Effect of livestock grazing on the fuel load control in an Open Mediterranean Forest (NE Portugal)

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Abstract

Fuel loads can be achieved artificially by a prescribed burn or mechanical removal or through ecologically based procedures such as target grazing. The objective of this study was to compare the effect of mechanical clearing and grazing on fuel load accumulation, assessed by herbaceous biomass available on the understory of open Oak Mediterranean Forest. For this, 4 ha was mechanically cleared in May 2019, and six months later, a flock of sheep was included. The experimental design includes three treatments, grazing without clearing, clearing with grazing, and clearing without grazing. Herbaceous biomass varied between 94.91g m^{-2} and 264.10g m^{-2} ($p<0.01$). Grazing pressure must be increased to ensure its effectiveness over time.

Keywords: Herbaceous biomass, mechanical clearing, grazing pressure.

Introduction

Southern Europe is particularly affected by wildfires, mainly due to its type of climate and the type of vegetation cover (Cit by Tonini et al., 2018); It experiences currently about 47,000 fires per year, which burn, on average, 400,000 hectares of natural and forest areas (average 1980-2019; San Miguel-Ayanz et al., 2020). Fire incidence has dramatically increased in the last decades, having the average burned area quadrupling since the 1960s, (Cit by Tonini et al., 2018); mainly due to the landscape homogenization and fuel load accumulation, as result of massive rural depopulation in European rural areas after the Second World War (Lasanta et al., 2017; Torres-Manso et al., 2017; Castro et al., 2021). In the last decade, in addition to the direct effects on the destruction of forests and landscapes and the consequent loss of ecosystem services that have a drastic economic impact, fires also result in the loss of human lives every year (Cit by Insauti et al., 2021).

In this scenario, wildfire suppression response does not guarantee, by itself, to be an adequate procedure to avoid damages caused by this disturbance. It is necessary to begin earlier with preventive forest management procedures at the stand scale level. Typical options include selecting the tree species to plant, promoting the use of the essences most resistant to fire, coupled with their organization in space through compartmentation, and at the stand level, with the reduction of fuel loads of the understory vegetation and downed woody material (Fonseca et al. 2021). For existing forests, reduction of fuel loads can be achieved artificially by a prescribed burn or mechanical removal or through ecologically based procedures such as target grazing. Targeted grazing is interesting and feasible; however, grazing usually needs to be associated with previous intensive interventions such as prescribed fire or mechanical clearing in general situations (Castro et al. 2020; Ruiz-Mirazo et al. 2011, Fuhlendorf et al., 2009). The study aimed to compare the effect of mechanical cleaning and grazing on the reduction of fuel load, evaluated by the consumption of available herbaceous biomass, in the understory of an open Mediterranean oak forest in Northern Portugal.

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Material and methods

Study area

This study was conducted in Romeu parish, a site of community interest (SIC PTCON0043) located in the Trás-os-Montes region, northeast Portugal (41°32'N, 7°02'W), at 500 m above sea level.

The climate is Mediterranean, the mean annual temperature is 14.2 °C, and the total rainfall is 520 mm. The landscape is dominated by an open Mediterranean forest with Portuguese oak (*Quercus faginea* Lam.), cork oak (*Quercus suber* L.) and holm oak (*Quercus rotundifolia* Lam.), and several shrub species such as *Cytisus scoparius* L., *Cytisus multiflorus* L'Hér, *Lavandula stoechas* L., *Crataegus monogyna* Jacq., *Cistus ladanifer* L., with an herbaceous stratum, generally dominated by annual grasses. The soils are classified as Distric Leptosols derived from schists.

In May 2019, we carried out a mechanical vegetation clearance procedure using a 1.5 m wide chain ripper mounted on a caterpillar tractor. Shrubs and dead and accumulated herbaceous strata were removed. The plot was fenced in early September and the livestock was added in December. The experimental area covers a total area of about 4 ha and consists of three treatments, comprised of two plots cleared mechanically, one without grazing (**Clearing + No grazing**) and another with grazing (**Clearing + grazing**), and the other one without clearing but accessible to the flock (No **Clearing + grazing**), which represents the control.

The plots were grazed by a local flock of approximately 150 head of sheep in a livestock husbandry system based on daily grazing circuits over the agro-pastoral landscape. The flock was monitored from December 2019 to June 2021. In the first period, December 2019 to June 2020, the flock was in the experimental plot for about 52 days (totalizing 88 hours); in the second period, 97 days (totalizing 169 hours); and in the third period (December 2020 to June 2021), 89 days, totalizing 132 hours (Castro al., 2021).

