4	121	11.08	0.92	115	Mediocre
The vegetation of mesophile grasslands								
6.	*Poetum pratensis*	5.2	69.9	133	12.23	1.02	127	Average
7.	*Festuco - Agrostetum*	4.6	59.6	114	9.98	0.83	104	Average
8.	*Agrostetum tenuis*	4.2	56.9	108	9.13	0.76	95	Mediocre
9.	*Lolietum perennis*	4.9	66.8	127	13.04	1.09	136	Average
The vegetation of xerophile and xeromesophile grasslands								
10.	*Ventenata dubia - Xeranthemum foetidum*	2.4	10.1	19	0.85	0.07	9	Degraded
11.	*Botriochloetum ischaemi*	3.1	18.0	34	1.77	0.15	19	Degraded
12.	*Medicagini - Festucetum valesiacae*	2.5	32.5	62	4.03	0.34	42	Very weak
13.	*Chrysopogonetum grylli oltenicum*	2.3	45.9	87	15.12	1.26	157	Good
14.	*Festuco (rubrae) - Danthonietum*	4.3	58.4	111	9.98	0.83	104	Average
	GENERAL AVERAGE	**4.5**	**52.5**	**100**	**9.56**	**0.80**	**100**	**Mediocre**

Source: Own results.

The lowest GM production of 9.13 t/ha was reached by the same association, namely *Agrostetum tenuis* while the highest GM production of 13.04 t/ha was recorded this time at *Lolietum perennis*, with a grazing capacity of 0.76 - 1.09 LU/ha.

The xerophile and mesoxerophile grasslands showed extremely low humidity indices from 2.3 found on *Crysopogonetum grylli oltenicum* to 4.3 in *Festuco (rubrae) Danthonietum*.

The pastoral value was 10 (degraded) for As. *Ventenata dubia - Xeranthemum foetidum* and higher than 58 (medium) in *Festuco (rubrae) Danthonietum*. Green mass production recorded values between 0.85 t/ha (degraded) and 15.12 t/ha in *Crysopogonetum grylli oltenicum* with an optimal loading with animals ranging between 0,07 LU/ha and 1.26 LU/ha.

On average, the soil moisture indices for the whole area were 4.5 for mesoxerophile to mesophile grasslands, 6.0 as the upper limit for mesophile to mesohygrophilic in the *Molinio - Juncetea* class and 2.9 as the lower limit for xerophile to mesoxerophile grasslands in *Festuco - Brometea* class (Table 3).

Table 3) The productivity and the average grazing capacity according to the humidity factor at the level of vegetation classes

Phytosociologycal classes (ecological group)	*Humidity factor (ind.)*	*Pastoral value (ind.)*	*GM production (t/ha)*	*Grazing capacity (LU/ha)*	*%*
MOLINIO - JUCETEA (mesohigrophilic)	6.0	63.5	11.53	0.96	120
ARRHENATERETEA (mesophilic)	4.7	63.3	11.10	0.93	116
FESTUCO - BROMETEA (xerophilic and xeromesophilic)	2.9	33.0	6.35	0.53	66
AVERAGE	**4.5**	**53.3**	**9.66**	**0.80**	**100**

Source: Own results.

Considering the average productivity, we found out that the mesohygrophile and mesophile grasslands reached very close values for pastoral value and of green mass production (63 PV and 11.1 - 11.5 t/ha GM).

The xerophile and xeromesophile grasslands included in *Festuco - Brometea* Class recorded a decrease with 34% in grazing capacity (0.53 LU/ha) compared to the average area grazing capacity (0.8 LU/ha), which could be explained by the lower soil moisture.

Our results highlighted the special influence of the soil moisture ecological factor on the productivity of the grasslands.

Conclusions

(1) The grasslands from Oltenia Sub Carpathians, spread on altitudes between 200-600 m showed a very high diversity comprising an average of over 150 plant species in the 14 phytosociologycal associations.

(2) The productivity of mesohigrophile and mesophile grasslands reached very closed values, with over 63 pastoral value and between 11.1-11,5 t/ha GM production.

(3) The productivity of xerophile and xeromesophile grasslands reached a lower pastoral value with 48% and lower green mass production with 34% compared to the other grasslands studied in this manuscript.

(4) The optimal grazing capacity is 0.95 LU/ha on grasslands with optimal soil moisture (mesophile) and 0.53 LU/ha on grasslands with moisture deficit (xerophile) in 185 days of grazing season.

(5) Soil humidity showed to have a determinant role in grassland productivity, being considered as an important indicator for the proper management of this agricultural system.

R E F E R E N C E S

[1] Kovacs, A. J., Biological, ecological and economical indicators of grasslands flora (Indicatorii biologici, ecologici şi economici ai florei pajiştilor), Redacţia de propagandă tehnică agricolă Publishing House, (1979).

[2] Marușca, T., Arsene, G.G., Taulescu, Elena, Assessment of permanent grassland productivity in Poiana Ruscă Mountains (Southwest Romanian Carpathians), Annals of the Academy of Romanian Scientists: Series on Agriculture, Silviculture and Veterinary Medicine Sciences, Vol. 9(1):62 – 69, (2019a).

[3] Marușca, T., Taulescu, E., Roșca, V., Băjenaru, B., Memedemin, D., Contributions to the Evaluation of Grassland Productivity on the Măcinului Mountains National Park, Romanian Journal of Grassland and Forage Crops (RJGFC), Vol. 20, pp. 17 - 26, (2019b).

[4] Marușca, T., Praticulture in everybody's language (Praticultura pe înțelesul tuturor), Profesional-Agromedia SRL Publishing House, (2016).

[5] Marușca, T., Contributions to the evaluation of pasture productivity using the floristic releve, Romanian Journal of grassland and forage crops (RJGFC), Vol. 19, pp. 33- 47, (2019).

[6] Pavel, C. (coord.), Grasslands from the subCarpathian zone of Oltenia (Pajiștile din zona Subcarpatică a Olteniei), Scrisul Românesc Publishing House, (1973).

[7] Păcurar, F., Rotar, I., Study and interpretation methods of grassland vegetation (Metode de studiu și interpretare a vegetației pajiștilor), Risoprint Publishing House, (2014).