

Influence of the Management on the Phytocoenotic Biodiversity of Some Romanian Representative Grassland Types

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Abstract

The pastoral area of Romania, covering of over 4.8 million ha, has been influenced, over the last decades, by natural and human factors, which affect the normal functioning of the grassland ecosystem. The aim of this paper is to point out the dynamics of phytocoenotic biodiversity, as a result of applying grassland technical measures, in order to improve the yield and quality of grassland ecosystems with minimum effects on the environment. Therefore, the main aim of our study is to establish a positive relationship between biodiversity and the optimum quantity of organic fertilizers, which would improve the quality and quantity of the yield, without diminishing the floristic biodiversity. In the case of the studied grasslands, the phytocoenotic biodiversity is influenced by the type of fertilization, the used rates and by the soil and climatic conditions. These grasslands may be improved by manure fertilization and reasonable usage, if proper management is applied. In Gradinari, Caras-Severin county, the dominant species are *Festuca rupicola* and *Calamagrostis epigeios*, in Magurele, Brasov county, *Agrostis capillaris*, *Festuca pratensis*, *Poa pratensis* and *Trifolium repens*, and in Pojorata, Suceava county, *Agrostis capillaris*, *Trisetum flavescens*, *Trifolium repens* and *T. pratense* species. The highest number of identified species (43) has been recorded by the meadow made up of *Agrostis capillaris* and *Festuca rubra*, from Pojorata, Suceava county.

Keywords: forbs, grasses, legumes, organic fertilization, vegetal canopy

Introduction

Biodiversity has become one of the main concerns of our world, because modern farming, forestry and meadow culture focussed, in these latter years, on developing methods and proceedings for achieving high productions, without being interested in the quality of produces or environment health. Among the factors threatening biodiversity, one enlists human activities, high pressures on natural resources, division, change or even destruction of habitats, excessive use of pesticides, chemical fertilizers etc. (Weigelt *et al.*, 2009). Nowadays, many specialists are concerned with adapting the technologies of fodder production to the new economic and ecological requirements, whilst the maintaining of biodiversity occupies an important place (Belesky *et al.* 2002; Duelli, 1997; Elsaesser *et al.*, 2008; Hopkins *et al.*, 1999; Jeangros, 2002; Nilsson, 2009; Peeters *et al.*, 2004; Rotar *et al.*, 2010; Vintu *et al.* 2003; 2008). Previous research, done in different climatic and managerial conditions proved that there is a relationship between biodiversity and pastures productivity. The latter is influenced by the soils fertility, chemical reaction, and usage, intensity of grazing, altitude, amount and distribution rainfalls (Dolek and Gezer, 2002; Dumont *et al.*, 2007; Hector and Loreau, 2005; Isselstein *et al.*, 2007; Ko-

pec *et al.*, 2010; Metera *et al.*, 2010; Mosquera-Losada *et al.*, 2009; Soder *et al.*, 2007; Tilman *et al.*, 1996).

The objectifs of this paper are to establish the influence of the management on the rate of species in the structure of vegetation, and dominant species in the vegetal canopy; to establish the influence of the type of fertilization on the dynamics of biodiversity and to establish the best dose of fertilization in order to improve the production on the permanent grassland.

For attaining the paper's objectives, the main meadow ecosystems assessed have been qualitatively and quantitatively and the evolution of vegetal canopy has been diagnosed according to the management of some meadow types found under different ecological conditions.

Materials and methods

For the study of the meadows' vegetation, we have used the geo-botanical method (Braun Blanquet, 1964) by carrying out observations on experimental variants and replicates during the first cycle of vegetation.

