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Prescribed fire combined with guided herbivory can control shrub development in an Iberian heathland

ÁLVAREZ-LÓPEZ V.[1], SANTIAGO-FREIJANES JJ.[1], FERREIRO-DOMÍNGUEZ N.[1], RIGUEIRO-RODRÍGUEZ A.[1] and MOSQUERA-LOSADA MR.[1*]

1 Department of Crop Production and Engineering Projects, High Polytechnic School, University of Santiago de Compostela, Lugo, Spain

*corresponding author: Mosquera-Losada Rosa
e-mail: mrosa.mosquera.losada@usc.es

Abstract

The high amount of biomass fuel accumulated in Mediterranean areas due to land abandonment, combined with the effects of climate change, results in high severity fires that strongly affect local environment and social communities. Traditional fire practices and livestock grazing can be efficient tools to manage fuel loads and reduce wildfire impacts. This work is within the Open2preserve project, aimed at the evaluation of prescribed fire use combined with guided herbivory for the control of shrub growth and flammable biomass accumulation in an Iberian heathland dominated by *Erica* spp.

The low intensity prescribed fire led to a strong reduction in the phytovolume of the whole studied area. An increase in the understory biomass in the non-grazed area was found in the first and second year of the experiment compared to the grazed area. A significant effect of grazing was observed in the phytovolume of *Chamaespartium tridentatum* in both years of the experiment. Moreover, although not significant, an increase in the phytovolume of *Daboecia* spp was observed with time in the non-grazed areas. Similarly, *Agrosti curtisii* appeared only in the non-grazed treatment and showed a tendency to increase with time.

Keywords: *Erica* sp., *Chamaespartium* sp., grazing, horse, cattle

1. Introduction

Nowadays, the high impact of wildfires in the Mediterranean region makes necessary to set up new environmentally friendly technologies to control biomass that acts as fuel load. The high amount of fuel accumulated in these areas due to land abandonment, results in high severity fires. Traditional fire practices and livestock grazing have played an important role in shaping the structure and composition of Mediterranean landscapes, and both can be efficient tools to manage them (Pausas et al 2004).

This work is within the Open2preserve project, aimed to the evaluation of the use of prescribed fire combined with guided herbivory for the control of shrub growth and flammable biomass accumulation in the Iberian heathlands. Iberian heathlands are the most biodiverse in Europe, as they are in the boundary between the Mediterranean and Atlantic biogeographical regions (Loidi et al., 2010). They are valuable for their biodiversity, aesthetic and cultural value and are classified as a very rare and valuable habitat type under the Habitats Directive (European Commission,1992). These are immature communities that evolve into tree-lined formations (usually starting with birch) if not periodically rejuvenation/restoration actions (clearings, controlled burning, grazing etc) are carried out.

In this study we evaluate the effects prescribed fire and horse and cattle grazing on the growth and development of different plant species dominating an ericaceous acidophilus heath. The site of study is included in the Iberian heathlands, habitat of community importance within the framework of the Natura 2000 Network.

2. Material and methods

2.1. Study site and experimental set up

The experiment was conducted in O Cerredo (Rao) Forest Community (Navia de Suarna (Lugo) in the region of Galicia (northwestern Spain) European Atlantic Biogeographic Region) at an altitude of 1394 m to 1392 m a.s.l. This area is included in several Protection networks: Biosphere Reserve, ZEC (Special conservation area), ZEPA (Special Protection Area for Birds), ZEPVN (Zone of special protection of the natural values). Most of the vegetation can be characterized as scrub (85%, according to the SIOSE of 2014), being the majority *Erica australis* and *Erica arborea*, which have a homogeneous distribution, among which are also homogeneous and to a lesser extent *Calluna vulgaris, Cytisus scoparius, Chamaespartium tridentatum* and *Daboecia cantabrica*. In addition, there are some *Ulex minor* spots that account for 5% of the scrub.

In March 2019 a controlled burning of 2 ha was conducted. Horse grazing (3 horses ha^{-1}) was carried out in 1 ha for 37 days in September 2019. In June 2020, horse grazing (3 horses ha^{-1}) was carried out for 15 days and cattle grazing (3 cows ha^{-1}) for 36 days. A summary

of the actions carried out during the experiment is shown in Figure 1.

