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Note

Quercus suber L breeding strategy for cork quality

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Summary — According to official statistics, cork oak (*Quercus suber* L) occupies about 670 000 ha, mainly distributed to the south of the Tagus River. This represents about 22% of the country's forest area, 8% of its total area and produces about 52% of the total cork production which amounts to 307 500 tonnes. In face of its importance, and to avoid a decrease in the area of the species and the quality of cork, it is urgent to introduce effective silvicultural and breeding techniques. The aims of this paper are to analyze the breeding programs for cork oak in which the Forest Research Station (EFN) is involved which are concerned with mass selection, vegetative propagation and progeny tests. These breeding programs must be very specific because of the characteristics of cork oak.

***Quercus suber* / cork quality / breeding strategy / vegetative propagation**

Résumé — Stratégie d'amélioration génétique de *Quercus suber* L. *D'après les statistiques officielles, le chêne liège (*Quercus suber *L) occupe une surface approximative de 670 000 ha au Portugal. Son aire, principalement répandue au sud du Tage, représente 8% de la superficie totale du pays et 22% de la surface forestière. La production du Portugal représente 52% de la production mondiale soit 307 500 tonnes par an. Compte tenu de l'importance économique de l'espèce et des risques de réduction de la quantité et de la qualité du liège produit, il est devenu urgent de développer des techniques sylvicoles efficaces et de mettre en place un programme d'amélioration génétique. L'objectif de cet article est de décrire le programme d'amélioration mené par l'EFN (station de recherches forestières). Il préconise la sélection massale, la multiplication végétative et la mise en place de tests de descendances. Le programme d'amélioration doit prendre en compte les particularités du chêne liège.*

Quercus suber */ qualité du liège / stratégie d'amélioration / multiplication végétative*

INTRODUCTION

Cork oak (*Quercus suber* L) is an extremely variable Mediterranean species, of which several varieties have been recognized. The characteristics which distinguish this species from all other oaks are the thickness attained by the suberous involucre of the stem and branches, and the speed of its regeneration whenever cork is removed. The physical, mechanical and chemical characteristics of cork make *Q suber* an economically very important species (Natividade JV, 1950; Gois E, 1992).

Portugal is the world's most important producing country both for quality and

quantity but production is not sufficient to fulfill global market demands (Anonymous, 1990a). Some first class quality cork is therefore imported representing approximately 7% of the raw material used.

In the face of the increasing needs for cork of high quality and a tendency for yields to decrease, it is urgent to introduce proper silviculture as well as improvement by breeding.

The Forest Research Station (EFN) has developed a research strategy aimed at improving cork oak. It is intended to determine the heritabilities of various characteristics under study, possible genetic gains, and simultaneously to achieve an immediate improvement by the utilization of seeds or propagules from trees selected on the basis of cork quality.

MATERIALS AND METHODS

Presently EFN is carrying out a cork oak breeding program aimed at the replacement of old and decrepit cork oak stands as well as establishing new areas on marginal or uncultivated agriculture land. It is intended to use the variability existing within the stands to concentrate the genes responsible for the best qualitative characteristics of cork in some individuals. Mass propagation of these trees will allow an increase of production and improvement of quality.

It should be noted that cork oaks are characterized by a very high allogamy, great genetic variability, late flowering and slow development of ultimate quality of cork (Roldão, 1986). The harvest of virgin cork takes place at age 25–30, and, thereafter, every 9 years. At the harvest in the 43–48th year, cork is considered to be of the average quality produced over the rest of the economic cork production period of the trees, up to age 100–120 years. So, the strategy for breeding this species must take these characteristics into account. The proposed model for improvement is depicted in figure 1.

From the base population, some plus trees will be selected. The use of rigorous and sound criteria in selection will be essential. The quality of cork, as evidenced by several peeling operations, will be the main criterion. Plus trees will constitute the reproductive population which will be the basis of the whole breeding program. These trees, once selected, will be represented in clone bancks and will provide the material for propagation.

Simultaneously, clonal and progeny tests will be established under different ecological conditions. These will allow the investigation of, for example, intraclonal and interclonal variability as well as the genotype–environment interactions.

Half-sib progeny tests will provide information on the reproductive capacity of the various plus trees and their general combining capacity.

Considering the complex floral biology, the immediate accomplishment of large scale controlled pollination trials will be difficult. Due to the lack of knowledge about heritability of cork quality, a fundamental aspect, it was decided to carry out a short preliminary test involving controlled crosses using 5–6 trees each of good and poor quality.

Some other aspects will also be studied: the relationship between the rate of growth and cork quality, the influence of environment on quality of cork and a search for any relationships between quality and any morphological characteristics. Carvalho (1991) recommended that a detailed study of the periderm be carried out.

