Contribution of mountain pastures to agriculture and environment

Proceeding of the 16th Meeting of the FAO CIHEAM Mountain Pastures Network

25–27 May 2011, Kraków, POLAND

Edited by

Agroscope Changins-Wädenswil Research Station ACW, Switzerland
Institute of Technology and Life Sciences ITP, Poland

Falenty – Kraków 2011

Organizing Committee

Local. Halina Jankowska-Huflejt (Coordinator), Barbara Wróbel, Jerzy Barszczewski, Antoni Kuźniar and Stanisław Twardy, Institute of Technology and Life Sciences ITP, Poland

International. Alain Peeters (FAO-CIHEAM Pasture and Fodder Crops Research Network)
Eric Mosimann (FAO-CIHEAM Mountain Pastures Sub-Network)

Scientific Committee

René Baumont (France), Isabel Cassasus (Spain), Halina Jankowska-Huflejt (Poland), Bernard Jeangros (Switzerland), Ryszard Kostuch (Poland), Florian Leiber (Switzerland), Giampiero Lombardi (Italy), Marco Meisser (Switzerland), Paride d'Ottavio (Italy), Giuseppe Parente (Italy), Alain Peeters (Belgium), Veronica Serateanu (Romania), Maria Sitzia (Italy), Maya Stoykova (Bulgaria), Stanislaw Twardy (Poland) and Maria Yiakoulaki (Greece)

Scientific Secretary

Eric Mosimann (Agroscope Changins-Wädenswil Research Station ACW, Switzerland)

With support of the following organizations

Food and Agriculture Organization
of United Nations (FAO)

Institute of Technology and Life Sciences
www.itep.edu.pl
Departement of Grasslands Falenty
Małopolski Research Centre Kraków

Association of Water and Land Reclamation
Engineers and Technicians
Main Sections of Grasslands and Peatlands (SITWM)

Patronage

Ministry of Agriculture and Rural Development
(MRiRW)

ISBN 978-83-62416-16-5

Address of Editorial Office: Falenty, al. Hrabska 3, 05-090 Raszyn
tel. (22) 72-00-598, e-mail wydawnictwo@itep.edu.pl; www.itep.edu.pl

Print: OWP "SIM", Warsaw

Organic farming in northeast of Portugal: effects of soil fertility management on DM yield and nutrients composition of pastures

Fernández-Núñez E.[1], *Cuiña-Cotarelo R.*[2], *Mosquera-Losada M.R.*[2], *Rigueiro-Rodríguez A.*[2], *Rodrigues M.A.*[1], *Arrobas M.*[1], *Pires J.M.*[1], *Aguiar C.*[1], *Moreira N.*[3]

[1]Moutain Research Centre (CIMO), IPB, 5300 Bragança, Portugal.
[2]Crop Production Department. High Politechnic School. University of Santiago de Compostela. 27002. Lugo. Spain.
[3]Department of Agronomy, Universidade de Trás-os-Montes e Alto Douro, 5000 Vila Real, Portugal
E-mail: esther.fernandez@ipb.pt

Abstract

The aim of this work was to evaluate the effect of six types of soil fertility management: no fertiliser (NF), lime inputs (Ca), mineral fertilisation combined with liming (CaP (lime and phosphorous), CaPB (lime, phosphorous and boron), manure (M), and manure+lime+mineral fertilisation (MCaPB), and two types of pasture (unsown and sown) on DM yield, botanical composition and nutrients content of pasture during two years of study. DM yield was significantly increased when plots were fertilised with manure (M and MCaPB), which also improved the proportion of legumes, mainly in the sown pasture.

Keywords: pasture, organic and mineral fertilisation, grasses, legumes

Introduction

The use of lime and fertilisers is one of the more extensively used agronomic practices to increase pasture productivity and to improve its nutritive value (Martiniello and Berardo, 2007). Both, lime and fertilisation introduce changes in the soil properties (pH, organic matter, available nutrients) that usually cause changes of pasture composition in a short period of time. The aim of this experiment was to study the effect of organic lime and manure fertilisation, combined or not with mineral fertilisation on DM yield, botanical composition and nutrients content.

