Restoration of grasslands on cleared holm oak forest in the Montseny Biosphere Reserve (NE Spain)

Madruga-Andreu C., Bartolomé J., Plaixats J.

in

Porqueddu C. (ed.), Ríos S. (ed.).
The contributions of grasslands to the conservation of Mediterranean biodiversity

Zaragoza : CIHEAM / CIBIO / FAO / SEEP
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 92

2010
pages 261-264

Restoration of grasslands on cleared holm oak forest in the Montseny Biosphere Reserve (NE Spain)

C. Madruga-Andreu, J. Bartolomé and J. Plaixats

Grup de Recerca en Remugants (G2R), Departament de Ciència Animal i dels Aliments,
Universitat Autònoma de Barcelona, Campus UAB, 08193 Bellaterra (Cerdanyola del Vallès) (Spain)
e-mail: mariacristina.madruga@uab.cat

Abstract. The actual changes in land use and management in Mediterranean grasslands have led to extensive revegetation with significant spread of shrubs and forests. This process causes landscape homogenization, biodiversity reduction and an increase in fire risk. Nowadays, the Montseny Natural Park management is working in the restoration and conservation of grazing areas. In 2008 a field experiment was conducted to investigate the establishment of grassland in a young cleared holm oak forest. The restoration treatments included the effect of post-clearing techniques (partial raking or grinding of mulch) and of sowing a commercial seed mixture. The influence of grazing by goats and sheep on each treatment was also evaluated. After the first year of the experiment, herbaceous cover, height, density and diversity indices (species richness, Shannon-Weaver) were measured to determine herbaceous plant establishment and development. Sown plots showed the highest herbaceous cover and density, followed by mulch raked plots that showed higher values than mulch grinded and control plots. However, sown plots presented the lowest values of Shannon-Weaver diversity index. Short-term results showed that post-clearing actions, such as sowing and/or mulch treatments (raking or grinding), could influence the development of the herbaceous layer, but there was no effect of animal grazing in terms of coverage and diversity.

Keywords. Grassland recovery – Biodiversity – Scrubs – Grazing.

Restauration de pâtures dans une forêt éclaircie de chêne vert dans la Réserve de Biosphère de Montseny (NE de l'Espagne)

Résumé. *Les changements actuels d'utilisation des terres et de gestion des parcours méditerranéens ont conduit à la revégétation avec un accroissement significatif du nombre de buissons et de forêts, entraînant une homogénéisation du paysage, une réduction de la biodiversité et une augmentation du risque d'incendie. Aujourd'hui, la gestion du Parc Naturel de Montseny travaille sur la restauration et la conservation des zones de pâturage. En 2008, une expérience de terrain a été réalisée afin d'étudier la restauration des parcours à partir d'une jeune forêt de chênes verts éclaircie. La phase de restauration a inclus les effets post-éclaircissement (débris végétaux partiellement ratissés ou broyés) et le semis d'un mélange de graines commerciales. L'influence du pâturage des chèvres et des moutons dans chaque traitement a également été évaluée. Après la première année de mise en œuvre, la couverture herbacée, sa hauteur, sa densité et les indices de diversité (richesse des espèces, Shannon-Weaver) ont été mesurés afin de déterminer l'établissement et le développement des plantes herbacées. Les parcelles de semis ont montré les plus hautes et denses couvertures herbacées. En second, les parcelles de débris végétaux partiellement ratissés ont montré des valeurs supérieures à celles des parcelles de débris végétaux broyés et parcelles témoins. Toutefois, les parcelles ensemencées ont présenté les valeurs les plus faibles pour l'indice de diversité de Shannon-Weaver. Ces résultats à court terme ont montré que les actions de post-éclaircissement, telles que les semis et/ou le ratissage ou le broyage des débris végétaux, pourraient influencer le développement de la couverture herbacée, mais aucun effet du pâturage des animaux n'a été révélé en termes de couverture et de diversité.*

Mots-clés. *Récupération des parcours – Biodiversité – Buissons – Pâturage.*

I – Introduction

The abandonment of traditional forestry and pastoral management in last decades is leading to

a rapid extension of productive and highly competitive species, both herbaceous and woody. The progressive encroachment of scrubs and trees is causing a landscape homogenization, with a loss of the flora and fauna associated with these habitats, as well as an increase in fire risk. In addition, this process also causes a direct loss of pastoral resources in production and nutritive value (Zarovali *et al*., 2007). The restoration of these ecosystems involves the rejuvenation of vegetation cover through mowing and/or grazing (Muller *et al*., 1998).