The species included in the floristic catalogues of the areas under study have been classified into several categories, according to their dominance: *dominant* species (coverage degree of 60-100%), *co-dominant* species (coverage degree of 25-40%) and *indicator* species, with a low presence in

Tab. 1. Experimental variants in the studied sites

Variants	Gradinari, Caras-Severin county	Magurele, Brasov county	Pojorata, Suceava county
1	unfertilized control	unfertilized control	unfertilized control
2	10 t/ha manure, applied once in 3 years	20 t/ha manure every 2 years, application in autumn and usage as hayfield	10 t/ha manure every year
3	20 t/ha manure, applied once in 3 years	20 t/ha manure every 2 years, application in autumn and usage by simulation grazing	20 t/ha manure every 2 years
4	30 t/ha manure, applied once in 3 years	20 t/ha manure every 2 years, application in spring and usage as hayfield	30 t/ha manure every 3 years
5	40 t/ha manure, applied once in 3 years	20 t/ha manure every 2 years, application in spring and usage by simulation grazing	20 t/ha manure in the first year+10 t/ha manure in the second year+0 t/ha manure in the third year
6	10 t/ha manure, applied each year	40 t/ha manure every 4 years, application in autumn and usage as hayfield	20 t/ha manure in the first year+0 t/ha in the second year+10 t/ha manure in the third year
7	20 t/ha manure, applied each year	40 t/ha manure every 4 years, application in autumn and usage by simulation grazing	20 t/ha manure in the first year+10 t/ha manure in the second year+10 t/ha manure in the third year
8	30 t/ha manure, applied each year	40 t/ha manure every 4 years, application in spring and usage as hayfield	10 t/ha manure in the first year+20 t/ha manure in the second year+10 t/ha manure in the third year
9	40 t/ha manure, applied each year	40 t/ha manure every 4 years, application in spring and usage by simulation grazing	-
10	40 t/ha manure, applied every 3 year +10 t/ha manure, applied each year	60 t/ha manure every 4 years, application in autumn and usage as hayfield	-
11	-	60 t/ha manure every 4 years, application in autumn and usage by simulation grazing	-
12	-	60 t/ha manure every 4 years, application in spring and usage as hayfield	-
13	-	60 t/ha manure every 4 years, application in spring and usage by simulation grazing	-

the vegetal canopy, still expressing the specific features of the ecological factors (acid or alkaline soils, fertile or poor soils in nutrients, moist or dry soils etc.).

The studies have been carried out in Gradinari, Caras-Severin county, Magurele, Brasov county and Pojorata, Suceava county (Romania), and they have been organized in monofactorial experiments, in randomized blocks with four replicates, as presented in Tab. 1. The manure was applied manually in very early spring, in March, at the beginning of grass growth.

The experimental variants were differed from location to location according to the variation of the manure dosis used in order to fertilize the natural pastures of the area by the animal growers.

In Gradinari and Pojorata, the meadows was mowed in haystacks, at the level of inflorescences formation at the dominant grasses, while, in Magurele, half of the experimental variants have been harvested by mowing, as haystacks, as if by simulating grazing, mowed at a height of 15-18 cm of dominant plants.

Results and discussion

The experiments presented in this paper have been conducted on representative meadows, found under di-

verse ecological conditions from three sites and spread in two vegetation zones: the forest-steppe zone/level with one site (Gradinari, Caras-Severin county), the nemoral level with two sites (Magurele, Brasov county, Pojorata, Suceava county) (Fig. 1).

The data presented in Tab. 2 have shown that the mean multiannual temperatures recorded values that vary between 6.5 and 10.4°C, and the rainfall regime that influenced greatly the productivity and composition of the vegetal canopy registred mean annual values comprised between 700 and 836.0 mm. The analysed meadow ecosystems are located at average heights varying between 195 and 707 m.

Tab. 2. Soil and ecological characteristics of the studied sites

Site	Mean temperature (°C)	Mean rainfall (mm)	Average altitude (m)	Soil type
Gradinari-Caras-Severin	10.4	836	195	Moderately eroded cambic chernozem
Magurele-Brasov	7.2	700	600	Dark eumesobasic
Pojorata-Suceava	6.5	708.7	707	Dark eumesobasic



