LOW MINERAL FERTILIZATION ON GRASSLAND AFTER 6 YEARS

Ioan ROTAR[1], Florin PĂCURAR[1], Anca PLEŞA[1], Ágnes BALÁZSI[1]

e-mail: rotarioan52@yahoo.fr

Abstract

Nowadays, all over the world, the tendency is to maintain biodiversity and prevent the loss of it by replacing intensive management systems with sustainable and beneficial ones. The traditional management degradation due on one hand to depopulation of mountain villages and on the other hand due to mechanization leads into vegetation succession that is unpredictable. Finding alternative and combined solutions to preserve the landscape and reducing depopulation of the mountain area are necessary. This is the reason why our experience is combined and includes a study during 6 years in a low-input system from Apuseni Mountains, Romania. The experimental treatments are designed to follow the effect of low mineral inputs on floristic composition of grasslands. The results show a decline in species richness under the influence of mineral inputs. Changes in abandon phytocenosis should be taken with reserve because time is too short. Although have been applied different amounts of mineral fertilizer it has not changed the type of grassland during 6 years.

Key words: abandon, diversity, grasslands, mineral

In Central Europe, almost one third of the total higher plant flora (i.e. some 1000 species) is related to grassland (Ellenberg and Leuschner, 2010). Grasslands in Europe harbor a huge biodiversity and they contribute most significantly to the overall diversity of the European agricultural landscapes (Isselstein and Kayser, 2014). The focus on biodiversity role in ecosystem services was developed before 2010 new global and national policies (Maes *et al*, 2011). Land use change scenarios prove that the natural conditions in new EU Member States are suitable for agricultural production, integrating environmental and landscape protection and nature conservation (Maurice *et al*, 2012). Land use changed drastically over the 190-year period, and the largest relative change occurred for hay meadows with late harvest (like it happens in Romania), which decreased from 28% to 0% (Nilsson *et al*, 2008), and increased fragmentation and habitat loss pose a threat to terrestrial biodiversity (Ramesh and Downs, 2015). The importance is also reflected by the fact that the grassland area is a major contributor to the high nature value farmland (EEA 2004). This is becoming even more important with the recently claimed requirement for 'sustainable intensification' which appears as the new paradigm of agriculture. Long-term application of NPK fertilizers increases plant productivity and soil nutrient concentrations but also reduces plant species richness, and this can result in the dominance of largely species-poor grasslands with little conservation value (Pavlu *et al*., 2014). In this paper we tried to give answers to these concerns equally scientific and practical and assess what happens with biodiversity after 6 years in a mineral low fertilization system. The considered hypothesis was that small quantities of mineral fertilizer do not produce major changes.

MATERIAL AND METHOD

Study site

The experiment was established in 2009 in Poienile Ursului, Ocoale Village, Gîrda de Sus Commune, Apuseni Mountains, Romania in a *Agrostis capillaris* L. - *Festuca rubra* L. grasslands type. The area shows a typical boreal climate with 5.2°C average temperature and 1122.65 mm average annual rainfall (Păcurar *et al*, 2014 b). The experiment was put on a preluvisol soil with average content of nitrogen but poor in phosphorus and potassium (Parinchi and Stănilă, 2005) at 1349 m above sea level (a.s.l). The experiment is organized using a randomized block design with 7 treatments in 5 replications (*tab. 1*). The vegetation observations were made on 35 plots each sized 6 m^2. Hay meadows are a dominant landscape feature, and there is high variation of land use and topoclimatic conditions in the area. Plots were mowed at 5–7 cm cutting height, when the grasses were in bloom. Mulched were in the same time with traditional mowing period. Cattle and horse manure (which

[1] University of Agricultural Science and Veterinary Medicine Cluj-Napoca

contains 3.04 kg t^{-1} N, 2.90 kg t^{-1} P and 2.47 kg t^{-1} K) were applied in early springtime on the plots (in the beginning of March), according to the treatments The floristic composition was interpreted using an improved Braun-Blanquet scale with subdivisions (Păcurar and Rotar, 2014 a).

Data analysis

Floristic data processing was performed with PC-ORD, version 6, which uses the multivariate analysis of the ecological data entered into the spread sheet (McCune and Mefford, 2011). For data processing, best interpretation and to visually explore the floristic gradient in our dataset non-parametric multidimensional scaling (NMS) was performed on the Bray-Curtis dissimilarity matrix. NMS was carried out several times in autopilot mode, in order to minimize the stress (McCune *et al*, 2002; Peck, 2010). The recommended solution for data presentation was tridimensional and we present axes 1 with 2 because they have the highest level in explaining the variance 0.607. The significant floristic differences were then verified using a multi response permutation procedure (MRPP) and a Monte Carlo Test.