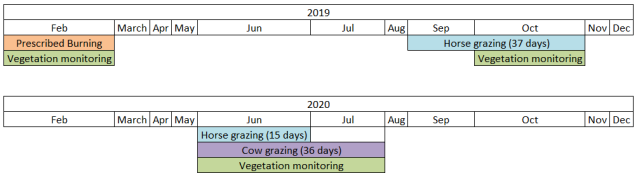

Figure 1. Summary of the actions carried out in the experimental site

2.2. Vegetation monitoring: Phytovolume determination

The evaluation of the vegetation phytovolume was carried out on three dates: (1) just before the 2019 prescribed fire (February 2019), (2) eight months after prescribed fire and just after 37 days of horse grazing (October 2019) and (3) sixteen months after prescribed fire, 15 days after horse grazing and during the 36 days of cattle grazing (June 2020). Vegetation was monitored in six random transects of 20 m located in each of the plot treatments. In each transect, the linear interception of the vertical projection of each species that fall on the transect, is recorded. Species cover was calculated as the percentage of linear interception of each species in the whole transect. Species phytovolume (m^3) was calculated as the product of the species cover per ha (m^2) by the mean height of the species in the transect (m).

3. Results

No differences in the phytovolume between both studied areas were found before prescribed fire and even a tendency to a lower phytovolume in the non-grazing plot was observed. A low intensity prescribed fire led to a strong reduction in the biomass phytovolume of the whole studied area. This tendency was inverted in the first year of experiment towards an increase in the understory biomass in the non-grazed area (8 months after the fire, including a grazing period of 37 days) which become significant in the second year of experiment (16 months after the fire (including a grazing period of 15 days for horses and 36 days for cows)) (Figure 2).

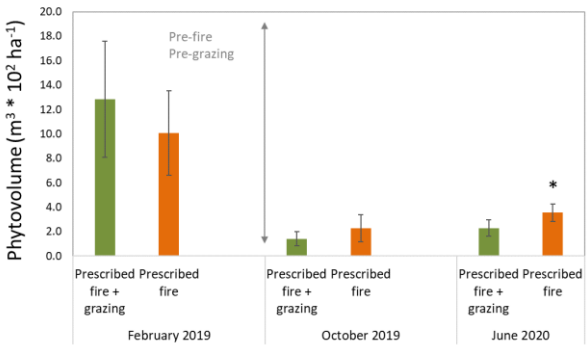

Figure 2. Total heathland phytovolume ($m^3 * 10^2 ha^{-1}$) in the different treatments

Figure 3 shows the evolution in the phytovolume of the most representative species conforming the shrubland. Understory biomass was dominated by *Erica* spp. (E. arborea and *E. australis*) and followed by *Chamaespartium tridentatum* although with a much lower volume (Figure 3). A significant effect of grazing was observed in the phytovolume of *Chamaespartium tridentatum* in both the first and second year of the experiment. Although not significantly, an increase in the phytovolume of *Daboecia* spp was observed with time in the non-grazed areas. Moreover, the grass *Agrosti curtisii* appeared only in the non-grazed treatment and showed a tendency to increase with time. Finally, no effects of grazing were found in the biomass load of *Erica* spp.

4. Discussion

Iberian heathlands over wide areas and represent almost a quarter of the total European heathland coverage (Rosa-García et al., 2013). They are also the most biodiverse in Europe and are included in distinctive habitats listed in the European Habitats Directive (Ramil-Rego et al., 2013).

