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Restoration of burned forest areas in Galicia (NW Spain)

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Abstract. Climate change has a wide-ranging impact on ecosystems, economy, human health and well-being. Therefore, the adaptation to climate change of both forest and agricultural sectors providing solutions to accelerate forest regrowth after extreme events, such as forest fires, by creating a more stable and resilient forest structure is needed. The objective of this study was to evaluate the establishment of different perennial (*Taxus baccata, Quercus ilex, Quercus suber, Pinus pinaster*) and not perennial (*Castanea sativa, Quercus robur, Sorbus aria, Betula alba, Quercus pyrenaica, Acer pseudoplatanus, Prunus avium*) forest trees and medicinal/aromatic plants (*Rosmarinus, Lavandula* sp*, Laurus nobilis, Origanum vulgare, Thymus vulgaris, Salvia officinalis, Sambucus nigra, Ruta graveolens, Vaccinium myrtillus*) in a forest area located in Galicia (NW Spain) which was destroyed by a forest fire in August 2021. Results showed that one year after the planting, in general, medicinal/aromatic plants had a lower mortality rate than trees. Therefore, under edaphoclimatic conditions similar to those of this study, it is recommended to use small plants, such as medicinal/aromatic plants, for the initial restoration of degraded areas. In any case, successive monitoring is necessary to evaluate the evolution of the vegetation in the area over time.

Keywords: climate change, forest fires, trees, medicinal, aromatic, degraded areas

1. Introduction

In recent decades, the increasing occurrence of extreme climatic events such as storms, floods, or forest fires has had a wide-ranging impact not only on ecosystems but also on the economy, human health, and well-being (Clarke et al., 2022). In this context, Galicia (NW Spain) is one of the most forest fire-prone areas in Europe where wildfires are increasing in frequency and intensity due to climate change. Therefore, in areas like Galicia, developing forest restoration techniques is essential, particularly those that can accelerate regrowth following such events and foster more stable and resilient forest structures.

The careful selection of plant species plays a critical role, especially when agroforestry strategies are used as a means to address the damage caused by extreme climatic conditions (Whiting et al., 2004). Moreover, evaluating plant growth following forest restoration is essential, as forest ecosystems can be altered by extreme climatic events, which may negatively affect plant adaptation to new environmental conditions.

The objective of this study was to evaluate the establishment of different perennial (*Taxus baccata, Quercus ilex, Quercus suber, Pinus pinaster*) and not perennial (*Castanea sativa, Quercus robur, Sorbus aria, Betula alba, Quercus pyrenaica, Acer pseudoplatanus, Prunus avium*) forest trees and medicinal/aromatic plants (*Rosmarinus, Lavandula sp, Laurus nobilis, Origanum vulgare, Thymus vulgaris, Salvia officinalis, Sambucus nigra, Ruta graveolens, Vaccinium myrtillus*) in a forest area located in Galicia which was destroyed by a forest fire in August 2021.

2. Materials and methods

The study was established in a forest area located in the Quiroga municipality (Lugo, Galicia, NW of Spain) which was completely and heavily destroyed by a forest fire in August 2021. The former forest was a *Pinus pinaster* plantation carried out decades ago. Under the VAIA project, a pilot area covering over 1 km² was established, consisting of two pilot sites of 2.5 hectares each. In each pilot site, a set of perennial and non-perennial forest trees and a medicinal/aromatic plant experiment were established. Eleven forest species adapted to the Atlantic and Mediterranean areas were planted in January 2023. Part of the species were perennial (*Taxus baccata, Quercus ilex, Quercus suber, Pinus pinaster*) and part not perennial (*Castanea sativa, Quercus robur, Sorbus aria, Betula alba, Quercus pyrenaica, Acer pseudoplatanus, Prunus avium*). Trees were intercropped, except for *Castanea sativa*, to increase the landscape value of the species when the leaves fall. In February 2023, medicinal/aromatic plants (*Rosmarins, Lavandula sp, Laurus nobilis, Origanum vulgare, Thymus vulgaris, Salvia officinalis, Sambucus nigra, Ruta graveolens, Vaccinium myrtillus*) were established in both pilot sites to carry out an adaptation study of the plants to the conditions of the area. The mortality rate of trees and medicinal/aromatic plants was evaluated in October 2023. Data were analyzed with

ANOVA and the means were separated by the LSD test when the results of ANOVA were significant.