RESULTS AND DISCUSSIONS

During the six year study period, the sampled plots fall within 7 compositionally distinct groups which largely represent temporal changes in the *Agrostis capillaris* L. - *Festuca rubra* L. grassland type (*figure 1*). The vegetation plots (during 6 years) fell into seven groups (like numbers of treatments are). Statistically, significant experimental factors which explain the changes in floristic composition are mineral fertilization: N (Axis 1: r = -.114, tau= - .060; Axis 2: r = .560, tau= .489), P (Axis 1: r = -.211, tau= -.181; Axis 2: r = .157, tau= .135); K (Axis 1: r = -.211, tau= - .181; Axis 2: r = .157, tau= .135).

Although mineral fertilization is applied in different time per years it seems that all treatments compared with the control are statistically ensured and also different (*tab. 2*). Between control (T1) and mulching once per year (T2) or twice per year (T3) there is no statistically difference so therefore, we observed that mulching, should be an acceptable solution for grasslands, because could prevent the return of woody species (Gaisler *et al*, 2004). The differences between treatments are recorded between variants mulching once per year + N25P25K25 applied annually (T4) compared with treatment without nitrogen T6 (mulching once per year + P25K25 applied annually) and T7 (mulching once per year +P25K25 applied once in two years) where $p<0.05$ and A= 0.154, respectively A=0.151. Like we expected, the treatments T6 and T7 are the one with whom all other treatments are different so nitrogen is the main element that affect grasslands productivity and species diversity (Pavlů *et. al*, 2012).

Table 1

Investigated treatments

Treatments	Applied treatments
T1	Mowing once per year in July, unfertilized
T2	Mulching once per year in July
T3	Mulching twice per year in July
T4	Mulching once per year + N25P25K25 applied annually
T5	Mulching once per year + N25P25K25 applied once in two years
T6	Mulching once per year +P25K25 applied annually
T7	Mulching once per year +P25K25 applied once in two years

Table 2

Floristic composition comparisons between experimental treatments (mulching + organic fertilizer) with MRPP (T -T test, A - homogeneous group, p - statistical significance)

Pairwise comparation	T	A	p	Significace	Pairwise comparation	T	A	p	Significace
T1 vs. T2	-0.996	0.036	0.150	ns	T3 vs. T4	-0.203	0.008	0.312	ns
T1 vs. T3	-0.927	0.028	0.160	ns	T3 vs. T5	-0.272	0.008	0.355	ns
T1 vs. T4	-3.084	0.110	0.008	**	T3 vs. T6	-1.770	0.052	0.060	ns
T1 vs. T5	-2.733	0.074	0.009	**	T3 vs. T7	-1.939	0.063	0.047	*
T1 vs. T6	-2.979	0.091	0.010	*	T4 vs. T5	-1.571	0.053	0.072	ns
T1 vs. T7	-3.338	0.109	0.005	*	T4 vs. T6	-3.587	0.154	0.005	**
T2 vs. T3	0.307	-0.012	0.513	ns	T4 vs. T7	-3.531	0.151	0.004	**
T2 vs. T4	-0.511	0.023	0.225	ns	T5 vs. T6	-4.056	0.135	0.003	**
T2 vs. T5	-0.510	0.016	0.272	ns	T5 vs. T7	-3.168	0.101	0.004	**
T2 vs. T6	-1.897	0.069	0.052	ns	T6 vs. T7	-3.018	0.118	0.013	*
T2 vs. T7	-2.040	0.071	0.036	ns					

(* = p <0.05, ** = p <0.01, ns - not significant)

Taking in consideration the Shannon diversity Index (H) the highest value, 2.73, is recorded in T7 (mulching once per year +P25K25 applied once in two years) with 0.03 percentage more than is in recorded in control treatment (*tab. 3*). With a value below average are treatments T2 and T4, broadly, species richness is expected to decrease as land-use intensification increases (Flynn *et al*, 2009).

Regarding number of species we can observe that after 6 years from 30.4 species, in T1, arrive at 26.2 at T2 (mulching once per year) and T5 (mulching once per year + N25P25K25 applied once in two years). A similar result obtains Pavlů *et al*, (2011) when show that the total number of plant species regardless of cover was higher in the cut treatment after the first four years of the study.

