THE LOW-INPUT EFFECT UPON OLIGOTROPHIC GRASSLANDS IN APUSENI MOUNTAINS

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Abstract

Grassland's management by low-input might be a viable method for maintaining the high conservative value grassland. Our goal is to study the effect of organic fertilization and mulching upon the phyto-diversity and productivity of oligotrophic grasslands in Gârda de Sus commune, Apuseni Mountains. An experimental field with 7 variants in 5 repetitions was founded using the random blocks method, at an altitude of 1320 m, on an *Agrostis capillaris* with *Festuca rubra* grassland type. After organic fertilizers and mulching's application, there haven't been noticed any significant growths of the DM yield in any of the two experimental years. At the sward's level minimum changes have been recorded. The grassland type of the witness variant is *Agrostis capillaris* with *Festuca rubra,* and through treatment's performance, *Festuca rubra* with *Agrostis capillaris* type is being installed. Also, the phyto-diversity slightly changes.

Key words: grassland areas, low-input, oligotrophic grasslands

Grassland systems' intensification in the European community has had negative effects upon the environment, and, especially, upon the biodiversity. As consequence, the common agricultural policy has elaborated extensivisation plans for some grassland systems which are meant to protect the environment and, implicitly, the biodiversity (Osterburg, 2010). In our country, important grassland areas are being extensively exploited and have a high phyto-diversity (Larkham and Sutcliffe, 2010).

In Apuseni Mountains, lately, numerous grasslands with high phyto-diversity have been abandoned (Gârda, 2010). A similar situation has been recorded also in the Polish Carpathians, where due to abandonment important changes happened at the sward level through biodiversity loss (Zarzicki and Misztal, 2010). At the same time, experimental administration, for a long period of time, of larger quantities of organic fertilizers on oligotrophic grasslands has produced a strong decrease of phyto-diversity (Păcurar et al., 2007). Thus, for these grasslands there must be identified viable methods to maintain them in the mountainous landscape.

Our paper's objective is to survey the effect of smaller quantities' administrating and mulching upon the phyto-diversity and productivity of oligotrophic grasslands.

MATERIAL AND METHOD

Our study area is found in the territory of Gârda de Sus commune in Apuseni Mountains, Romania, at 1320 m altitude. The region is characterized by 4,9 °C annual mean temperature and 1177 mm annual mean precipitations.

The experimental field was placed in 2009 using random blocks method, with 7 variants in 5 repetitions, and the parcel's size 6 m^2. The experimental variants have been the following: V1 - Witness, V2 - Mulching 1/year, V3 - Mulching 1/ year +5t/ha manure, V4 - Mulching 1/ year +5t/ha manure 1/2 years, V5 - Mulching 1/ year +10t/ha manure 1/2 years V6 - Mulching 1/ year +10t/ha manure 1/3 year, V7 -Abandonment.

The technological inputs were applied each year early in spring. The floristic studies were performed at *Poaceae*'s blooming, by Braun-Blanquét method. Mowing was made using a motorised scythe at 5 cm height. In order to process and interpret the phyto-sociological data, the mean abundance-dominance (MDA) and constancy (K) have been calculated. The phyto-diversity is indicated as mean of species number over all 5 repetitions. Processing and interpreting the data related to production was made using the variance analysis.

RESULTS AND DISCUSSIONS

In 2009 the productivity of the respective meadow is very low, situation which explains one of the reasons for the abandonment of oligotrophic grasslands in the area. The low DM (dry matter)

yield can be explained through the reduced quantities of rainfall from spring and, of course, through the reduced trophicity of the soil. The effect of organic fertilisers' application upon our grassland is very poorly felt at the level of the DM's level (*table 1*). Even if in some treatments' case a low yield growth is noticed, the differences do not have statistic insurance. The same situation is seen also in the second year of treatments` application (*table 2*).