Material and methods

The experiment was carried out in Vila Meã, (NE Portugal; 860 m a.s.l.) on an acidic soil with an initial soil water pH around 4.5 (1:2.5). The experimental design was a hierarchical split-plot, where pasture type was the main plot and the soil fertility management treatments were the sub-plots. Two types of pasture were studied: spontaneous vegetation (unsown), and sown pasture (sown) with a mixture (kg ha^{-1}): *Trifolium subterraneum* (2.6), *Trifolium vesiculosum* (1.3); *Trifolium michelianum* (0.6), *Trifolium incarnatum* (1.3), *Ornithopus sativus* (1.3); *Ornithopus compressus* (0.6); *Trifolium resupinatum* (0.6), *Biserrula pelecinus* (0.6)), *Trifolium repens* (0.6), *Trifolium fragiferum* (0.3), *Lolium perenne* (3.8), *Lolium multiflorum* (2.5), *Dactylis glomerata* (0.4), *Ph. Aquatica* (0.6), and *Cichorium intybus* (0.6). Soil fertility management treatments included: no fertiliser (NF), lime inputs (Ca), mineral fertilisation combined with liming (CaP (lime and phosphorous (P)), CaPB (lime, phosphorous and boron (B)), manure (M), and manure+lime+mineral fertilisation (MCaPB). Manure and lime treatments implied inputs of 30 and 1.5 Mg ha^{-1}, respectively. The inputs of phosphorous (P_2O_5; rock phosphate 26%) and boron (B; borax 15.2%) were of 100 and 1 kg ha^{-1}, respectively. Finally, a control treatment without inputs was established (NF). In spring 2005 and 2007, three pasture samples were harvested inside exclosure cages on an area of 0.25 m^2 within each sub-plot. In spring 2006, no grazing was allowed in order to favour natural reseeding in sown and unsown pastures. The species were hand separated to determine botanical composition (grasses + other species (G+Ot) and legumes (Leg)). The samples were dried to constant weight (at 60 °C for 48 h) in order to determine dry matter content and pasture production and to perform chemical analyses. Total N and P were determined after a microKjeldahl digestion by colorimetry using TRAACS 800+ (Castro et al.,1990) and total Ca, Na, K and Mg were analysed with a VARIAN 220FS spectrophotometer using atomic absorption (VARIAN, 1989). Results were analysed by principal component analysis (PCA) based on a correlation matrix for the dependent variables, followed by ANOVA(s) on the PCA scores and original variables and mean separation (Tukey's HSD test).

Results and Discussion

PCA was significant (P <0.000 – Bartlett's test of sphericity) in the explanation of dependent variables G+Ot and Leg, DM yield and nutrients composition of pastures (Figure 1). The first three PCA-axes explained 73% of the variation and were significantly influenced by pasture type and soil management treatment (P<0.05 – ANOVA(s) on the PCA scores). PCA1 was positively related to legumes percentage (Leg), DM yield and N, Ca and Mg levels, and negatively to G+Ot percentage, and CaPB soil fertility management treatments. PCA2 showed a positive relation with K, P and Mg levels, and negative with MCaPB treatment. Finally, PCA-3 was positively related to Na pasture levels and lime inputs (Ca), and negatively to M and MCaPB treatments and P pasture levels.