RESULTS AND DISCUSSION

Projects which have already been started or are planned are described below. Selection of plus trees on the basis of the quality of cork: 230 selected trees have already been registered in the principal cork oak producing areas in the country. They were selected mainly on the basis of the quality of cork produced, but other parameters were taken into consideration, such as stem straightness and branch angle, resistance to insects and diseases, and the straightness of the grain in the cork (Carvalho, 1991). Cork quality was determined from studies of structural aspects of the inner side (ventre), the mass (massa), and the external side (costas).

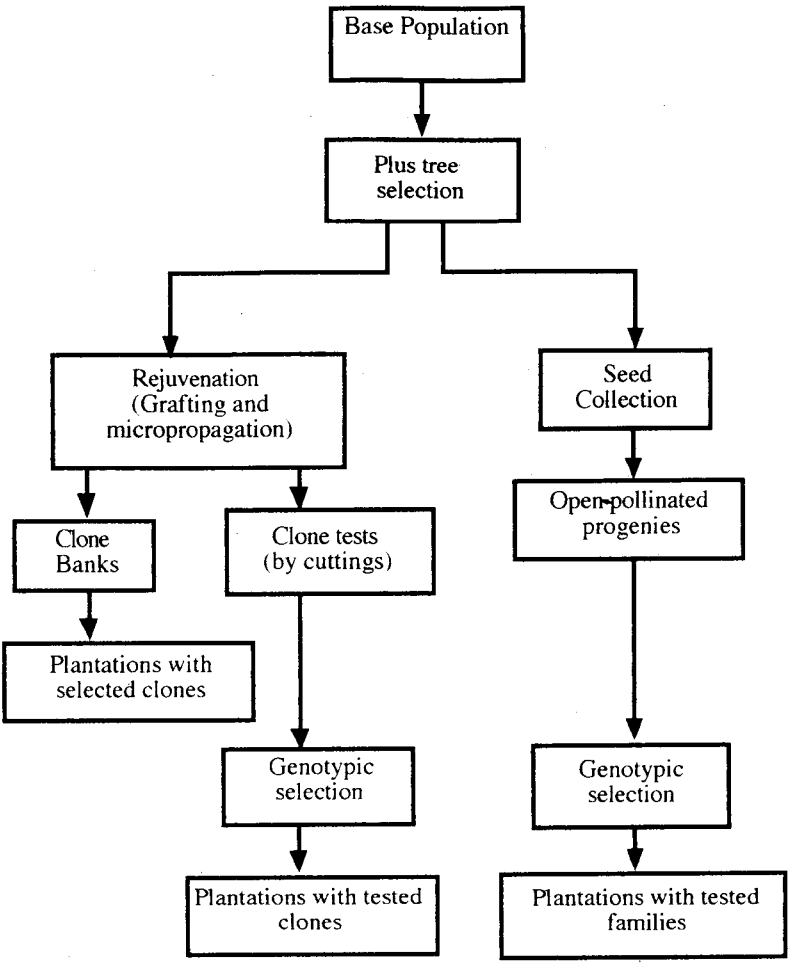

Fig 1. Cork oak breeding program (Anonymous, 1990b).

Vegative macropropagation: vegetative propagation is not easy to accomplish with cork oak, either through grafting or cuttings, although some success has been achieved. This approach includes the use of homoplastic and heteroplastic bark grafting in cork oak and holm oak (*Quercus rotunfifolia* Lam) with 4–5-year-old stocks and also through side grafting in 2-year-old stocks. Top grafting has frequently been found to suffer from rejection of the graft unions (Roldão *et al,* 1990).

Correia (1981) used bud grafting to establish a small single clone plot but this method requires very skilled workers. This plot, now aged 14–15 years, has not produced seeds so far, leading to the belief that the technique may be valuable for re-

juvenating material from old trees. Experiments are being carried out to test this hypothesis.

The production of rooted cuttings from young plants, under controlled environmental conditions, has been successful (Roldão, 1990). The strategy outlined for the cork oak breeding program at EFN consists of obtaining vegetative reproduction of the plus trees by means of bud and side grafting and later mass propagation by cuttings.

Establishment of clone banks: the clone bank of plus trees selected has been started.

Investigation of morphological and structural correlations: a forecast of the quality of cork is very important for a breeding program.

Assuming that the cork oak trees produce cork of high quality and show a continuity of consecutive (renewed) periderms as opposed to the peridermic rings which characterize the other Querciniae, as well as the products resulting from hybridization with *Quercus suber*, we intend to pursue the study of their periderms from the 3rd year of sowing (Carvalho, 1991). This is a very relevant point to be considered in experiments with young plants.

At the same time, high quality clones are being characterized using chemical methods, looking for eventual genetic correlations between the occurrence of certain isoenzymes, the characteristics of the cork tissue and the environment. A study of the isoenzymes and proteins in pollen produced by cork oak has been started using electrophoresis on acrylamide gel (Nobrega *et al*, 1990).

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