After technological inputs' administration, at the sward's level, in the founding year (2009), rather reduced changes are being noticed (*table 3*). In witness' case, the grassland type is *Agrostis capillaris – Festuca rubra*, and in other variants's case, the ratio between the two species is changing and the phytocenosis are prevailed by first of all by *Festuca rubra*, and, secondly by *Agrostis capillaris* (the *Festuca rubra – Agrostis capillaries* type). The witness' phytocenosis shows in average 41,05% *Poaceae*, 0,1 % *Cyperaceae* and *Juncaceae*, 0,75 % *Fabaceae* and 46,1 % plants of other botanical families (OBF). Other variants phytocenosis are by *Poaceae* comprised between 34,5 and 41,3 %, *Fabaceae* between 0,55 and 3,95 % and OBF between 39,3 and 47,25 %.

In case of the witness, among the *Poaceae, Agrostis capillaris* (22,25 %), *Festuca rubra* (17,5 %) and *Anthoxanthum odoratum* (1,3 %) are present. In general, when the technological inputs are being applied the species *Festuca rubra* prevails, followed by *Agrostis capillaris* and by *Anthoxanthum odoratum*. *Cyperaceae* and *Juncaceae* are represented by *Carex sylvatica* and *Luzula campestris*, which are less present in case of the witness and occur with a slightly raised cover in case of the treatments. The most representative among *Fabaceae* are *Trifolium repens* and *Trifolium pratense*, which appear rather scarcely in case of the witness (0,1 %, respectively 0,5 %), but with a slightly enhanced presence in case of other experimental treatments. The plants of other botanical families are represented by some species with larger cover, such as: *Arnica montana, Centaurea mollis, Hieracium aurantiacum, Hypericum maculatum, Pimpinella major, Rhinanthus minor, Thymus pulegioides* etc. All these species are representative also in case of the other experimental variants. Regarding the species number, the witness' phyto-diversity has a average composition of 22,8 species per 6 m^2, and in case of some treatments, even a slightly growth of the species number is being noticed up to a maximum of 24,6.

Inputs' administration in 2010 does not imply other changes at the sward's level in comparison to the year before. The witness' phytocenosis is prevailed by *Agrostis capillaris – Festuca rubra*, type, and in case of the other variants the *Festuca rubra – Agrostis capillaris* type occurs (*table 4*). The witness' phtyocenosis is represented by 44,5 % *Poaceae*, 0,3 % *Cyperaceae* şi *Juncaceae*, 9,75 % *Fabaceae* and 38,8 % plants of other botanical families. In comparison to the year before, a strong growth of the *Fabaceae* from 0,75 %, in 2009, to 9,75 % in 2010, as well as a slightly growth of the *Poaceae* (from 41,05 % in 2009 to 44,5 in 2010) in detriment of plants of other botanical families which are being reduced from 46,1 %, in 2009, to 38,8 % in 2010. These differences might be explained by climatic conditions and the change of land-use. The floristic composition of the other experimental variants is represented by *Poaceae*, having a share comprised between 40,75 and 53,5 %, *Fabaceae* between 7,7 and 14,5 % and plants of other botanical families between 31,9 and 42,35 %. In comparison to the year before, the *Fabaceaes* have a larger share reaching up to a maximum of a maximum of 14,05 %. Among the *Poaceae,* the same as the year before, the following species are present: *A. capillaris, F. rubra* and *A. odoratum*. The *Cyperaceae* and *Juncaceae* are weakly represented by the species *Luzula campestris*. The mostly encountered *Fabaceae* are: *Trifolium pratense, Trifolium. repens* and *Lotus corniculatus*. In this year, the representative species of other botanical families are similar to the year before and no considerable changes are being noticed as result of technological inputs' application. The witness' phyto-diversity is represented by 30,2 species per 6 m^2, and in case of treatments, in general, a slight decrease up to 26,8 (V5) of the species number is being noticed.

CONCLUSIONS

After organic fertilizers' administration, in none of the two experimental years, no significant growths of the dry matter yield are being noticed.

At the sward's level, minimum changes are registered, even after the second year of experiment. Inputs' introduction has produced a replacement of the *Agrostis capillaris - Festuca rubra* grassland type, in case of the witness, with the *Festuca rubra - Agrostis capillaries* type. Also, the influence of organic fertilization is weakly noticed at the phyto-diversity level.