3. Results and discussion

Figure 1 shows that in both pilot sites, *Prunus avium* had a lower mortality rate than *Betula alba*, *Quercus suber*, *Quercus ilex* and *Taxus bacata.* Previous studies have highlighted the potential of *Prunus avium* to grow in diverse forest contexts, both in clonal plantations (Fernández-Moya and Urbán-Martínez, 2022) and in mixtures with other tree species (Stojecová and Kupka, 2009). It should be noted that *Prunus avium* is a valuable hardwood species that enhances forest biodiversity while also increasing income for forest owners, which is especially important in the context of forest restoration after an extreme event such as a forest fire.

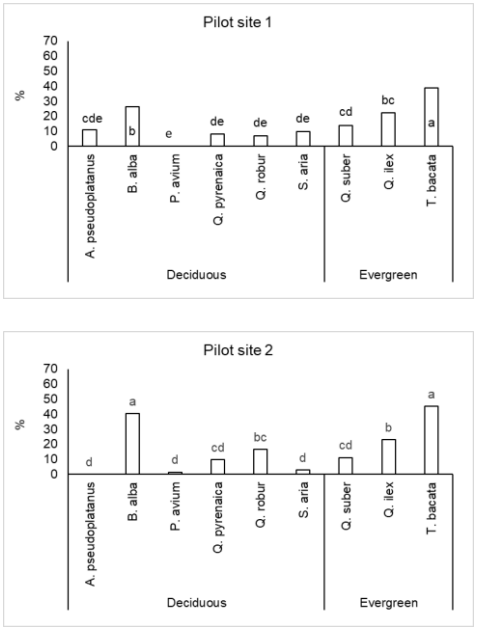

Figure 1: Mortality rate (%) of trees established in both pilot sites. Different letters indicate differences between tree species in each pilot site.

In the case of the medicinal/aromatic plants, in the pilot site 2, it was found that *Origanum vulgare, Rosmarinus, Thymus vulgaris and Laurus nobilis* had a lower mortality rate than *Ruta graveolens, Sambucus nigra* and *Vaccinium myrtillus* (Figure 2). Moreover, it seems that in general, the medicinal/aromatic plants presented a lower mortality rate than trees. This result could be explained because medicinal/aromatic plants are characterized by their ability to tolerate stressful environmental conditions (Ait Elallem et al., 2021). Therefore, the restoration of degraded forest lands with medicinal/aromatic plants seems to be a reliable, feasible, and sustainable approach due to their effective natural resource conservation and providing a value-added land-use system. However, successive monitoring is necessary to evaluate the evolution of the vegetation in the area over time.

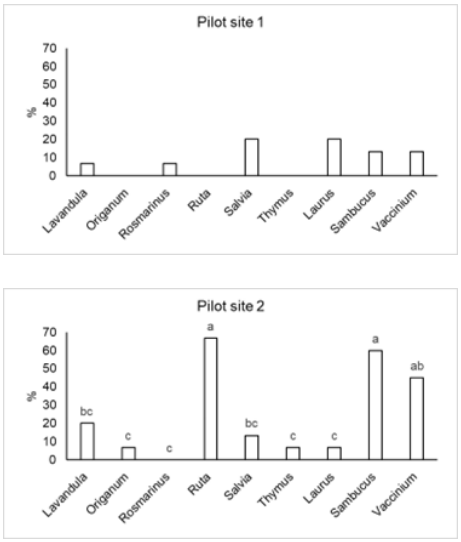

Figure 2: Mortality rate (%) of medicinal/aromatic plants established in both pilot sites. Different letters indicate differences between medicinal/aromatic species in each pilot site.

4. Conclusion

One year after the planting, in general, medicinal/aromatic plants had a lower mortality rate than trees. Therefore, under edaphoclimatic conditions similar to those of this study, it is recommended to use small plants, such as medicinal/aromatic plants, for the initial restoration of degraded areas. In any case, successive monitoring is necessary to evaluate the evolution of the vegetation in the area over time.

5. Acknowledgements

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