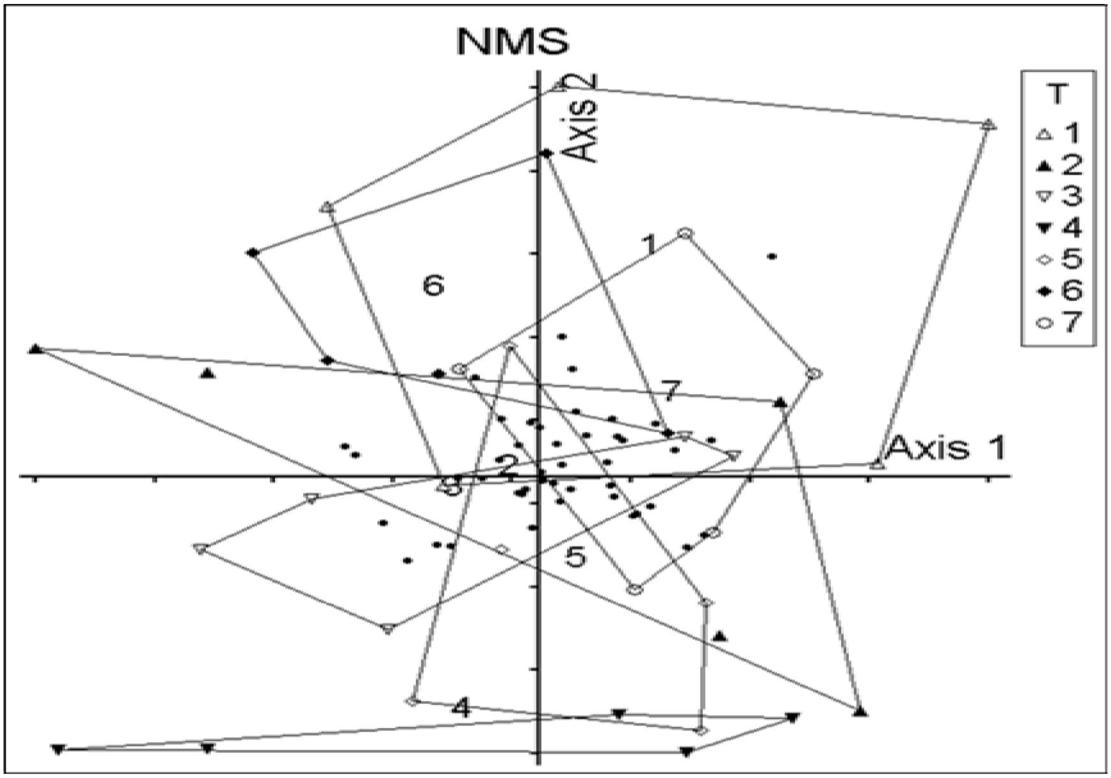

Figure 1 **Ordination diagram from non-metric multidimensional scaling (NMS**). The composition dataset was based on cover values per plot by species. Bray-Curtis distance was used for the ordination. We choose axes 1 with 2 for the presentation of the results. Symbols represent individual plots coded by vegetation type that are further delimited with polygons. The T means treatments and the points are species from each treatments. The arrows represent the explanatory variables fitted onto the ordination. Polygons delimit the treatment types (please see table 1)

Table 3

Data Summarization Analysis

Treatments	Mean	Stand.Dev.	Sum	Maximum	S	E	H	D`
T1	1.92	3.76	84.3	20.2	30.4	0.79	2.70	0.89
T2	1.78	3.79	78.2	21	26.2	0.79	2.58	0.88
T3	1.87	3.98	82.2	24.4	27.8	0.80	2.66	0.88
T4	1.72	4.30	75.8	26.8	27	0.75	2.45	0.84
T5	1.73	3.41	75.9	21.2	26.2	0.84	2.72	0.89
T6	1.97	3.64	86.52	19.5	27.6	0.82	2.72	0.90
T7	1.85	3.54	81.5	20.2	27.4	0.82	2.73	0.90
AV	0.83	3.77	80.63	21.9	27.5	0.80	2.65	0.88

T=Treatments
S= Richness =number of non-zero elements in row; E= Evenness = H/ln (Richness)
H= Diversity = - sum (Pi*ln Pi) = Shannon's diversity index
D= Simpson's diversity index for infinite population = 1-sum (Pi*Pi), where Pi=importance probability in element, i (element i relativized by row total)
AV = Average

The main practical message of the study is that some types of mountain grasslands can be left unmanaged for several years without substantial changes in plant species composition and, that such lack of management is not detrimental to the preservation of the target vegetation (Pavlů *et al*., 2011).

The positive effect of fertiliser on plant species richness in the PK treatment could be explained by the "hump-back" model of Grime (2001), in the case of grassland with low-fertility, an enhancement in nutrient availability can increase species richness (Pavlů *et al.*, 2012), even so, the authors suggest that moderate application of NPK does not generate irreversible structural and compositional changes in upland *Festuca rubra* L. grassland.

CONCLUSIONS

In the future, when in mountains it is noticed a massive depopulation will be able to use these possibilities: mulching and low mineral fertilization to keep phytodiversity of grasslands.

This study covers the common oligotrophic grassland types from Apuseni (East Carpathians) but will be necessary to provide specific lists for different areas.

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