ORGANIC FERTILIZATION OF A *FESTUCA RUBRA* L. MEADOW IN THE BOREAL FLOOR IN ROMANIA

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Abstract

Organic fertilizer application and traditional use for long periods of time have influenced the rich plant diversity in Apuseni Mountains, Romania). The objective of this study was to identify the effect of manure's application upon the plant diversity and productivity of Festuca rubra L. –Agrostis capillaris L. grasslands. The experimental field evaluated four variants (V_1: control, V_2: 10 t ha^{-1} manure, V_3: 20 t ha^{-1} manure, V_4: 30 t ha^{-1} manure). After ten years, important changes at the sward level were observed. Phytocenosis control is naturally represented by Festuca rubra L. - Agrostis capillaris L. grassland type. Then, following the application of organic fertilizers, Trisetum flavescens L. - Agrostis capillaris L. appeared. The large quantities of organic fertilizers produced a considerable constraint on plant diversity.

Key words: organic fertilization, fitodiversity, boreal floor, *Festuca rubra* L. - *Agrostis capillaris* L. grassland type,

INTRODUCTION

Grassland system can provide ecosystem service such a soil conservation, water quality protection, biodiversity conservation, medicinal plants, pleasing landscapes, soil carbon storage, and greenhouse gas mitigation (Sanderson and Wätzold, 2010). Grassland biodiversity is an important consideration in many agri-environmental policies (Orth *et al.*, 2010). Overall, the biological diversity in temperate grasslands, both in terms of functional diversity and species richness, does play a critical role in maintaining ecosystem functioning and ecosystem services and its ongoing reduction will most likely affect human well-being (Weigelt et al., 2010). In the following world summit, the parties declared that their goal was "to achieve by 2010 a

significant reduction in the current rate of biodiversity loss at the global, regional, and national level"(United Nation, 2002). The Grasslands from Europe suffer a creeping loss of biodiversity features because of fertilization, land abandonment or the transformation of grassland into cropland (European Environment Agency, 2007). The first systematic assessment of Europe's most vulnerable habitat types and species has already shown that grasslands in particular have an unfavourable conservation status (Bruchmann and Hobohn, 2010). In less-favored areas, this can take form of preserving plant diversity, e.g. through low-input farming system (Duru et al., 2010). Semi-natural grasslands need a management system which supports biodiversity conservation (Rotar, 2010). Being one of the most diverse plant communities, mountain meadows are the habitat of many rare species (Zarzycki and Misztal, 2010). The meadows found near the perimeter of the Gârda de Sus commune, Apuseni Mountains, Romania are highly phyto-diversified (Gârda, 2010), due to traditional management performed over long periods of time. Most traditional management techniques used organic fertilization via manure combined with the mixed uses (Morea, 2008). However, in habitats with low soil nutrient availability, richness and diversity can be positively affected by moderate intensification (Côp *et al.*, 2010). Furthermore, a minimum intensity is needed to maintain characteristic species composition (Tonn and Briemle, 2010). Manure fertilization contributes to grasslands' phyto-diversity, while spring overgrazing or frequent mowing are disadvantageous (Nettier *et al.* 2010). Questions remain as to what level of organic fertilization optimally maintains the phyto- diversity of meadows. With regard to the effectiveness of organic fertilizer and their impact on the plant species composition of meadows there are divergent opinions (Szewczyk et al., 2010). Organic fertilization and rational use of fertilizers can

produce substantial increases in the production and biodiversity, and in food quality improvement. (Vantu et al., 2008). In the Central part of Apuseni Mountains, fertilization by manure is the most important component of the traditional management that means to increase the biomass yield, species diversity and identity of the cultural landscape maintenance in this area (Rotar, 2010). As such, the objectives of this study were: 1) observe the reaction of a *Festuca rubra* L. grassland to organic fertilization and 2) establish the manure quantity at which a minimum change in plant diversity and dry matter (DM) yield growth were produced.

MATERIAL AND METHODS

The study was initiated in 2001, in the Gheţari village, Gârda de Sus commune, Romania (within the territory of Apuseni Natural Park) using a randomized blocks design with four replications and four experimental variants (V_1 – control, V_2 – 10 t/ha manure, V_3 – 20 t/ha manure, V_4 – 30 t/ha manure). Each plot was 10 m^2. The control variant is the grassland type *Festuca rubra L.-Agrostis capillaris L.* (*Festuco rubrae-Agrostetum capillaris* association Horv., 1951, quoted by Coldea et al. 2008). Manure was collected from cattle and horses (mixed with bedding matter) and has been spread in early spring. Floristic studies were conducted at the beginning of July using the Braun- Blanquét method. Harvest took place on the 7th of July, at 5 cm cut height above the ground. Framing the grassland type was performed using the one made by Tucra *et al.* (1987). For floristic data, the mean abundance-dominance (ADm) and constancy (K) were calculated (Cristea *et al.*, 2004). Data regarding the share of economic groups (*Poaceae, Cyperaceae-Juncaceae, Fabaceae* and diverse), species number and Shannon Index (SI) were processed by variance analysis. Four classes of constancy were used, so that the number of classes and

replications were equal. Data processing of DM yield was made by variance analysis. Results presented in this paper relate to the 10th experimental year.