Table 1

The influence of organic fertilizers on the dry matter yield (2009)

Year	Variant	DM t/ha	%	difference	significance
2009	Witness	0.83	100	0.0	-
	Mulching 1/year	0.67	80.7	- 0.16	-
	Mulching 1/ year +5t/ha manure	0.94	113.2	+ 0.11	-
	Mulching 1/ year +5t/ha manure 1/2 years	0.7	84.3	- 0.13	-
	Mulching 1/ year +10t/ha manure 1/2 years	0.68	81.9	- 0.15	-
	Mulching 1/ year +10t/ha manure 1/3 year	0.86	103.6	+ 0.03	-

DL(p 5%) - 0,26 t/ha DL(p 1%) - 0,36 t/ha DL(p 0,1%) - 0,48 t/ha

Legend: DM-Dry matter, DL- diferenţa limită

Table 2

The influence of organic fertilizers on the dry matter yield (2010)

Year	Variant	DM t/ha	%	difference	significance
2010	Witness	2,61	100	+0,00	-
	Mulching 1/year	2,13	81,70	-0,48	-
	Mulching 1/ year +5t/ha manure	2,69	103,20	+0,08	-
	Mulching 1/ year +5t/ha manure 1/2 years	2,33	89,40	-0,28	-
	Mulching 1/ year +10t/ha manure 1/2 years	2,70	103,60	+0,09	-
	Mulching 1/ year +10t/ha manure 1/3 year	2,36	90,60	-0,25	-

DL(p 5%) - 0,51 t/ha DL(p 1%) - 0,69 t/ha DL(p 0,1%) - 0,94 t/ha

Table 3

The influence of organic fertilization on floristic composition

Species (%)	2009													
	V1	K	V2	K	V3	K	V4	K	V5	K	V6	K	V7	K
Poaceae	41,05		34,50		39,80		40,70		37,90		41,30		37,90	
Agrostis capillaris	22,25	V	12,50	V	17,00	V	17,00	V	19,00	V	21,50	V	13,75	V
Anthoxanthum odoratum	1,30	IV	1,75	IV	1,30	IV	2,20	IV	0,65	II	0,30	III	2,65	IV
Festuca rubra	17,50	V	20,25	V	21,50	V	21,50	V	18,25	V	19,50	V	21,50	V
Cyperaceae and *Juncaeae*	0,10		0,75		0,10		1,10		0,00		0,10		1,20	
Carex pallescens	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,10	I
Carex sylvatica	0,00	0	0,55	I	0,10	I	1,00	I	0,00	0	0,00	0	1,10	II
Luzula campestris	0,10	I	0,20	II	0,00	0	0,10	I	0,00	0	0,10	I	0,00	0
	V1	K	V2	K	V3	K	V4	K	V5	K	V6	K	V7	K
Fabaceae	0,75		1,05		2,80		3,90		3,95		3,05		0,55	
Lotus corniculatus	0,00	0	0,10	I	0,65	II	0,20	II	0,65	II	0,55	I	0,00	0
Trifolium pratense	0,10	I	0,20	II	0,30	III	1,40	V	0,20	II	0,20	II	0,55	I
Trifolium repens	0,65	II	0,75	III	1,85	V	2,30	V	3,10	IV	2,30	V	0,00	0
OBF	46,10		47,25		39,60		39,30		45,15		45,05		45,85	
Achillea distans	0,10	I	0,20	II	0,55	I	0,00	0	0,20	II	0,10	I	0,65	II
Ajuga genevensis	0,00	0	0,10	I	0,10	I	0,20	II	0,00	0	0,00	0	0,00	0
Alchemilla vulgaris	2,10	III	0,10	I	0,75	III	1,55	II	0,65	II	1,20	III	0,10	I
Anthyllis vulneraria	0,00	0	0,00	0	0,10	I	0,10	I	0,10	I	0,10	I	0,00	0
Arabis hirsuta	0,30	III	0,10	I	0,10	I	0,20	II	0,30	III	0,10	I	0,20	II