The Montseny Natural Park and Biosphere Reserve (NE of Catalonia, Spain), as other protected Mediterranean areas, has also suffered this process of colonization by woody species (Bartolomé *et al.*, 2005). For this reason, during the last years, the managers of the park have been conducting clearing actions to cope with this process. In 2008 a field experiment was conducted to evaluate different restoration treatments, undertaken after tree and scrub clearing. The aim of this study was to asses the different treatments that could improve the recover and development of the herbaceous layer in a young cleared holm oak forest.

II – Materials and methods

The study was carried out in the Montseny Natural Park, in the Spanish Mediterranean region. Experimental plots were placed around 1300 m a.s.l. in La Calma plateau (longitude 2º18'-2º22' E, latitude 41º44'-41º47' N). The climate is humid Mediterranean, with an average rainfall of 700 mm and a mean annual temperature of 10ºC. The topographic emplacement and humidity circulation produces a situation that favours the Atlantic vegetation dominated by grasslands and heathlands. However, nowadays the area of Mediterranean woods (*Quercus ilex* L. and *Q. humilis* Mill.) is increasing to the detriment of scrublands and pastures (Bartolomé *et al*., 2005).

During the spring of 2008, a young holm oak forest with scrubs of *Erica scoparia* L. and *Cytisus scoparius* L. was cleared with the aim of restoring the area as a grazing forest. After this initial restoration action, 3 experimental plots of 25 m x 20 m were placed randomly. These plots were divided into five subplots of 5 m x 10 m, a control area (cleared forest) and four areas with different post-clearing treatments each: (i) mulch grinded; (ii) mulch grinded and sowing of a commercial seed mixture; (iii) mulch partial raked; and (iv) mulch partial raked and sowing. The commercial seed mixture used consisted of 25% *Festuca ovina* L., 22.5% *Dactylis glomerata* L., 22.5% *Agrostis capillaries* L., 15% *Trifolium repens* L. and 15% *Lotus corniculatus* L. Finally, from the beginning of the experiment, half area of the plot was fenced to assess the effect of the absence or presence of grazing by goats (50%) and sheep (50%), with a total of 50 LU.

After the first year of implementation, cover, height and density of herbaceous species were measured in three random replicate point quadrates (Goodall, 1952), in 1 m^2 squares with a total of 100 equidistant sampling points inside. The species richness and Shannon-Weaver [$-\sum (p_i \times \ln p_i)$] diversity indices were calculated to determine species diversity after each treatment.

All results were subjected to two-way Anova statistical analysis, using the SAS statistical package. The general model applied was: y = post-clearing + grazing (no significant interactions were found). When Anova results revealed a significant effect, a Tukey's multiple comparison test was conducted to identify which treatments differed significantly (at $p \leq 0.05$) from the other.

III – Results and discussion

The application of post-cleared treatments jointly with the sown of a commercial seed mixture clearly affected the structure of vegetation implanted, as showed in Table 1. Coverage percentages of sown plots were significantly higher (62.67 to 68.93%) than those of non-sown plots (36.68 to 48.75%). In turn, herbaceous coverage in raked plots was higher than in control plots. However, herbaceous vegetation density was affected only by the sowing effect (Table 1). Sown plots presented higher density than non-sown plots. Moreover, none of these three variables showed differences in treatments with presence or absence of grazing. Vegetation

height was the only parameter having a response to the grazing effect. Non-grazed and sown plots presented greater height herbaceous layer than the grazed and non-sown plots.

Table 1. Herbaceous layer structure (cover, specie densities and height) and diversity indices in post-cleared and grazing treatments

	Herbaceous layer structure			Diversity indices	
	Cover (%)	Density (contacts/point)	Height (cm)	Richness	Shannon–Weaver
No grazed					
Grinded	43.93b	0.46b	10.10b	10.78	1.95a
Grinded & seeded	68.93a	0.87a	12.16a	11.11	1.74b
Raked	46.51b	0.49b	9.30b	12.22	2.08a
Raked & seeded	63.09a	0.74a	12.69a	11.11	1.75b
Control	39.47c	0.41b	9.40b	11.11	2.14a
Grazed					
Grinded	38.71b	0.41b	7.53c	12.00	2.12a
Grinded & seeded	66.70a	0.82a	7.55c	10.00	1.75b
Raked	48.72b	0.51b	8.48c	12.78	2.13a
Raked & seeded	62.67a	0.72a	9.75b	9.67	1.71b
Control	36.68c	0.38b	7.78c	10.33	2.00a
Analysis of variance					
df (degrees of freedom)	5	5	5	5	5
F-test	32.82	12.7	39.86	1.36	5.68
p-value	<0.0001	<0.0001	<0.0001	0.2459	<0.0001

Means (n=9) in the same column with different letters (a, b, c) were significantly different ($p \leq 0.05$).

