Effects of grazing and understorey clearing on regeneration of a valonia oak silvopastoral system in Western Greece

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Abstract

Valonia oak (*Quercus ithaburensis* subsp. *macrolepis*) forms traditional silvopastoral systems in Greece and other eastern Mediterranean countries. In a meeting that was organized under the framework of the AGFORWARD (FP7) research project, local stakeholders of the Xeromero area (Western Greece), where valonia oak forms such agroforestry systems, expressed their concerns for the low regeneration of the oaks, and attributed the problem to the livestock overgrazing and the overgrowth of the woody understorey. To test this hypothesis, an experiment was organized in the particular area. Specifically, four sheep and goat sheds as well as the pathways that the livestock follow daily for grazing were identified and 6 paired plots, 5X8 meters in size each, were established per shed territory, a total of 24 plots. In each pair, one plot was fenced and the other plot was left free to grazing. Woody understorey vegetation was cleared in half of each plot in early autumn of the first growing season. Data were collected twice per year (May and October) and included number of seedlings and young samplings, acorns and acorn-cups as well as the floristic characteristics. A two-years results show that understorey clearing did not have any significant effects on two variables measured while fencing significantly increased the number of seedlings and young saplings as well the number of acorns only in October.

Keywords: Agroforestry, silvopastoral systems, regeneration, Mediterranean region, *Quercus ithaburensis* subsp. *macrolepis*

1. Introduction

Valonia oak woodlands in Greece, due to their open structure and combined use for forest and livestock production, are considered as grazed woodlands and specifically silvopastoral land rather than productive forests (Papanastasis, 1996). After Der Herder *et al.* (2015), they can be characterized as agroforestry systems of high natural and cultural value. These systems are scattered throughout the insular and continental part of Greece covering an area of 29,632 ha (Pantera *et al.*, 2008). Among them, the valonia oak silvopastoral systems of Xeromero, W. Greece, hold a distinctive place due to their large scale and distinctive silvicultural structure.

During a stakeholders' meeting organised in Xeromero – Western Greece within the framework of the AGFORWORD project (Pantera, 2014) it was reported that one of the main problems of the system is the poor regeneration of the trees. Oak regeneration problem in silvopastoral systems have been identified also in other Mediterranean regions (Dufour-Dror, 2007; Pulido *et al.*, 2013; López-Sánchez *et al.* 2014; Dias *et al.*, 2016; Simões *et al.*, 2016). The continuous hampering of the regeneration process may then lead to the progressive reduction of the forest cover (Quezel and Medail, 2003; Plieninger *et al.*, 2004). Overgrazing has been identified as one of the most important factors affecting regeneration in the Mediterranean region (Le Houérou, 1981; Quezel and Barbero, 1990). However more factors have been identified affecting oak regeneration such as acorn production and consumption by animals, seed dispersion and seedling destruction by animals, shading and competition by understory vegetation, forest fires, climate change (Lorimer 1992; Pulido and Diaz, 2005; Annighöfer *et al.* 2005). Additionally, Plieninger *et al.* (2004) mention that regeneration may be affected also by physiognomic characteristics and long-term human interventions and not directly by present livestock rate. Furthermore, Hudges and Gardiner (1992), note that oak ecology and physiology helps to explain why it is often difficult to obtain satisfactory regeneration of oaks. Oaks are generally not very flexible to acclimate morphologicaly and physiologicaly well to changing environments especially light (Hudges and Gardiner, 1992).

For the Xeromero forest, a basic hypothesis based on the observations of the local forest explaining the poor or lack of oak regeneration, is the high grazing pressure that exists in the region, or the presence in certain locations of a dense wood understorey vegetation, which, in combination with climatic and site factors, affects natural regeneration. However there are not many research studies for the area. As for valonia oak in Greece, there is a limited number of studies on the role of grazing, of understory or of land uses changes and management to the species regeneration (Koutsidou *et al.* 2008; Pantera and Papanastasis, 2011; Plieninger *et al.*, 2011; Kizos *et al.*, 2013; Schaich *et al.*, 2015). There is also a limited number of studies on the effect of cattle garzing (Dufour-Dror, 2007) and overstory release (Cooper *et al.*, 2014) for the subspecies Tabor oak

(*Quercus ithaburensis* subsp *ithaburensis*) in Israel. In this respect, it was considered appropriate to investigate the effect of grazing and understorey vegetation clearing on tree regeneration that can occur in many parts of the forest because of a lack of management.