Fig. 1. Location of the three sites on Romanian territory

The meadow vegetation from the Gradinari area presented a 100% coverage degree; the dominant species in the vegetal canopy was *Festuca rupicola* with a specific coverage of 16-66% when fertilised, compared with 33% in the unfertilized control. The *co-dominant* species in the Gradinari area is *Calamagrostis epigeios*, with a specific coverage of up to 49% at a fertilization rate of 20 t/ha manure, applied once in 3 years. The grass species had a significant contribution to the vegetal canopy, varying between 63-89%. Data analysis recorded a diminishing of the share of the *Calamagrostis epigeios* species, with low fodder value, in the majority of fertilised variants. The legumes species presented very low participation in the vegetal canopy, with a 1-2% coverage degree, but the forbs contributed at the vegetal canopy formation with 11-36%, of major importance being *Filipendula vulgaris* and *Achillea millefolium* (Tab. 3). Manure fertilisation, under the terrain and climatic conditions of the Gradinari area brought no important changes in the legumes share, but determined a rise in weeds presence in five of the fertilised variants and a diminishing of their presence in only two of the studied variants (from 22% to 11% in V7, respectively 12% in V9). The chemical reaction of the vegetal canopy at fertilisation depends, among others, on the soil type and climatic conditions (Hector, 2005; Kopec, 2010). The vegetal canopy of this meadow was made up of 31 species, of which 29% belong to the grass family, 6% to *Cyperaceae* and *Juncaceae* and 10% to legumes, the rest of 55% being represented by the species belonging to other botanical families.

As for the number of species, which form the vegetal canopy of the Gradinari meadow, we have identified 31

species, 9 of them belonging to the grass family, 3 to legumes, 2 to *Cyperaceae* and *Juncaceae* and 19 species to other botanical families (forbs).

In Magurele, Brasov county, the organic fertilization has especially influenced the floristic composition, 20-31 species being found on average in the vegetal canopy. The grass species participated in the vegetal canopy with 61-72%, the legumes, with 13-29% and the forbs, with 7-18%. Tab. 4 shows the increase in the presence of *Poa pratensis* species by 15-30% and of *Festuca pratensis* species, by 15-20%, according to different manners of usage. An increase in the presence of valuable grasses was also found: *Dactylis glomerata* (until up to 10% in V10) and *Arrhenatherum elatius*, in some fertilization variants (2-3% in V2-V4), as well as *Festuca pratensis* and *Poa pratensis*, to the prejudice of *Festuca rubra* and *Agrostis capillaris* species, whose contribution to the composition of the vegetal canopy decreased visibly. Therefore, the increase of soil fertility determined a change of meadow dominance and also an increase in valuable species share, with high productivity, aspects that have also been identified by Mosquera-Losada (2009), Tilman (1996).

Within the species of legumes, we have noticed their increased presence in the vegetal canopy, until 13-29%. Among all the variants, the dominant species, was *Trifolium repens*, with a growth of 12-22% at fertilization rates, compared with only 2% at the unfertilized control, followed by *Trifolium pratense* 2-5%, *Lotus corniculatus* 1-3% and *Medicago lupulina* 2-7%.

Under the eco-climatic conditions of Magurele, manure fertilization has determined an important growth

Tab. 3. Dynamics of phytocoenotic biodiversity on *Festuca rupicola* grassland from Gradinari, Caras-Severin county (%)

