Adaptability of New Provenances of *Quercus suber* in Trás-os-Montes, Portugal: Its Importance for the Sustainability of the Forest Systems

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Introduction

The cork oak (*Quercus suber*) is an important species in the Mediterranean region for ecological, environmental and economical reasons. In Portugal the cork oak area is 794x10^3 ha located in zones of Mediterranean influence. Based on its ecological requirements the cork oak may be defined as a thermophilous, hygrophilous, tolerant to drought species (Bellarosa, 2000). Thus, cork oak presents high potential of expansion for zones of Mediterranean influence such as Trás-os-Montes (Portugal), being an important species to consider in the adaptive silviculture strategies in response to the climatic changes. In this region the species occupy an area of 6380 ha. Despite its potential for adapting to the future water deficit scenarios in Trás-os-Montes, it is necessary to assure the improvement of the populations and the increment of cork productivity. Thus, testing new populations through breeding programs is important to improve the adaptability of the species and finding the best provenances for the future afforestations in this region.
In 1998, in the framework of Concerted Action FAIR1-CT95-0202, a provenance trial was established in Mogadouro, Trás-os-Montes as a part of a multi-locality provenance test belonging to the EUFORGEN Network with 34 populations from the Mediterranean basin (Figure 1).
Considering that an important source of variation in the characteristics related with adaptability are at the provenance level, 11 years afterward, we evaluated the inter-provenance variability at the growth and survival levels.

Site description
The trial was established on a private farm located in Mogadouro (41º20'19'' N, 6º40'29'' W and 750 m a. s. l.). The mean annual rainfall is 819.3 mm with a maximum of 106.2 mm registered in February and a minimum of 13.4 mm in August. The mean annual temperature is 12ºC with an absolute maximum of 38.8ºC in June and an absolute minimum of -12.3 ºC in January.
Main soil types in the site are *Dystric Cambisols* according to World Reference Base for Soil (FAO, 1998).
Before planting, the dominant species of trees in the area were *Quercus suber*, *Quercus ilex* and *Quercus pyrenaica*.

General view of the trial of provenances after plantation

Eleven years after the establishment of the trial

Materials and Methods

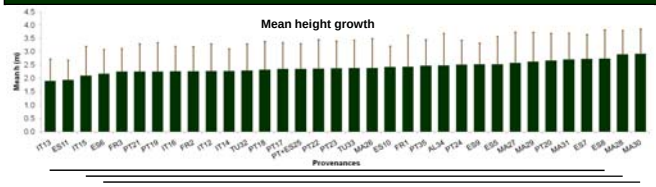
Experimental trial and plant material
In March 1998 a trial with 34 provenances of cork oak, from 7 countries (Figure 1), was established in Trás-os-Montes. The trial occupies an area of 11.8 ha. The experimental design is a completely randomized block with 30 blocks. Each block initially contained 2 randomly assigned plots with 2 plants of each population per plot. The spacing was 6x6 m, with 1 meter distance between the two plants in the same plot. Each pair included plants of the same family that were thinned in 2008.

Data collection
The data collection was made in April 2009. At the study site the survival percentage was evaluated as the proportion of the number of survival trees, after thinning, considering half of the trees initially planted.
The total height h (m) and diameter at breast height d (cm) were also measured on each surviving tree in each block.

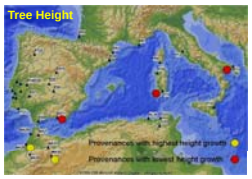
Data analysis
An ANOVA was performed to compare the growth of the provenances in relation to the h and d after verifying the statistical requirements.
A Tukey test (α = 0.05) was done for mean multiple comparisons for the two variables.

Although the growth variables d and h could not be "adaptive" characteristics, they can be assumed as a growth indicator giving some information about the adaptability of the trees to the site.

Results



Pairs of means grouped by a horizontal line are not significantly different from each other (Tukey test, P>0.05)



✓ **The Moroccan provenances show the highest height growth**
The mean height is not correlated with survival

✓ **Height growth at eleven years**

✓**Provenances assayed:**

9 Portuguese
7 Spanish
6 Moroccan
5 Italian
3 French
2 Tunisian
1 Algerian
1 Luso-Spanish

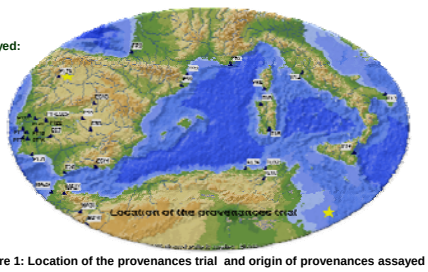
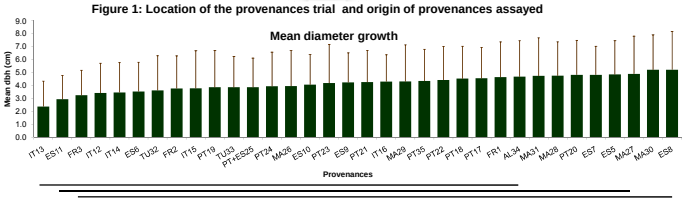


Figure 1: Location of the provenances trial and origin of provenances assayed

✓**Portuguese provenances can be observed among the ones that present a high rate of survival**

✓ **Some mortality is not caused by effects related to adaptation but to an indiscriminate mice attack.**



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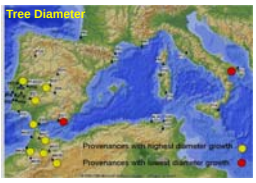

✓ **The Moroccan and some Portuguese and Spanish provenances show higher diameter growth (dbh1.30m) .**

✓ **Diameter (dbh) growth at eleven years**

Conclusions

✓The studies developed until now show differences among provenances.
✓After eleven years, results point out the importance of considering the seed origin: significant differences between populations were observed for survival as well as diameter and height growth. The highest height growth is being observed in the Moroccan provenances.
✓The growth indicators give some information about the adaptability of the trees to the site. The Moroccan ones show higher values.
✓The mean height is not correlated with survival. Provenances as the Italian ones present lower height but higher survival.
✓In future afforestation programmes the seedling origin and the selection at the individual level must be considered.

References

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Acknowledgements

This study was supported by FFP – Project nº 2005.09.002239.2 and FCT project number PTDC/AGR-AAM/104364/2008

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