2. Material and methods

The study area situated in the valonia oak woodland of Xeromero - W. Greece, which is located 16 Km west of Agrinio (Fig. 1a). In this region valonia oak develops mainly in shallow limestone soils from 0 to 580 m above sea level. The Mediterranean bioclimate is humid with temperate winter with a mean annual precipitation of 938,5 mm and mean annual temperature 18.8^{o}C. Three vegetation layers compose the forest. The understorey vegetation is composed of old-aged valonia oak trees, at a mean density of 20-50 tree/ha and mean ground cover 20-80%, mean tree height 10-15 m. Pubescent (downy) oak is sparsely present in the most fertile locations.

A representative area in terms of vegetation structure and grazing intensity, approximately 120 ha, was chosen (Figure 1b). In this area, 12 pairs of rectangular plots covering an area of 40 m^2 each (5 m x 8 m) will be established in four different grazing allotments by sheep and goats (three pairs per allotment). These allotments are composed of open to relatively open stands with ground cover 30-70% and 25-50 trees/ha^{-1}, 150-250 years and have similar topographic and geological conditions. Half of the subplot located under the tree crown and the other half will be away from the canopy. One of the paired plots was fenced to provide protection from grazing, while the other remained open to grazing. Each of the 24 plots (protected or not) were split into two parts of 20 m^2 (8 m x 2.5 m); one part was cleared from the understorey vegetation (shrubs) by clear cutting to investigate its role in tree regeneration. A two way between subjects factor design was used. The two factors were "grazing" and "understorey vegetation" and the experimental treatments were FNS= fenced and cleared of shrubs; FWS= fenced with shrubs; GNS= Grazed and cleared of shrubs and GWS= Grazed with shrubs. There were 12 replications of each treatment.

Measurements carried out on the number and the height of seedlings and young sapling in May before the summer period, for the years 2015, 2016. Plant survival (number of living seedlings and sapling) and their height in meter measured after the 1st and 2nd drought period (autumn 2015 and 2016). In this second period, the number of acorns and acorn caps with a wired frame sized 0.5 m x 0.5 m measured in three fixed positions of each subplot (0.5 m from the corner and 1 m from the middle of the fence side. All the measurements expressed in numbers per square meter. Vegetation dynamics will be assessed by the measurement of understorey vegetation (species and number per species) at May of each year with the wired frame 0.5 m x 0.5 m.

3. Results – Discussion

From the analysis of the 2 years data, it appears that no statistical significant differences exist for the number of seedlings and young sapling among the four treatments. The same is valid for the number of acorns and the cups. However by examining separately the treatments grazing and understorey clearing, it appears a tendency to increased number of seedlings and young saplings (Fig. 2) and the number of acorns in October in the protected areas as compared to the grazed ones (Fig. 3). The difference in the number of seedlings and young sapling in the protected areas as compared to the grazed ones is greater in October compared to those of May which is indicative to the fact that a number of seedlings is consumed by the livestock during the summer or that a number of seedling do not survive the summer due to the intense xerothermic period and the shallow soils of the area

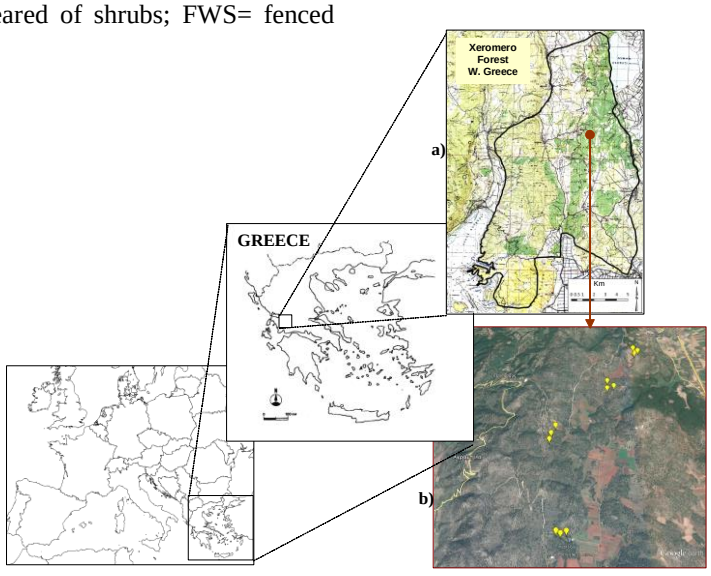

Figure 1. a) Map of Xeromero forest and b) satellite image (from Google Earth) with the position (yellow points) of 12 pair experimental sites in the valonia oak silvopastoral system.