Species	V ₁	V ₂	V ₃	V ₄	V ₅	V ₆	V ₇	V ₈	V ₉	V ₁₀
<i>Festuca rupicola</i>	33	32	16	49	66	47	46	15	49	47
<i>Poa pratensis</i>	15	+	+	+		+	+	+		+
<i>Calamagrostis epigeios</i>	30	46	49	16	15	32	14	45	+	29
<i>Anthoxanthum odoratum</i>	+	+	+	+	+	+	+	+	1	+
<i>Bromus inermis</i>			+	+		+	29	3	15	
<i>Briza media</i>			+			+				
<i>Brachypodium pinnatum</i>			+		+			+	+	+
<i>Alopecurus pratensis</i>		+		12			+		13	
<i>Bromus mollis</i>					+	+				+
Grasses	78	78	65	77	81	79	89	63	78	76
<i>Trifolium repens</i>				+	+			1	+	
<i>Lotus corniculatus</i>	1	+	2	+	+	1	+	+	+	1
<i>Genista tinctoria</i>			+				+			+
Legumes	1	-	2	-	-	1	-	1	-	1
<i>Luzula luzuloides</i>	+					+				
<i>Carex praecox</i>				+			+		+	+
<i>Filipendula vulgaris</i>	1	15	29	5	14	16	5	15	5	14
<i>Plantago media</i>	1	+	2	+	1	1	1	+	+	1
<i>Cichorium intybus</i>	+	+								+
<i>Agrimonia eupatoria</i>	+	2	+	7	+	+	2	+	+	1
<i>Achillea millefolium</i>	16	2	+	2	1			14	3	4
<i>Rosa gallica</i>	+	+		+		1	1			+
<i>Ranunculus acris</i>	+		+	+	+			+	1	
<i>Thymus serpyllum</i>	1	1		+	1	1		1	1	1
<i>Crataegus monogyna</i>		+					+			
<i>Galium molugo</i>	1	+	+			+		+		1
<i>Euphorbia cyparissias</i>			1	9	1		+	1	1	+
<i>Hieracium pilosella</i>		1			+			+		
<i>Linaria genistifolia</i>			1		+	1	1		+	1
<i>Pastinaca sativa</i>			+			+				+
<i>Origanum vulgare</i>						+				
<i>Prunella vulgaris</i>	1	1		+	1		1	2	1	+
<i>Scabiosa ochroleuca</i>			+							+
Forbs	21	22	33	33	19	20	11	36	12	23
Species number	16	17	20	17	17	18	17	18	18	22

of legumes rate within the vegetal canopy, improving the quality of fodder, in all of the studied variants, confirming thus the hypothesis of a strong link between plants and the environmental conditions (Kopec, 2010; Hopkins, 1999; Metera, 2010).

The forbs are of reduced importance in the formation of biomass; still, they include a relatively high number of species (10-14), some of which can be used as fodder: *Achillea millefolium*, *Bellis perennis*, *Plantago lanceolata*, *Taraxacum officinale*, *Convolvulus arvensis*, whereas other are harmful to meadows: *Cirsium arvense*, *Colchicum autumnale* and *Ranunculus acris*.

In Pojorata, Suceava county, the organic fertilization had a positive influence on the floristic composition, were 33-40 species have been found in the vegetal canopy; the percentage of grasses was of 32-43%, legumes, 27-36% and that of plants belonging to the diverse group, varied be-

tween 21-32%. Data from Tab. 5 show the increased presence of legume species, from 19% (control) to 27-36% (V6, respectively V4 si V8), especially *Trifolium repens*, *T. pratense* and *Lotus corniculatus*. The group of forbs was largely present in the formation of the biomass (20-29 species), some of them having fodder value (*Achillea millefolium*, *Plantago media*, *P. lanceolata*, *Taraxacum officinale*) and others without fodder value (*Chrysanthemum leucanthemum*, *Filipendula hexapetala*, *Prunella vulgaris*), or even being toxic (*Colchicum autumnale*).

Conclusions

The management of permanent grasslands, in terms of usage, type and intensity of fertilization and method of control has a great influence on phytocoenotic biodiversity, on the rate of species in the structure of vegetation,

Tab. 4. Dynamics of phytocoenotic biodiversity on *Agrostis capillaris* grassland from Magurele, Brasov county (%)