	V1	K	V2	K	V3	K	V4	K	V5	K	V6	K	V7	K
Arnica montana	6,70	IV	9,25	III	1,75	IV	3,10	V	5,25	V	1,85	V	3,45	IV
Centaurea mollis	1,30	IV	1,10	II	1,75	IV	1,10	II	1,20	III	1,75	IV	2,20	IV
Centaurea pseudophrygia	1,00	I	0,10	I	0,20	II	0,10	I	0,10	I	0,20	II	0,65	II
Cerastium holesteoides	0,10	I	0,20	II	0,10	I	0,30	III	0,20	II	0,40	IV	0,20	II
Cirsium erisithales	0,10	I	0,10	I	0,10	I	0,00	0	0,20	II	0,55	I	1,00	I
Colchicum autumnale	0,00	0	0,10	I	0,20	II	0,30	III	0,00	0	0,20	II	0,10	I
Euphrasia officinalis	0,10	I	0,10	I	0,10	I	0,00	0	0,00	0	0,00	0	0,00	0
Euphrasia roskoviana	0,30	III	0,85	IV	0,40	IV	0,10	I	0,50	V	0,85	IV	0,50	V
Galium mollugo	0,65	II	0,55	I	0,00	0	1,10	II	0,00	0	0,55	I	0,00	0
Genistella sagittalis	0,10	I	0,10	I	0,00	0	0,10	I	0,00	0	0,20	II	0,10	I
Gentianella lutescens	0,30	III	0,20	II	0,20	II	0,20	II	0,30	III	0,20	II	0,30	III
Gymnadenia conopsea	0,00	0	0,10	I	0,10	I	0,10	I	0,00	0	0,00	0	0,00	0
Hieracium aurantiacum	1,30	IV	0,85	IV	0,65	II	1,20	III	1,75	IV	1,20	III	1,10	II
Hieracium pilosella	0,00	0	0,10	I	0,00	0	0,00	0	0,10	I	0,00	0	0,00	0
Hypericum maculatum	2,20	IV	2,20	IV	4,80	IV	3,90	IV	2,65	IV	3,55	IV	1,55	II
Knautia dipsacifolia	0,65	II	1,40	V	1,40	V	0,30	III	0,40	IV	1,85	V	0,20	II
Leontodon autumnalis	0,00	0	0,00	0	0,00	0	0,10	I	0,00	0	0,00	0	0,00	0
Leucanthemum vulgare	0,10	I	0,20	II	0,40	IV	0,40	IV	0,75	III	0,40	IV	0,50	V
Linum catharticum	0,20	II	0,10	I	0,10	I	0,20	II	0,10	I	0,10	I	0,10	I
Parnasia palustris	0,00	0	0,00	0	0,00	0	0,10	I	0,00	0	0,20	II	0,00	0
Pimpinella major	3,20	V	4,35	IV	2,30	V	2,65	IV	2,75	V	2,75	V	1,65	III
Plantago lanceolata	1,85	V	1,30	IV	1,40	V	1,85	V	1,65	III	1,40	V	1,20	III
Plantago media	0,10	I	0,10	I	0,10	I	0,10	I	0,00	0	0,10	I	0,10	I
Polygala comosa	0,20	II	0,65	II	0,20	II	0,30	III	0,20	II	0,30	III	0,10	I
Potentilla erecta	0,55	I	0,00	0	0,00	0	0,00	0	0,10	I	0,00	0	0,00	0
Primula veris	0,10	I	0,65	II	0,75	III	0,20	II	0,00	0	0,20	II	0,65	II
Ranunculus bulbosus	0,85	IV	0,30	III	0,65	II	0,20	II	0,85	IV	0,20	II	0,40	IV
Rhinanthus minor	4,45	V	4,00	V	2,75	V	3,65	V	2,75	V	4,90	V	3,55	V
Rumex acetosa	0,40	IV	0,40	IV	0,50	V	0,95	V	0,40	IV	0,85	IV	0,40	IV
Salvia verticilata	0,00	0	0,55	I	1,10	II	0,00	0	0,55	I	0,10	I	0,55	I
Scabiosa columbaria	0,20	II	0,20	II	0,20	II	0,10	I	0,30	III	0,30	III	0,10	I
Silene nutans	0,20	II	0,20	II	0,10	I	0,30	III	0,20	II	0,10	I	0,10	I
Stellaria graminea	0,30	III	0,30	III	0,10	I	0,20	II	0,10	I	0,20	II	0,20	II
Thymus pulegioides	6,50	IV	10,00	V	8,55	IV	8,85	IV	11,25	V	12,50	V	18,25	V
Trollius europaeus	5,80	V	4,00	IV	4,10	V	3,55	IV	7,05	V	3,90	IV	3,55	IV
Vaccinium myrtillus	0,55	I	1,00	I	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0
Veratrum album	0,20	II	0,10	I	0,20	II	0,00	0	0,10	I	0,30	III	0,55	I
Veronica chamaedrys	1,65	III	0,55	I	1,30	IV	0,30	III	0,75	III	0,65	II	0,75	III
Viola canina	1,40	V	0,50	V	1,30	IV	1,30	IV	1,40	V	0,75	III	0,85	IV
	V1	K	V2	K	V3	K	V4	K	V5	K	V6	K	V7	K
Species number	22,80		23		24,60		24,40		23,20		25		20,60	