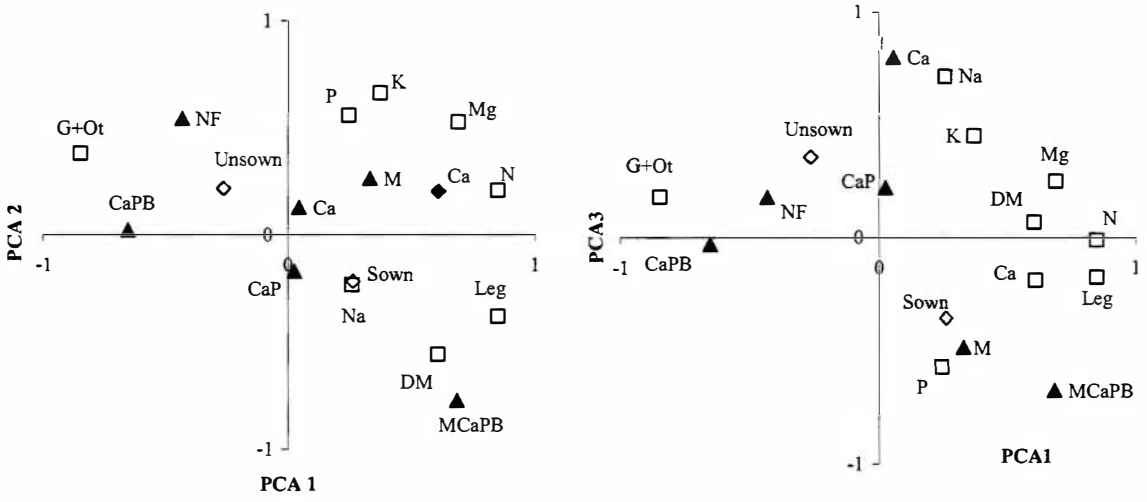

Figure 1. Loadings and scores of the first three PCAs, where: □: loadings of dependent variables (G+Ot: percentage of grasses and other species; Leg: percentage of legumes; DM: DM yield; nutrients levels: N, P, Ca, Na, K, and Mg).◊: scores for pasture type (unsown and sown); ▲: scores for soil fertility management treatments (no fertiliser (NF), lime (Ca), manure (M), lime+phosphorous (CaP), lime+phosphorous+boron (CaPB), and manure+lime+mineral fertiliser (MCaPB)).

DM yield increased significantly during the second year (68% more in 2007 as compared to 2005) and on sown plots (24%) compared to unsown plots (p<0.001). It is known that grasses respond strongly to farmyard manure application and quickly invades areas with animal manure. However, when manure+lime+mineral fertilisation (MCaPB) was applied we observed a significant increase of DM yield and of the percentage of legumes (Figure 2). The same response was observed in 2007 when lime (Ca) or lime+phosphorous (CaP) were applied on sown plots. Brau-Nogue (1996) found that lime inputs quickly increases soil pH and soil nutrient availability, favouring a higher proportion of legumes (Spiegelberger *et al.* 2010) whose growth can be also enhanced by soil P fertilisation (Snyman, 2002).

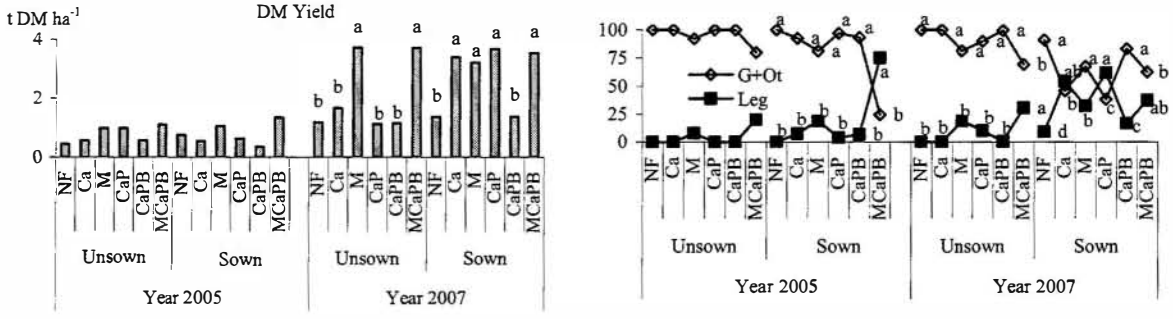

Figure 2. DM yield (t DM ha^{-1}), percentage of grasses + other species (G+Ot) and legumes (Leg) in the two years of study (2005 and 2007), on the two types of pasture (unsown and sown) and in the six soil fertility management treatments. Different letters indicate significant differences between soil fertility management treatments in the same pasture type and in the same year (p<0.01).

The N, Mg and Ca content of the pasture tended to be higher in the MCaPB treatment (Table 1). This effect can be explained by the higher percentage of legumes, species that have higher concentrations of these nutrients than grasses (Thompson and Troeh, 1988). The percentage of P increased significantly in the treatments with manure (M and MCaPB) during the first year. Zhao *et al.* (2009) found that farmyard manure combined with mineral fertiliser increases soil available P compared to mineral fertiliser alone. Higher K content was obtained in Ca treatment compared to M, CaPB and MCaPB treatments. Finally, the levels of Na tended to be higher in the Ca treatment of unsown pasture. The obtained percentages of N, P, K, and Ca overcame cattle maintenance requirements; while those of Na and Mg were lower (NRC, 2000).