Species	V ₁	V ₂	V ₃	V ₄	V ₅	V ₆	V ₇	V ₈	V ₉	V ₁₀	V ₁₁	V ₁₂	V ₁₃
<i>Agrostis capillaris</i>	38	13	15	15	30	20	25	24	20	19	15	15	20
<i>Festuca rubra</i>	5	-	+	-	-	+	+	+	-	-	-	-	-
<i>Festuca pratensis</i>	6	15	15	15	15	14	20	15	20	20	15	20	15
<i>Dactylis glomerata</i>	3	4	5	5	2	5	2	+	2	10	5	5	4
<i>Cynosurus cristatus</i>	8	-	1	+	+	-	-	-	-	-	-	-	-
<i>Holcus lanatus</i>	2	+	+	+	+	-	+	-	-	-	2	-	-
<i>Arrhenatherum elatius</i>	+	3	2	2	+	+	+	+	1	-	-	-	-
<i>Phleum pratense</i>	5	+	+	-	+	-	+	-	-	+	-	-	-
<i>Bromus mollis</i>	-	+	+	+	-	-	+	5	5	+	3	3	2
<i>Anthoxanthum odoratum</i>	1	+	+	+	+	-	+	-	-	-	-	+	+
<i>Poa pratensis</i>	4	25	30	25	20	25	25	20	15	15	25	20	20
Grasses	72	60	68	62	67	69	62	64	63	64	65	63	61
<i>Trifolium repens</i>	2	22	20	15	15	15	20	15	20	15	20	12	18
<i>Trifolium pratense</i>	7	+	2	5	2	2	3	2	2	2	3	2	3
<i>Lotus corniculatus</i>	3	1	+	+	2	1	2	+	2	1	3	2	1
<i>Medicago lupulina</i>	1	7	3	7	5	3	2	4	5	+	-	2	2
<i>Lathyrus sp.</i>	-	-	-	-	-	-	-	+	-	-	-	-	-
<i>Vicia cracca</i>	-	-	-	-	+	+	+	1	-	+	-	2	+
Legumes	13	30	25	27	24	21	27	22	29	18	26	20	24
<i>Achillea millefolium</i>	4	2	1	2	2	4	2	2	2	5	2	3	3
<i>Chrysanthemum sp.</i>	+	+	-	1	1	+	+	1	-	1	+	1	+
<i>Stellaria graminea</i>	+	+	1	+	1	+	+	1	1	1	1	1	+
<i>Veronica chamaedris</i>	2	+	1	1	+	+	2	2	-	2	1	2	1
<i>Cirsium arvense</i>	-	-	-	-	+	+	-	-	-	-	-	-	-
<i>Cichorium intybus</i>	-	1	+	1	-	+	-	-	-	-	1	-	-
<i>Prunella vulgaris</i>	1	-	1	+	+	+	1	1	-	1	+	1	1
<i>Colchicum autumnale</i>	-	-	-	-	+	-	-	+	-	-	-	+	-
<i>Alchemilla ternata</i>	1	+	+	+	+	-	+	+	+	+	-	1	1
<i>Leontodon autumnalis</i>	-	+	-	+	1	-	-	-	+	+	-	-	1
<i>Galium aparine</i>	2	+	+	2	1	+	+	-	+	3	1	2	2
<i>Rumex crispus</i>	-	-	+	-	+	-	-	+	-	-	-	-	-
<i>Taraxacum officinalis</i>	3	3	+	2	3	4	3	2	2	3	1	1	3
<i>Bellis perennis</i>	+	1	+	+	+	+	1	1	1	+	+	+	+
<i>Plantago lanceolata</i>	1	2	2	1	+	2	1	2	2	1	1	2	2
<i>Convolvulus arvensis</i>	+	1	-	+	+	+	-	2	-	-	1	2	-
<i>Ranunculus acris</i>	+	+	+	1	+	+	-	-	-	1	-	-	-
<i>Arctium lappa</i>	-	-	-	+	-	+	-	-	+	-	-	-	-
<i>Hieracium pilosella</i>	1	-	-	-	+	-	+	+	-	-	-	-	-
<i>Matricaria inodora</i>	-	-	1	-	-	-	1	-	+	-	-	1	1
Forbs	15	10	7	11	9	10	11	14	8	18	9	17	15
Species number	27	25	28	28	31	25	27	26	20	23	20	24	23

and dominant species in the vegetal canopy. In the three experimental sites, three representative types of natural grasslands with a very various floristic composition have been studied. In Gradinari, Caras-Severin county, *Festuca rupicola* and *Calamagrostis epigeios* are the dominant species, in Magurele, Brasov county, *Agrostis capillaris*, *Festuca pratensis*, *Poa pratensis* and *Trifolium repens*, and in Pojorata, Suceava county, our study has identified the *Agrostis capillaris*, *Trisetum flavescens*, *Trifolium repens* and *T. pratense* species. The highest number of identified species (43)

has been recorded by meadow made up of *Agrostis capillaris* and *Festuca rubra*, from Pojorata, Suceava county. The high dynamics of biodiversity is influenced by the type of fertilization, the quantities of fertilizers and by soil and climatic conditions. These grasslands may be improved by manure fertilization and the reasonable utilization, if and only proper management is applied. From the point of view of the biodiversity index, the studied meadows have high phytocoenotic diversity, the dominant species being the ones with closely related population stocks.