Table 4

The influence of fertilization on floristic composition

	2010													
	V1	K	V2	K	V3	K	V4	K	V5	K	V6	K	V7	K
Species (%)														
Poaceae	44,50		43,70		50,85		46,05		43,95		53,30		40,75	
Agrostis capillaris	25,50	V	19,00	V	23,50	V	22,25	V	20,25	V	25,50	V	19,50	V
Anthoxanthum odoratum	2,75	V	3,20	V	1,75	IV	2,30	V	2,20	IV	2,30	V	1,75	IV
Festuca rubra	16,25	V	21,50	V	25,50	V	21,50	V	21,50	V	25,50	V	19,50	V
Cyperaceae and Juncaceae	0,30		0,40		0,20		0,20		0,20		0,20		0,10	
Luzula campestris	0,30	III	0,40	IV	0,20	II	0,20	II	0,20	II	0,20	II	0,10	I
Fabaceae	9,75		8,30		13,70		14,05		12,45		11,80		7,70	
Lotus corniculatus	0,75	III	0,65	II	1,75	IV	1,20	III	3,35	III	1,55	II	0,85	IV
Trifolium pratense	4,45	V	2,30	V	7,85	V	7,50	V	4,10	V	5,25	V	1,85	V
Trifolium repens	4,55	V	5,35	V	4,10	V	5,35	V	5,00	V	5,00	V	5,00	V
OBF	38,80		39,45		34,30		35,50		40,85		31,90		42,35	
Achillea distans	0,10	I	0,10	I	0,10	I	0,20	II	0,55	I	0,10	I	0,65	II
Achillea millefolium	0,10	I	0,00		0,00		0,00		0,00		0,00		0,00	
Ajuga genevensis	0,10	I	0,20	II	0,10	I	0,10	I	0,20	II	0,30	III	0,20	II
Alchemilla vulgaris	0,30	III	0,65	II	0,30	III	0,00		0,65	II	0,10	I	1,20	III
Antennaria dioica	0,00		0,00		0,00		0,00		0,20	II	0,00		0,00	
Anthyllis vulneraria	0,30	III	0,10	I	0,20	II	0,20	II	0,30	III	0,20	II	0,30	III
Arnica montana	5,70	III	4,50	II	0,65	II	0,20	II	2,90	III	1,65	III	2,30	V
Astrantia major	0,00		0,10	I	0,00		0,00		0,00		0,10	I	0,10	I
Campanula abietina	0,10	I	0,10	I	0,10	I	0,10	I	0,20	II	0,00		0,20	II
Centaurea mollis	0,40	IV	2,20	IV	1,75	V	1,65	III	1,30	IV	1,75	IV	1,40	V
Centaurea pseudophrygia	1,10	II	0,65	II	0,75	III	1,10	II	0,10	I	0,75	III	0,65	II
Cerastium holesteoides	0,40	IV	0,40	IV	0,50	V	0,40	IV	0,50	V	0,40	IV	0,50	V
Cirsium erisithales	0,10	I	0,10	I	1,10	II	0,10	I	0,10	I	0,55	I	0,55	I
Colchicum autumnale	0,20	II	0,20	II	0,20	II	0,30	III	0,40	IV	0,10	I	0,20	II
Euphrasia roskoviana	0,30	III	0,50	V	0,50	V	0,40	IV	0,40	IV	0,30	III	0,50	V
Galium mollugo	0,30	III	1,75	IV	0,30	III	0,30	III	0,65	II	0,65	II	0,30	III
Gentianella lutescens	0,20	II	0,30	III	0,00		0,10	I	0,10	I	0,10	I	0,10	I
Gnafalium sylvaticum	0,00		0,00		0,00		0,10	I	0,00		0,00		0,00	
Gymnadenia conopsea	0,10	I	0,20	II	0,10	I	0,10	I	0,20	II	0,20	II	0,10	I
Hieracium aurantiacum	1,85	V	0,30	III	2,75	V	1,40	V	2,20	IV	1,85	V	4,45	V
Hypericum maculatum	4,70	IV	1,75	IV	2,20	IV	1,85	V	4,35	IV	1,75	IV	4,00	V
Knautia dipsacifolia	0,75	III	0,50	V	0,50	V	0,40	IV	0,85	IV	1,30	IV	1,30	V
Leucanthemum vulgare	0,50	V	0,50	V	0,40	IV	1,40	V	1,40	V	0,95	V	0,40	IV
Linum catharticum	0,30	III	0,40	IV	0,20	II	0,30	III	0,20	II	0,00		0,00	
Parnasia palustris	0,10	I	0,10	I	0,10	I	0,10	I	0,00		0,10	I	0,00	
Pimpinella major	2,75	V	3,55	V	2,65	IV	4,10	V	2,75	V	2,20	IV	3,20	V
Plantago lanceolata	2,30	V	1,85	V	0,85	IV	1,40	V	1,40	V	1,85	V	0,95	V
Plantago media	0,10	I	0,00		0,00		0,10	I	0,00		0,00		0,00	
Polygala comosa	0,95	V	0,40	IV	0,40	IV	0,40	IV	0,20	II	0,40	IV	0,30	III
Potentilla erecta	0,10	I	0,00		0,00		0,00		0,00		0,00		0,00	
	V1	K	V2	K	V3	K	V4	K	V5	K	V6	K	V7	K
Primula veris	0,30	III	0,40	IV	0,10	I	0,85	IV	0,20	II	0,10	I	0,10	I
Prunella vulgaris	0,10	I	0,00		0,00		0,00		0,00		0,00		0,00	
Ranunculus acris	1,30	IV	0,55	I	0,40	IV	0,20	II	0,65	II	0,20	II	0,85	IV