Methods

The herbaceous biomass was evaluated by cutting and weighing in units of 0.25 m^2 in the winter of 2020 and two times at the end of spring (end of June 2020 and end of May 2021). Three replicates by treatment were used in the first sampling year and five in the last one due to the large variation found in the 1st case, making thirty-three samples.

The statistical analysis was made from an analysis of variance (Two-factor ANOVA - Type III SS) considering sampling date and treatments as sources of variation. Later the means were compared by Tukey's Honestly-Significant-Difference Test. Means and standard error by groups (treatment and date) were calculated, all analyzes were performed with the help of the SISTAT® software.

Results and discussion

Herbaceous biomass varied significantly between treatments and years (Table 1). In 2020, significant differences were found between cleaned and uncleaned plots, whereas in 2021, significant differences were found between grazed and ungrazed plots.

Table 1: Statistical results of the analysis of herbaceous, n = 33

Source variation	degrees of freedom	p-value*
Treatment	2	0.006
Year	1	0.002

Source: Own authorship (2022).

Table 2 shows the mean and standard error values for 2020 and 2021 for the three treatments (Cl + G, Cl + NG, NCl + G). The effect of mechanical clearing on the accumulation of herbaceous biomass was still visible one year after the operation, varying between 94.91 g.m-2 and 234,71 g.m-2.The higher biomass value in the grazed plot CL+ G (118.41 g.m-2), although not significant, in relation to the ungrazed one CL+ NG (94.91 g.m-2), may be related to the consumption effect that generally benefits plant productivity (NOY-MEIR, 1993) due to compensatory growth processes (BELSKY, 1986; MCNAUGHTON, 1983).

After two years of mechanical clearing, we found significant differences between grazing (193.34 g.m-2) and without grazing plots (264.10 g.m-2). It is also remarkable that after two years of mechanical clearing, the non-intervention plot shows a more favorable pattern of fine fuel accumulation than the one that was cleaned but subsequently not grazed.

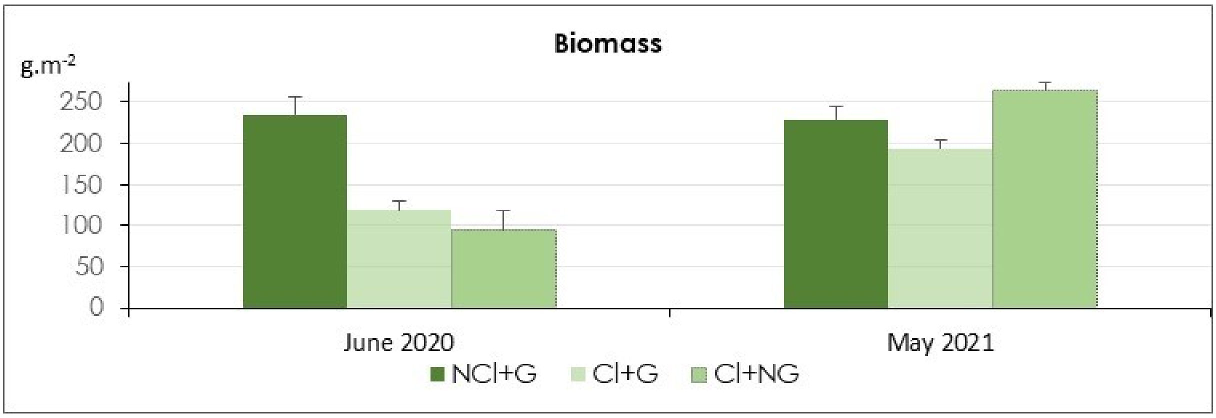
Figure 1 shows the evolution of herbaceous biomass over two years in the three treatments, and tree issues could be highlighted. The short time interval in which the effect of mechanical cleaning is visible. Comparing the treatments grazing with (**Cl + G)** and without clearing (**NCl + G**) one year after the clearing process, its effect on the biomass control stands out. When comparing mechanical grazing treatments two years ago, the impact of grazing on fuel reduction is clear; however, when comparing 2021 and 2022, it is clear that the grazing pressure used is not sufficient to control the growth of fine fuels.

Table 2: Evolution of biomass over time in the treatments.

Year	Cl + G ($g.m^{-2}$)	Cl + NG ($g.m^{-2}$)	NCl + G ($g.m^{-2}$)
2020	$118.41^B \pm 22.60$	$94.91^B \pm 11.62$	$234,71^A \pm 24.12$
2021	$193.34^B \pm 16.05$	$264.10^A \pm 10.4$	$229.07^B \pm 9.20$

* *Different capital letters show significant differences within the.*
Source: Own authorship (2022).

