Mineral fertilization on mountain grassland

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Abstract

As seen in other studies conducted over time, mineral fertilization provides an opportunity to improve grassland productivity and fodder quality. The aim of our research is to follow the effect of large amounts of mineral fertilizers on mountain grassland systems (for conditions specific to Apuseni Mountains, Romania) as well as to evaluate if increasing the quantity and quality of sward fodder value is applicable for the highly diverse grassland specific to Apuseni Mountains. The findings come from an experiment with 4 treatments (T1 = control (unfertilized), T2 = $N_{50}P_{25}K_{25}$, T3 = $N_{100}P_{50}K_{50}$, and T4 = $N_{150}P_{75}K_{75}$). Mineral fertilization is directly proportional to dry matter (DM) harvested, which reaches up to 5.38 Mg ha^{-1} DM. As a result, radical floristic changes occurred, *Festuca rubra* L. grassland type evolved into a *Festuca rubra* L. – *Trisetum flavescens* L. grassland, then into *Agrostis capillaris* L. – *Trisetum flavescens* L. grassland and then into one of *Agrostis capillaris* L. grassland type. The high inputs did not result in significant yield increases, but led to the disappearance of *Festuca rubra* L. grassland type and hence its specific diversity. Some nitrophilic species were better installed compared to oligomesotrophic species or oligotrophic species.

Keywords: mineral fertilization, mountains, grasslands, diversity

Introduction

N-fertilization is decreasing in North-West Europe grassland farming, mainly due to legal restrictions (EU directive 91/676/EEC) (Cougnon *et al.*, 2014). Research has shown that applying fertilizers on grasslands is economically justified since, generally, 1 kg of active element results in an increase of 80-100 kg of green matter (Coman and Moisuc, 2011). This economic productivity is also strengthened by the fact that 1 Mg ha^{-1} of dry matter can extract 20-21 kg of N, 6-8 kg of P, 20-21 kg of K and 10-14 kg of Ca. The aim of our research is to follow the effect of an intensified management with large quantities of mineral fertilizer on mountain grasslands (Apuseni Mountains, Romania) and to evaluate if this method of increasing the quantity and quality of sward fodder value is suitable for grassland phytodiversity in the Apuseni Mountains.

Materials and methods

The experimental variants designed to follow the effect of small and large inputs of mineral fertilizer on grassland productivity and floristic composition were installed in 2001, in the Apuseni Mountains, Romania. The experimental design was made according to the randomized block method in four replications (blocks), with 4 treatments: T1=control (unfertilized), T2 = $N_{50}P_{25}K_{25}$, T3 = $N_{100}P_{50}K_{50}$, and T4 = $N_{150}P_{75}K_{75}$, which included 1 cut per year at the end of July. The experimental site is located on an altitude of 1130 m.a.s.l. and characterized by an annual average temperature of 5.2 °C and annual precipitation of 1123 mm. Floristic composition was determined after the Bran-Blanquet method modified by Păcurar and Rotar (2014). Floristic data processing was performed with PC-ORD, version 6, which uses multivariate analysis of the ecological data entered into the spreadsheet (McCune and Grace, 2011). For data interpretation we used Principal Coordinates Analysis. In PCoA one can use any square symmetrical distance matrix, including semi-metrics such as Sorensen distance, as well as metric distance measures such as Euclidean distance (Peck, 2010). Production and quality data were analysed with Boxplots which provide simple graphical representation of the central tendencies of spread in variables with Tukey HSD Test. Sward fodder value was calculated based on species quality score on a scale from 1 (poor-) to 9 (excellent), after Dierschke and Briemle (2002), as modified by Păcurar and Rotar (2014). Sward fodder value was performed on a scale from 1 (poor sward quality dominated by toxic species) to 9 (excellent) after Păcurar and Rotar (2014).

Results and discussion

Treatments with mineral fertilizers caused linear increases in yields (statistically assured), from 2.2 Mg ha^{-1} DM (T1) to 5.3 Mg ha^{-1} DM (T4, Figure 1). The sward quality of T3 has a general tendency to increase which is proportional to the grassland intensification. On T2 we recorded 3.58 Mg ha^{-1} and on T3 4.49 Mg ha^{-1}. The highest quality was observed in T2, followed by T4 and then T3. Floristic composition of *Festuca rubra* L. grassland is modified under the influence of mineral fertilization (Figure 2). Under the influence of mineral fertilizer, *Festuca rubra* L. grassland evolved to a *Festuca rubra* L. – *Trisetum flavescens* L. grassland (T2) and further to an *Agrostis capillaris* L.-*Trisetum flavescens* L. grassland (T3) and an *Agrostis capillaris* L. grassland (T4, when $N_{150}P_{75}K_{75}$ were applied). T1 and T2 favoured a wide diversity with oligotrophic and oligo-mesotrophic species and with a large contribution of Fabaceae species. The other two treatments (T3 and T4) favour a stronger increased contribution of