RESULTS AND DISCUSSION

The control's grassland type has a large distribution overall the entire Apuseni Natural Park up to the superior limit of the beech forest (Coldea *et al.*, 2008) and even higher (Garda, 2010). This is a habitat of community interest (Natura 2000), South-Eastern Carpathian grasslands of *Agrostis capillaris* and *Festuca rubra* with code R3803 (Donita *et al.,* 2005). Manure's spreading on *Festuca rubra* L.-*Agrostis capillaris* L. (*F.r-A.c*) grassland generated considerable changes at the sward level (Table 1). The DM yield of the control was reduced. However, the manure application caused significant differences ($p<0.001$) across all treatments

Table 1.
*The influence of organic fertilizers upon the dry matter (DM) yield (*** = P<0.001) for Festuca rubra L. – Agrostis capillaris L. grasslands treated with manure near Gheţari, Romania in 2010.*

Experimental variants	DM t ha^{-1}	%	Difference	Significance
control	0.94	100.0	0.00	-
10 t ha^{-1} manure	1.62	172.7	0.68	***
20 t ha^{-1} manure	2.35	251.3	1.41	***
30 t ha^{-1} manure	2.83	302.4	1.89	***

After manure fertilizers' application, major changes were observed at the sward level (Table 2). After applying organic fertilizer, the control grassland type (*F.r*- A.c) evolved toward other successional stages. In the variant with 10 t ha^{-1} manure, *F.r-A.c* type was observed and in variants with 20 and 30 t ha^{-1} manure, *Trisetum flavescens* L.-*Agrostis capillaris* L. (*T.f-A.c*) occured. The *F.r-A.c* type of the control contained 52.9% *Poaceae* (P), 1.1% *Cyperaceae-Juncaceae* (C-J), 10.8% *Fabaceae* (F) and 38.1% species from other botanical families (OBF). This plant community included a mean of 30.3 species and had a SI of

1.96. The *F.r-A.c* type, when 10 t ha^{-1} manure were applied, contained 35.6% P, 0.4% C-J, 15.4 % F and 49.7% OBF. Compared to the control, this type showed a decrease in P ($P < 0.05$) and an increase in OBF ($P < 0.05$), but the grassland type remains the same. The floristic diversity of the *F.r-A.c* type was represented by 33 species and had a SI of 1.94. The number of species grew in comparison to the control and the SI slightly decreased compared to the control, but these variations were not totally due to experimental factors. Similar results were obtained by Garda (2010), when she performed a floristic study of the grasslands in Ghetari-Poiana Calineasa Plateau (Garda de Sus commune), where she identifies the *F.r-A.c* type in 119 sites. In this study, it's shown that the plant community comprises in average 37.19 % P, 0.59% C-J, 10.21% F and 48.39 % OBF. Also, in this study, it results that the participation of economic groups differs very much from one site to another. The *T.f-A.c* type contained 33.1-33.8% P, 0-0.1% C-J, 12.1-15.4% F and 59.1-59.9% OBF. The floristic structure of this grassland type was different from the control, with a reduction of P ($P < 0.05$, $P < 0.01$) and C-J ($P < 0.05$) and increased OBF ($P < 0,01$). Species number decreased towards the control, but did not show statistic insurance (ns). The SI was lower compared to the control, with a value between 1.58 and 1.6 ($P < 0.01$).

Table 2. The influence of manure upon plant diversity in grasslands near Gheţari, Romania in 2010.

Variants	Control		10 t ha^{-1} manure		20 t ha^{-1} manure		30 t ha^{-1} manure	
Phyto-sociologic indexes	ADm	K	ADm	K	ADm	K	ADm	K
Grassland type*	*F.r-A.c*	-	*F.r-A.c*	-	*T.f-A.c*	-	*T.f-A.c*	-
Cover	84.8	-	93.8	-	96.0	-	96.0	-
Poaceae	52.9	-	35.6^{0}	-	33.8^{0}	-	33.1^{00}	-