Tab. 5. Dynamics of phytocoenotic biodiversity on *Agrostis capillaris* and *Festuca rubra* meadow from Pojorata, Suceava county (%)

Species	V ₁	V ₂	V ₃	V ₄	V ₅	V ₆	V ₇	V ₈
<i>Agrostis capillaris</i>	19	13	14	11	10	10	13	12
<i>Festuca rubra</i>	7	3	4	3	2	2	2	2
<i>Festuca pratensis</i>	1	1	1	+	+	1	1	1
<i>Dactylis glomerata</i>	3	+	2	2	1	7	+	1
<i>Cynosurus cristatus</i>	4	10	5	5	4	5	3	5
<i>Holcus lanatus</i>	1	+	1				+	+
<i>Arrhenatherum elatius</i>	3	4	5	6	9	5	2	4
<i>Brachypodium pinnatum</i>	+	2	1	1	+	+	+	
<i>Anthoxanthum odoratum</i>	2	1	2	1	+	2	2	1
<i>Trisetum flavescens</i>	4	2	6	6	7	9	13	6
<i>Briza media</i>	3	3	2	2	1	2	+	+
Grasses	47	39	43	37	34	43	36	32
<i>Trifolium repens</i>	9	12	15	17	20	12	16	25
<i>Trifolium pratense</i>	5	9	7	7	10	6	12	8
<i>Lotus corniculatus</i>	5	7	7	8	4	9	4	3
<i>Medicago lupulina</i>	+	3	+					
<i>Trifolium montanum</i>	1	2	1		2			
<i>Anthyllis vulneraria</i>		+						
<i>Genista tinctoria</i>	+							
Legumes	19	33	30	32	36	27	32	36
<i>Chrysanthemum leucanthemum</i>	6	5	5	5	4	6	6	8
<i>Stellaria graminea</i>	+	+	+	+	+	+	+	+
<i>Veronica chamaedris</i>	2		+	+				+
<i>Taraxacum officinale</i>	4	4	+	7	8	6	6	4
<i>Cichorium intybus</i>	2							
<i>Prunella vulgaris</i>	3	3	2	2	3	5	5	3
<i>Colchicum autumnale</i>	1	+	+	+	2	3	+	2
<i>Achillea millefolium</i>	4	3	3	3	1	1	1	1
<i>Galium verum</i>	2	2	2	+	+	+	5	4
<i>Rumex sp.</i>	+			1		+	+	+
<i>Campanula sp.</i>	+	+		+		+	+	+
<i>Plantago media</i>	3	2	1	1	1	1	1	1
<i>Ranunculus polyanthemus</i>	+	+	+	1	+	+	+	+
<i>Filipendula hexapetala</i>	5	4	6	7	5	4	3	4
<i>Knautia arvensis</i>	+	+						
<i>Carduus acanthoides</i>	+	+				+		
<i>Carum carvi</i>	+	+	+	+	+	+	+	+
<i>Tragopogon orientalis</i>	+	+	+		+	+		+
<i>Thymus pannonicus</i>	+	+	+		+	+	+	+
<i>Carex sp.</i>	+	+		+	+	+	+	+
<i>Plantago lanceolata</i>	+	1	1	1	1	1	1	1
<i>Rhinanthus rumelicus</i>	+	+	+	+	1	1	3	1
<i>Alchemilla vulgaris</i>	+	1		+	+	+	+	+
<i>Plantago major</i>	+	1		1	1	1	1	1
<i>Potentilla reptans</i>	+			+		+		
<i>Hypericum perforatum</i>		1	1	+			+	
<i>Gimnadenia odoratissima</i>		+		+				
<i>Trollius europea</i>				+				
<i>Myosotis alpestris</i>				+	+	+		+
Forbs	32	27	21	29	27	29	32	30
Species number	43	40	33	37	33	36	34	35

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