Organic fertilization on mountain grassland

Pleșa A., Rotar I., Păcurar F., Vidican R., Balázsi A. and Stoian V.
University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Mănăștur Street no. 3-5, 400372 Cluj-Napoca, Romania; fpacurar@gmail.com

Abstract

Semi-natural grassland in the Central area of Apuseni Mountains, Romania is fertilized only with organic fertilizers. Manure from cows and horses is applied in quantities of 6 to 10 Mg ha^{-1}. There has been a recent tendency for intensification of grassland close to human settlements and a decline or even abandonment of that located further away. An experiment with four variants was established in order to follow the effect of enhanced inputs of manure on *Festuca rubra* L. grassland, in terms of productivity, quality and biodiversity, as well as to recommend the optimum quantity of fertilizer. Production increased with increasing amounts of manure, but the quality of fodder did not show the same trend. The cover of *Centaurea phrygia* C. A. Mey and *Pimpinella major* L. increased in the treatments with large amounts of manure and these species contributed to significant reductions in fodder quality.

Keywords: organic, mountains, biodiversity, fertilization

Introduction

Manures, as complex fertilizers, have an ameliorative effect on the physical, chemical and biological properties of soil, and their use causes significant increases in crop production (Rotar and Carlier, 2010). Increased production from permanent grasslands can be achieved by applying the most favourable dose of organic fertilizer (Vîntu *et al.*, 2010). Manure has been shown to improve the growth of a number of species, especially those from the forbs category, because of the pool of seeds contained by it (Samuil *et al.*, 2013). The aim of our study is to follow the effect of intensified treatments with organic fertilizer on *Festuca rubra* L. grassland on grassland productivity, quality and species richness and to recommend the optimum dose of organic fertilizer.

Materials and methods

Experimental variants were installed in 2001 and were designed to follow the effect of small and large inputs of manure on grassland productivity and floristic composition. The experimental design was a randomized block method with 4 treatments, in four replications: T1 – unfertilized, T2 – 10 Mg ha^{-1} manure, T3 – 20 Mg ha^{-1} manure, T4 – 30 Mg ha^{-1} manure. The manure contains 3.04 kg Mg^{-1} N, 2.90 kg Mg^{-1} P and 2.47 kg Mg^{-1} K, and was cut once a year. The harvesting period was chosen according to the particular site conditions, located on an altitude of 1,130 m.a.s.l. and characterized by an annual average temperature of 5.2 °C and annual precipitation of 1,123 mm. The floristic composition was determined by the Braun-Blanquet method as modified by Păcurar and Rotar (2014). Floristic data processing was performed with PC-ORD, version 6, which uses the multivariate analysis of the botanical data (McCune and Grace, 2011). For data processing and interpretation we used multidimensional scaling (NMS), which is well suited to data coordination that are not normal or discontinuous (Peck, 2010). Production and quality data, analysed with Boxplots, provides 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

The intensification of *Festuca rubra* L. grassland management by applying organic fertilizers resulted in an increased dry matter yield (DM, Figure 1). Yield increased asymptotically with fertilizer rate especially when 30 Mg ha^{-1} organic manure was applied (from 1.8 Mg ha^{-1} DM up to 3.5 Mg ha^{-1} DM). The treatment with 20 Mg ha^{-1} organic manure did not show significant differences relative to the unfertilized, while the treatment with 30 Mg ha^{-1} organic manure increased yield by 1 Mg ha^{-1} DM relative to treatment T2 and by 2.7 Mg ha^{-1} DM relative to the unfertilized (T1). The fodder sward value quality has an increasing trend in T2 and T3 compared to T1, but no statistical significance was detected. Treatment T4 caused a significant reduction of fodder sward value quality compared to all treatments. This phenomenon is related to treatment effects on floristic composition.