	V1	K	V2	K	V3	K	V4	K	V5	K	V6	K	V7	K
Ranunculus bulbosus	0,00		0,00		0,00		0,00		0,00		0,00		0,55	I
Rhinanthus minor	0,95	V	0,95	V	0,95	V	1,85	V	1,40	V	0,95	V	0,85	IV
Rumex acetosa	0,40	IV	0,40	IV	0,30	III	0,50	V	0,50	V	0,50	V	0,40	IV
Scabiosa columbaria	0,00		0,30	III	0,10	I	0,20	II	0,10	I	0,10	I	0,20	II
Scorzonera rosea	0,00		0,10	I	0,00		0,00		0,00		0,00		0,00	
Stellaria graminea	0,50	V	0,30	III	0,50	V	0,95	V	0,50	V	0,95	V	0,50	V
Thymus pulegioides	3,65	V	7,50	V	6,60	V	3,90	V	5,80	V	4,90	V	7,05	V
Trollius europaeus	4,55	V	4,55	V	5,00	V	7,05	V	6,15	V	4,00	V	5,70	V
Vaccinium myrtillus	0,10	I	0,00		0,00		0,00		0,00		0,00		0,00	
Veratrum album	0,50	V	0,40	IV	0,50	V	0,40	IV	0,30	III	0,40	IV	0,40	IV
Veronica chamaedrys	1,75	IV	2,10	III	2,65	IV	1,85	V	2,65	IV	1,20	III	1,40	V
Viola tricolor	0,50	V	0,50	V	0,50	V	0,50	V	0,50	V	0,95	V	0,50	V
Species number	30,20		29,40		28,40		29		28,20		26,80		29,60	

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