Agrostis capillaris L.	15.9	IV	11.3	IV	12.8	IV	12.8	IV
Anthoxanthum odoratum L.	0.5	IV	0.3	II	0.4	III	0.4	III
Briza media L.	0.5	II	0.4	III	-	-	-	-
Cynosurus cristatus L.	0.5	IV	0.5	IV	0.3	II	0.1	I
Dactylis glomerata							0.1	I
Festuca pratensis Huds.	-	-	0.1	I	0.4	III	0.9	III
Festuca rubra agg. L.	32.5	IV	15.9	IV	4.4	IV	3.3	IV
Trisetum flavescens L.	1.6	IV	8.1	IV	17.5	IV	20.0	IV
Cyperacaee and *Juncaceae*	1.1	-	0.4^{ns}	-	0.1^{0}	-	0^{0}	-
Luzula multiflora Ehrh.	1.1	IV	0.4	III	0.1	I	-	
Fabaceae	10.8	-	15.4^{ns}	-	12.1^{ns}	-	15.4^{ns}	-
Lathyrus pratensis			0.1	I	0.1	I		
Lotus corniculatus L.	5.4	IV	3.3	IV	2.2	IV	0.5	IV
Medicago lupulina							0.1	I
Trifolium pretense L.	4.3	IV	3.9	IV	3.3	IV	4.9	IV
Trifolium repens L.	0.5	IV	2.6	III	1.1	IV	0.5	IV
Vicia cracca L.	0.5	IV	5.4	IV	5.4	IV	9.1	IV
Other botanical families	38.1	-	52.7*	-	59.9**	-	59.1**	-
Achillea millefolium L.	0.5	I	0.3	II	0.1	I	0.1	II
Alchemilla vulgaris agg. L.	14.4	IV	12.8	IV	5.0	IV	5.0	IV
Arnica montana	0.5	I						
Campanula abietina agg.	0.5	II	0.4	III	1.1	IV	0.8	II
Calina acaulis			0.3	II	0.1	I		
Carum carvi L.	-	-	0.4	III	0.5	IV	0.3	III
Centaurea pseudophrygia agg C. A. Mey.	5.6	III	15.3	IV	28.4	IV	23.4	IV
Cerastium holosteoides	0.5	I						
Colchicum autumnale	4.8	III	3.3	IV	1.1	IV	3.3	IV
Crepis biennis	0.5	II	0.4	III	1.1	IV	2.2	IV
Gymnadenia conopsea L.	0.5	III	0.4	III	0.1	I	0.1	IV
Hieracium aurantiacum L.	0.5	I	0.1	I	-	-	-	-
Hypericum maculatum Crantz.	0.5	I	1.1	IV	0.9	III	0.5	IV
Leontodon autumnale	2.2	IV	0.5	IV	0.3	II	0.5	IV
Leucanthemum vulgare	0.5	IV	1.1	IV	0.5	IV	0.4	IV

Lam.								
Linum catharthicum					0.5	II		
Myosotis sylvatica Ehrh. Ex Hoffm.	-	--	0.4	III	0.4	III	0.3	II
Pimpinella major L.	1.6	IV	5.4	IV	4.9	IV	5.4	IV
Plantago lanceolata L.	1.3	III	0.4	III	0.3	II	0.1	II
Plantago media L.	1.1	IV	0.4	III	0.3	II	0.3	III
Polygala vulgaris L.	0.5	III	0.1	I	-	-	-	-
Potentilla erecta L.	3.3	IV	0.5	IV	-	-	-	-
Prunella vulgaris L.	0.5	II	0.4	III	-	-	0.1	I
Ranunculus acris L.	0.5	IV	0.5	IV	0.5	IV	0.5	IV
Rhinanthus minor L.	0.5	IV	1.6	IV	0.5	IV	0.5	IV
Rumex acetosa L.	0.5	IV	0.5	IV	0.5	IV	1.6	IV
Scabiosa columbaria L.	0.5	II	-	-	-	-	-	-
Stellaria graminea L.	0.5	IV	0.5	IV	0.5	IV	0.5	IV
Taraxacum officinale Weber ex F. H. Wigg.	0.5	II	1.1	IV	2.6	III	4.4	IV
Thymus pulegioides L.	1.6	II	0.1	I	-	-	-	-
Tragopogon pratensis L.	0.5	III	0.5	IV	0.3	II	0.5	IV
Trollius europeus					0.1	I		
Veronica chamaedrys L.	-	-	1.1	IV	9.7	IV	8.1	IV
Viola tricolor L.	0.5	IV	-		0.1	I	0.1	IV
Species' number	30.3	-	33^{in}	-	28.3^{in}	-	27.3^{in}	-
Shannon Index	1.96	-	1.94^{in}	-	1.6^{00}	-	1.58^{00}	-

(ADm = mean abundance-dominance, K = constancy, * = p<0.05, *** = p<0.01,* ^{0} *= p<0.05*, ^{00} *= p<0.01,* ^{ns} - insignificant); [1)] Grassland types: *F.r* = *Festuca rubra* L., *F.r-A.c* = *Festuca rubra* L. -*Agrostis capillaris* , L., *T.f-A.c* = *Trisetum flavescens* L. -*Agrostis capillaris*. L.

Organic fertilization of *Festuca rubra* L.-*Agrostis capillaris* L. grassland type produces significant growths of the DM yield even by applying 10 t ha $^{-1}$ manure.

By applying small quantities of manure (10 t ha^{-1}), leads to *Festuca rubra* L.-*Agrostis capillaris* L. grassland type occurrence, and the treatment with larger quantities (20-30 t ha^{-1} manure) generates the occurrence of *Trisetum flavescens* L.-*Agrostis capilaris* L. type.

The phyto-diversity is being slightly modified at treatment with 10t ha^{-1} manure, and by applying larger quantities significant decreases take place.

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