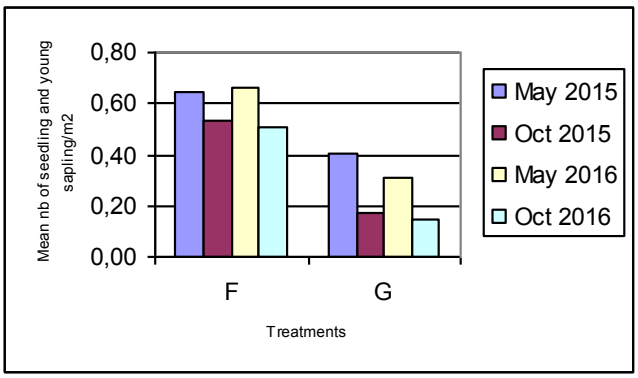

Figure 2. Mean number of seedlings and young saplings in fenced (F) and grazed (G) plots in May and October 2015, 2016.

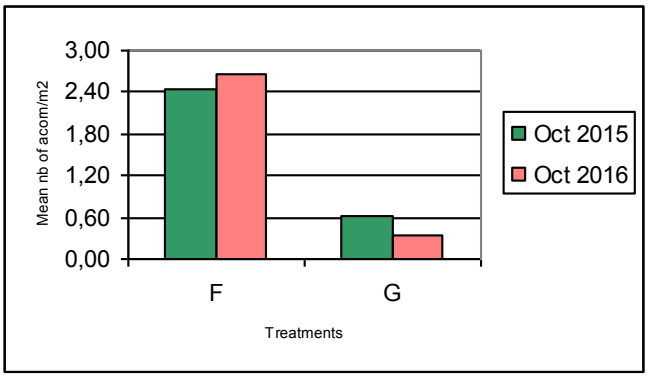

Figure 3. Mean number of acorns in fenced (F) and grazed (G) plots in October 2015, 2016.

Based on Pantera (2001) the stocking density in the study area is 5,5 LU ha^{-1} which is a quite high. Livestock graze throughout the year and are mostly composed sheeps and goats. Of these preliminary results it is understood that overgrazing plays a negative role to valonia oak regeneration possibly in combination with other environmental factors which are currently under investigation. Grazing, as expected, affects the number of available acorns in the area as they are consumed by the livestock. This negative affect of grazing is also mentioned by Plieninger *et al*. (2011) and Koutsidou *et al*. (2008) in Lesvos Island for valonia oak but also for the other subspecies, tabor oak (Dufour-Dror 2007). Based on the later, the density of seedlings and young saplings in the grazed tabor oak forest in Israel were, respectively, 61% to 67% lower than in the ungrazed treatment.

As for understory clearing, it appears that it does affect the number of seedlings and young saplings and the number of valonia oak acorns. However, there are differentiations in the number and height of seedlings based on the vegetative preliminary results not given in the present study. On a general basis, the two years data since the establishment of the experimental sites are not sufficient to draw final conclusions.

4. Conclusions

Grazing have been practiced intensively in the Xeromero forest for many decades and it negatively affects oak regeneration possibly in combination with other factors. However, it is a traditional practice and cannot or should not be banned assuming that is practiced within the framework of a sound management taking into account the grazing capacity of each location. It contributes to increase biodiversity, understory decrease and, subsequently, decreases forest fire risk. Therefore, in cases with regeneration problems due to overgrazing, actions should be considered to moderate and, overally, manage grazing in order to preserve and establish new valonia oak saplings taking into account the need to keep the open stand structure of the forest (40-50 trees/ha).

Acknowledgment

This research is part of the AGFORWARD project (Grant Agreement N° 613520) is co-funded by the European Commission, Directorate General for Research & Innovation, within the 7th Framework Programme of RTD, Theme 2 - Biotechnologies, Agriculture & Food. The views and opinions expressed in this report are purely those of the writers and may not in any circumstances be

regarded as stating an official position of the European Commission.

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