Table 1. Minerals contents for the two types of pasture (unsown and sown), and in the six soil fertility managements in the two years of the study (2005 and 2007). Different letters indicate significant differences between soil fertility management treatments in the same pasture type and in the same year ($p<0.01$).

		Unsown						Sown					
		NF	**Ca**	**M**	**CaP**	**CaPB**	**MCaPB**	**NF**	**Ca**	**M**	**CaP**	**CaPB**	**MCaPB**
Year 2005	% N	1.04	1.13	1.09	1.00	1.20	1.29	1.03	1.11	1.21	1.13	0.98	1.68
	% P	0.12 **b**	0.13 **b**	0.27 **a**	0.14 **b**	0.14 **b**	0.22 **a**	0.24	0.20	0.25	0.19	0.20	0.23
	% K	1.38	1.34	1.14	1.06	1.15	1.19	0.96	0.81	1.16	0.68	0.72	0.91
	% Na	0.03	0.05	0.01	0.02	0.02	0.01	0.02	0.02	0.00	0.04	0.03	0.04
	% Mg	0.17	0.09	0.14	0.12	0.12	0.15	0.08	0.07	0.11	0.05	0.13	0.17
	% Ca	0.32	0.25	0.49	0.43	0.33	0.55	0.68	0.26	0.62	0.23	0.11	0.54
Year 2007	% N	0.86	0.87	1.28	1.06	1.03	1.20	1.33	1.62	1.19	1.59	1.07	1.09
	% P	0.17	0.16	0.17	0.20	0.18	0.15	0.17	0.16	0.17	0.16	0.19	0.14
	% K	0.93	0.95	1.00	1.09	1.15	0.65	1.08 **ab**	1.56 **a**	0.89 **b**	1.18 **ab**	0.82 **b**	0.68 **b**
	% Na	0.02	0.07	0.04	0.03	0.04	0.03	0.03	0.04	0.04	0.06	0.02	0.03
	% Mg	0.11	0.14	0.09	0.18	0.13	0.14	0.16	0.16	0.13	0.07	0.09	0.08
	% Ca	0.27	0.44	0.80	0.66	0.52	0.49	0.66	0.67	0.39	0.45	0.28	0.67

Conclusions

Treatments with manure (M) or manure combined with lime and mineral fertilisation (MCaPB) showed the highest DM yields and legume percentage, mainly in sown pasture. Beyond the significant effect of manure+lime+mineral fertilisation (MCaPB) on DM yield and legume percentage, this treatment tended to have also higher N, P, Ca and Mg pasture levels.

References

BRAU-NOGUE C. 1996. Dynamique des pelouses d'alpages laitiers des Alpes du Nord externes. Département de Biologie, Joseph Fourier, Grenoble, France.

CASTRO M.P., GONZÁLEZ A., PRADA D. 1990. Determinación simultánea de nitrógeno en muestras de pradera. XXX Reunión Científica de la Sociedad Española para el Estudio de los Pastos, 200–207.

MARTINIELLO P., BERARDO N. 2007. Residual fertiliser effects on dry-matter yield and nutritive value of Mediterranean pastures. Grass and Forage Science, 62(1): 87–99.

NRC. 2000 Nutrients requeriments of diary cattle. Seventh Revised Edition, 1996. Ed. Nacional Academy of Science Nacional Research Council, 234.

SNYMAN H.A. 2002. Short-term response of rangeland botanical composition and productivity to fertilisation (N and P) in a semi-arid climate of South Africa. J. Arid Environ. 50, 167–183.

SPIEGELBERGER T., DELÉGLISE C., DEDANIELI S., CLAUDE BERNARD-BRUNET C. 2010. Resilience of acid subalpine grassland to short-term liming and fertilisation. Agriculture, Ecosystems and Environment 137: 158–162.

THOMPSON LM, TROEH F.R. 1988. Soils and fertility. McGraw-Hill, New York, USA pp.635

ZHAO Y., WANG P., LI J., CHEN Y., YING X., LIU S. 2009. The effect of two organic manures on soil properties and crop yields on a temperate calcareous soil under a wheat-maize cropping system. European Journal of Agronomy, 31: 36–42.