Sown plots showed the highest coverage due to the large percentages of graminoid coverage obtained (especially the species *F. ovina*, *D. glomerata* and *A. capillaris*, that were sown), while non-sown plots presented higher coverage of forbs. This trend can be seen in Fig. 1, where graminoid coverage percentages of the sown plots were significantly higher (52.8 to 48%) than in non-sown plots (16.6 to 11.7%). In contrast, forb coverage percentages in sown plots were significantly lower (6.4 to 5.7%) than in non-sown plots (20 to 15.8%). It's observed how sown species, particularly graminoids, were successfully implanted after the first year, reducing the percentage of bare ground but competing in coverage with the rest of species.

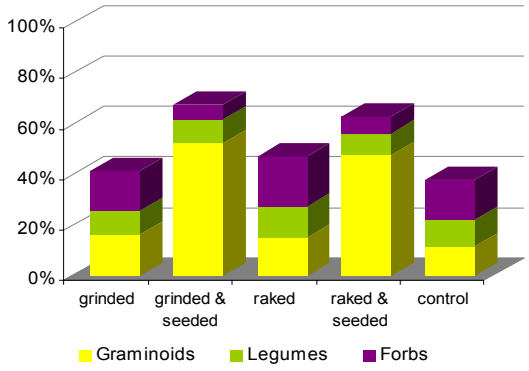

Fig. 1. Canopy cover percentages of plant functional groups in post-cleared and grazing treatments. Means of coverage percentage of graminoids and forbs differ significantly (df = 5 and p-*value* <0.0001) between sowed treatments and non-sowed treatments.

Results of diversity are shown in Table 1. There were no differences in terms of richness (total number of species), but with regard to the Shannon index, sown plots obtained lower values of Shannon index (about 1.7-1.8) than non-sown plots (about 2.0-2.1). Although, diversity results did not show differences by treatments in number of species, these species were distributed more equitably in non-sown plots than in sown plots, where species sown clearly dominate.

These initial results suggested that sowing a seed mixture of competitive grass species is an effective tool to meet initial cover vegetation, reduce the percentage of bare soil and protect it from erosion. The preservation of degradation processes after clearing actions is an important aim in Mediterranean restorations (Vallejo *et al*., 2005). However, the developed herbaceous cover dominated by commercial graminoids may initially compete with species of reference grasslands and reduce diversity (Török *et al*., 2010).

On the other hand, one year is a short period to observe substantially changes on the restoration process. In future samplings, we expect a spontaneous immigration of herbaceous species characteristics to the reference grassland, mainly due to the transport of target species through extensive grazing of goats and sheep (Traba *et al*., 2003).

IV – Conclusions

Grinded and raked plots sowed with a commercial seed mixture showed better results in relation to herbaceous layer structure (coverage, height and density) than control plots and plots with non-sown post-clearing treatments. In contrast, sowed plots presented a lower Shannon index, which could affect the preservation of indigenous species. Grazing only diminished plant height. Short-term results showed that post-clearing actions, such as sowing and/or raking or grinding of mulch, could influence the development of herbaceous layer, but there was no effect of animal grazing in terms of coverage and diversity.

Acknowledgements

This study was supported by the Natural Parks Service of the Barcelona Provincial Council.

References

Bartolomé J., Plaixats J., Fanlo R. and Boada M., 2005. Conservation of isolated Atlantic heathlands in the Mediterranean region: Effects of land-use changes in the Montseny Biosphere Reserve (Spain). In: *Biological Conservation*, 122, 1, p. 81-88.

Goodall D.W., 1952. Some considerations in the use of point quadrats for the analysis of vegetation. In: *Australian Journal of Scientific Research*, 5, p. 1-41.

Muller S., Dutoit T., Alard D. and Grévilliot F., 1998. Restoration and rehabilitation of species-rich grassland ecosystems in France: A review. In: *Restoration Ecology*, 6, 1, p. 94-101.

Török P., Deák B., Vida E., Valkó O., Lengyel S. and Tóthmérész B., 2010. Restoring grassland biodiversity: Sowing low-diversity seed mixtures can lead to rapid favourable changes. In: *Biological Conservation*, 143, 3, p. 806-812.

Traba J., Levassor C. and Peco B., 2003. Restoration of species richness in abandoned Mediterranean grasslands: Seeds in cattle dung. In: *Restoration Ecology*, 11, 3, p. 378-384.

Vallejo R., Aronson J., Pausas J.C. and Cortina J., 2005. Restoration of Mediterranean woodlands. In: Van Andel J. and Aronson J. (eds). *Restoration Ecology: A European Perspective*. Oxford, UK: Blackwell Science, p. 193-207.

Zarovali M.P., Yiakoulaki M.D. and Papanastasis V.P., 2007. Effects of shrub encroachment on herbage production and nutritive value in semi-arid Mediterranean grasslands. In: *Grass and Forage Science*, 62, p. 355-363.