Under the influence of manure, *Festuca rubra* L. grassland evolved to a *Festuca rubra* L. –*Agrostis capillaris* L. grassland (T2) and further in *Trisetum flavescens* L. grassland (T3, T4, Figure 2). T1 and T2 in the first type of grassland provided a quite high harvest with high quality fodder sward value and a high phytodiversity. These treatments (T1 and T2) favoured Juncaceous species and more oligotrophic species (*Hieracium aurantiacum* L.; *Potentilla erecta* L.) as well as oligo-mesotrophic species (*Agrostis capillaris* L.; *Leucanthemum vulgare* Lam.). T3 and T4 favoured the occurrence of mesotrophic species (*Trifolium pratense* L.; *Trisetum flavescens* L.) as well as *Fabaceae* species. However, the presence of *Fabaceae* did not result in increased in fodder quality, as usually happens when *Fabaceae* species are present. This

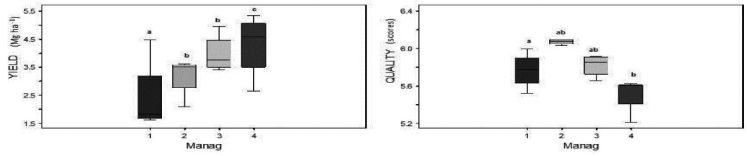

Figure 1. The effect of manuring on DM yield and herbage quality of *Festuca rubra* L. grassland. T1 = unfertilized; T2 = 10 Mg ha^{-1} manure; T3 = 20 Mg ha^{-1} manure; T4 = 30 Mg ha^{-1} manure.

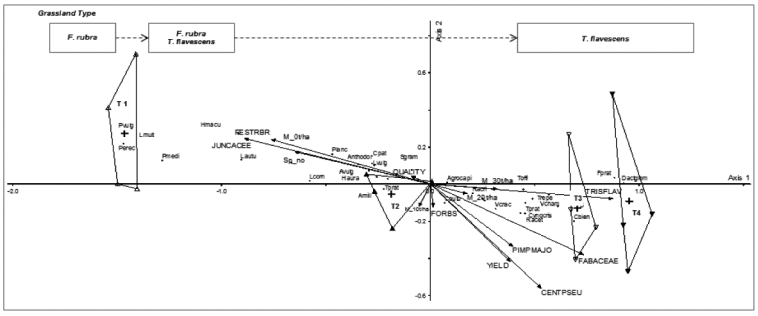

Figure 2. Botanical composition changes under the influence of manure.
Legend: M_oMg ha-^{1} = unfertilized; Sp_no = species number; Amill = *Achillea millefolium* L.; Agrocapi = *Agrostis capillaris* L.; Avulg = *Alchemilla vulgaris* L.; Anthodor = *Anthoxanthum odoratum* L.; Cpat = *Campanula patula* L.; Centpseu = *Centaurea pseudophrygia* C. A. Mey.; Cautu = *Colchicum autumnale* L.; Cbien = *Crepis biennis* L.; Cynocris = *Cynosurus cristatus* L.; Dactglom = *Dactylis glomerata* L.; 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.; Perec = *Potentilla erecta* L.; Pvulg = *Prunella vulgaris* L.; Racri = *Ranunculus acris* L.; Racet = *Rumex acetosa* L.; Sgram = *Stellaria graminea* L.; Taraoffi = *Taraxacum officinale* Weber ex F.H. Wigg.; Tprat = *Tragopogon pratensis* L.; Tprat = *Trifolium pratense* L.; Trepe = *Trifolium repens* L.; Trisflav= *Trisetum flavescens* L.; Vcham = *Veronica chamaedrys* L.; Vcrac = *Vicia cracca* L.); T1-T4 refers to treatments, Quality = refers to fodder sward value quality.

could be explained by the low proportion in the sward of red and white clover. The strong increase in the proportion of *Centaurea pseudophrygia* C. A. Mey and *Pimpinella major* L. had a negative effect on sward fodder value.

Conclusions

The intensification of *Festuca rubra* L. grassland management is justified in the Apuseni Mountains up to application levels of 10 Mg ha^{-1} manure. This treatment leads to an increase in sward quality and also to a wide phytodiversity of the grassland. The intensification with higher quantities of manure is not justified since they lead to higher yields of herbage of lower sward fodder value.

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