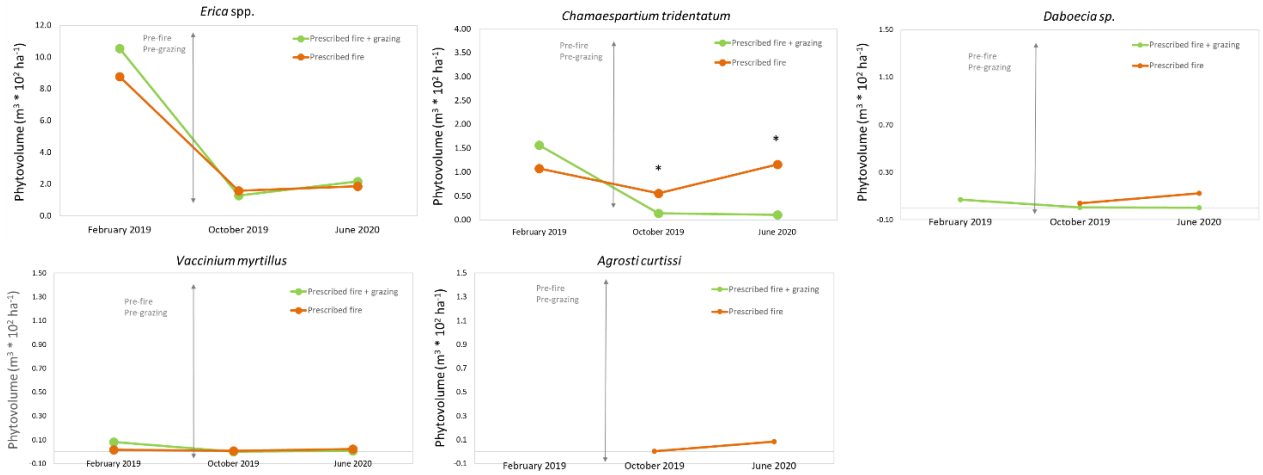

Figure 3. Phytovolume ($m^3 * 10^2 ha^{-1}$) of the five more abundant plant species of the heathland.

Several protection and restoration plans for European heathlands have been promoted by the European Union and individual countries to counteract the negative effects of different drivers of biodiversity loss over habitat quality (Pywell et al., 2011).
Land use practices as cutting, cultural burning and grazing have led to the formation of European heathlands, and their conservation is associated to a moderate anthropic activity. Nonetheless, the rural depopulation and abandonment of management practices have contributed to large accumulations of highly flammable phytomass in heathlands of NW Spain, making them susceptible to wildfires that can cause big social, economic and environmental losses (Rosa García et al., 2013).
Prescribed burning has been introduced in southern Europe primary to control fire regimes by managing fuels, counteracting the disappearance of biomass-consuming practices and reducing the fire risks inherent in highly flammable forest and shrublands (Fernandes et al. 2013). In the present study, the prescribed fire strongly reduced the total phytomass of the heathland. And this was maintained during the two years of monitoring.

On the other hand, in European temperate ecosystems, grazing by livestock is a management strategy that can improve rural sustainability while controlling the accumulation of flammable woody vegetation (Osoro et al., 1999; Rigueiro-Rodríguez et al., 2012). However, although the benefits of grazing on heathlands conservation provide a greater biodiversity than other interventions such as burning or cutting (Rosa García et al., 2013), grazing alone cannot maintain heathland in good conservation status and a combination of management is necessary (Bartolomé et al., 2000).

In this regard, we have found that prescribed fire combined with horse and cattle grazing resulted a successful tool for reducing heathland phytovolume. However, this was due mainly to the control of other plant species different than the dominant *Erica* spp. (where no effect of grazing was observed). Horses are known as mainly grass consumers (López López et al 2017a) and act as browsers of other species such as *Ulex europeaus*, *Rubus* sp., or *Calluna vulgaris* (Rigueiro-Rodríguez 2012, Gonzalez-Hernandez MP 2020). In general, cattle and horses graze preferentially on similar habitats, composed of herbaceous communities such as grasslands (Menard et al. 2002), showing a high degree of overlap in their diets (Ferreira et al. 2013). According to this, we found that herbaceous species such as *Agrostis* were only able to regrowth after fire in the non-grazed plot.

Nutritive quality of heathland vegetation is lower compared with improved grass pastures (López López et al 2019), which highlights the convenience of establishing some improved pastures areas available to grazing animals in order to supplement the diet (Osoro et al. 2017). Therefore, a better browsing of the heathland species composition could be achieved if livestock has access to certain areas with improved pasture to better meet the nutritional needs of animals (López López et al 2019)

Other small ruminants such as sheep and goats are known to be more efficient users of this poor-quality vegetation (lower intake per metabolic weight, higher digestibility of selected diets, and higher performance because of their lower body size and absolute nutrient requirements) (Osoro et al. 2017) and would be also adequate browsers for this type of ecosystem.

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