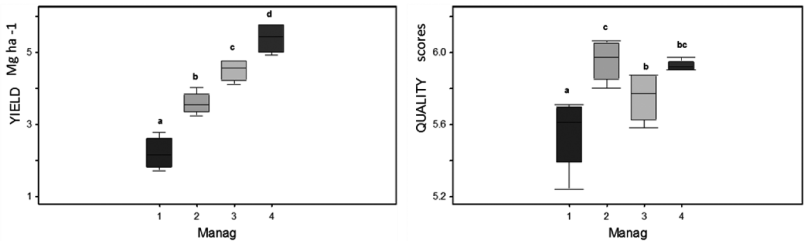

Figure 1. The effect of mineral intensification upon DM and quality on *Festuca rubra* L. grassland type.
Legend: Manag= management; Yield =Mg ha^{-1}; 1=control, T2= 50 kg ha^{-1} N; 25 kg ha^{-1} P; 25 kg ha^{-1} K, T3=100 kg ha^{-1} N; 50 kg ha^{-1} P; 50 kg ha^{-1} K; T4= 150 kg ha^{-1} N; 75 kg ha^{-1} P; 75 kg ha^{-1} K.

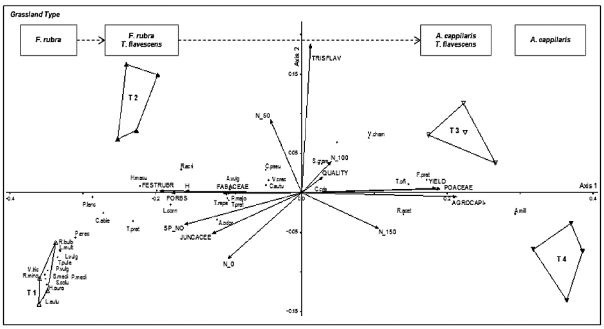

Figure 2 Botanical composition changes under the influence of mineral fertilization
Legend: T=treatments; Amill = *Achillea millefolium* L., Agrocapi= *Agrostis capillaris* L.; Avulg= *Alchemilla vulgaris* L.; Anthodor= *Anthoxanthum odoratum* L.; Bmedi = *Briza media* L.; Cabie= *Campanula abietina* Griseb.;Centpseu = *Centaurea pseudophrygia* C. A. Mey., Cautu = *Colchicum autumnale* L., Ceris = *Cirsium erisithales* Jacq.; Festprat = *Festuca pratensis* L., Festrbr= *Festuca rubra* L.; Haura = *Hieracium aurantiacum* L., Hmacu= *Hypericum maculatum* Crantz; Lautu =*Leontodon autumnalis* L., Lvulg =*Leucanthemum vulgare* Lam., Lcorn = *Lotus corniculatus* L., Lmult = *Luzula multiflora* Ehrh.; Pimpmajo = *Pimpinella major* L., Planc = *Plantago lanceolata* L., Pmedi = *Plantago media* L.; Pvulg = *Prunella vulgaris* L., Racri = *Ranunculus acris* L.; Rbulb = *Ranunculus bulbosus* L.; Rmino = *Rhinanthus minor* L.; Racet = *Rumex acetosa* L.; Sgram = *Stellaria graminea* L.; Scolu = *Scabiosa columbaria* L., Toffi = *Taraxacum officinale* Weber ex F.H.Wigg.; Tpule = *Thymus pulegiodes* L.; Tprat = *Tragopogon pratensis* L., Tprat = *Trifolium pratense* L., Trepe = *Trifolium repens* L., Trisflav= *Trisetum flavescens* L.; Vcham = *Veronica chamaedrys* L.; Vcrac= *Vicia cracca* L.; Vtric = *Viola tricolor*)

Poaceae and reduced Fabaceae species. Due to the decline of phyto-diversity, *Agrostis capillaris* L species became dominant. The presence of Fabaceae species and also the presence of *Trisetum flavescens* L. ensure a high quality on T2. In the T3 treatment, the presence of *Trisetum flavescens* L. and *Agrostis capillaris* L. determined the sward fodder value score, while in T4 the sward fodder value score is almost exclusively due to *Agrostis capillaris* L.

Conclusion

The results showed that increasing dry matter yield (DM) does not necessarily mean a corresponding increase in sward fodder value quality. Small amounts of fertilizers can sometimes cause a large increase in quality as a result of the installation of mesotrophic species and a favourable substrate for Fabaceae. For the specific conditions of the Apuseni Mountains, for the *Festuca rubra* L. grassland type we recommend treatments T2 or T3 or a solution found between their boundaries.

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