Figure 1: Evolution of biomass over time in different treatments.



Source: Own authorship (2022).

In forest ecosystems, undergrowth vegetation is related to the amount of incident radiation and the accumulation of deadwood (cited by Castro et al., 2007), besides the variables that usually condition plant productivity (temperature, precipitation, fertility). Therefore, the efficiency of grazing on fuel load reduction depends on the grazing intensity, and it is variable for each type of forest (Cit by Ollerer et al., 2019).

Conclusions

Target grazing can reduce the amount and alter the continuity of fine fuels, potentially changing wildlife fire spread and intensity. However, grazing intensity needs to be adjusted to the fuel renewal rate. At low intensity (i.e., < 30% utilization), it has little influence on the cover of herbaceous plants

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Bibliographic references

Belsky, A. J. Does Herbivory Benefit Plants? A Review of the Evidence. The American Naturalist, V. 127, n.6, p. 870–892, 1986.

CASTRO, J.; CASTRO, M.; GÓMEZ-SAL, A. Changes on the Climatic Edge: Adaptation of and Challenges to Pastoralism in Montesinho (Northern Portugal). Mountain Research and Development, V.41, n.4, p.29-37, 2021.

CASTRO, M.; AMERAY, A.; CASTRO, J. P. A new approach to quantify grazing pressure under Mediterranean pastoral systems using GIS and remote sensing. International Journal of Remote Sensing, V. 41, n. 14, p. 5371-5387, 2020.

CASTRO, M.; CASTRO, J.; SAL, A.G. Efeito da Pastorícia Tradicional na Redução de Combustíveis Finos em Bosques de Quercus pyrenaica, Silva Lusitana. V. 17, n. 2, p. 159- 169, 2009.

CASTRO, M.; CASTRO, J. P.; CASTRO, J.; PÁDUA, L. Regional vegetation monitoring report of the pilot experiments of North Portugal. Bragança, IPB, p. 43, 2021.
INSAUSTI, K.; BELDARRAIN, L. R.; LAVÍN, M. P.; ALDAI, N.; MANTECÓN, A. R.; SÁEZ, J. L.; CANALS, R. M. Horse meat production in northern Spain: ecosystem services and sustainability in High Nature Value farmland. Animal Frontiers, V.11, n. 2, p.47–54, 2021.

FUHLENDORF, S. D.; ENGLE, D. M.; KERBY, J.; HAMILTON, R. Pyric herbivory: rewilding landscapes through the recoupling of fire and grazing. Conservation Biology, V. 23, n. 3, p. 588-598, 2009.

LASANTA, T.; ARN ´AEZ, J.; PASCUAL, N.; RUIZ-FLA ˜, P.; ERREA, M.P.; LANA-RENAULT, N.; Space–time process and drivers of land abandonment in Europe. CATENA, Geoecology in Mediterranean mountain areas, V. 149, n,2 p. 810- 820, 2017.

MCNAUGHTON, S. J. Compensatory Plant Growth as a Response to Herbivory. Oikos, V.40, n. 3, p. 329–336, 1983.

NOY-MEIR I. Compensating Growth of Grazed Plants and Its Relevance to the Use of Rangelands. *Ecological Applications*, V.3, n.1, p. 21-34, 1993.

OLLERERA, K.; VARGAA, A.; KIRBYC, K.; DEMETERA, L.; BIROA, M.; BOLONIA, J.; MOLNARA, Z. Beyond the obvious impact of domestic livestock grazing on temperate forest vegetation. Biological Conservation, V. 237, n. 1, p. 209- 219, 2019.

RUIZ-MIRAZO, J.; ROBLES, A. B.; GONZÁLEZ-REBOLLAR, J. L.Two-year evaluation of fuelbreaks grazed by livestock in the wildfire prevention program in Andalusia (Spain). Agriculture, Ecosystems & Environment. V. 141, n. 2, p. 13-22, 2011.

TONINI, H.; SCHWENGBER, D. R.; MORALES, M. M.; DE OLIVEIRA, J. M. F. Crescimento e qualidade energética da madeira de Tachigali vulgaris sob diferentes espaçamentos. Pesquisa Florestal Brasileira, v. 38, p. 1- 8, 2018.

TORRES-MANSO, F.; DAGAR, J. C.; TEWARI, V. P. Silvopastoral Systems as a Tool for Territorial Sustainability and Biodiversity. Agroforestry, V. 3, n. 12, p. 317-333, 2017.