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A handbook on propagation of Mediterranean trees and shrubs from seed

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The Department of Environmental Prevention and Reclamation within the Italian Environment Protection Agency (ANPA) has prepared and published the handbook *Propagation of Mediterranean Trees and Shrubs by Seed* as a contribution to the Italian Committee to Combat Desertification. It has been printed in Italian but it will be translated in English. An Italian version, which is going to be translated into English* soon, is present in the web. Plainly we can say that the handbook is written for everyone who works with propagation of Mediterranean trees and shrubs. The first part includes chapters regarding the Mediterranean basin environment (vegetation, regeneration of vegetation after fires, reasons for vegetation decline, etc) and general methods of producing and handling seeds. The second part is a compilation of propagation data of 120 Mediterranean trees and shrubs.

The publication of the handbook gives a good chance to speak about the Mediterranean Ecosystem as well as about the seed problems of Mediterranean trees and shrubs, often neglected items.

The Mediterranean Ecosystem is undergoing a tropicalisation trend. In the last forty years there has been an increase of 20% in carbon dioxide in the atmosphere and in the last twenty years a noticeable increase of temperature has been recorded so that 'greenhouse effect' and 'desertification effect' can be considered as aspects of the same problem. Similarly there is enough evidence with respect to the high number of linkages between desertification, climate change and biodiversity.

Nearly 27% of the Italian territory, mainly located in areas with Mediterranean climate and vegetation, is threatened by processes of degradation, erosion or desertification.

Desertification in the European Mediterranean countries is linked to the following general characteristics of the region:

– highly vulnerable environment due to particular climatic and geomorphological characteristics combined with frequent unsustainable use of land;
– four thousand years of strong human pressure due to agricultural and pastoral activities, often in conjunction with phases of demographic growth and/or rapid economic development;
– increase of pressure from the '50s following major economic transformations which has led to intensification of mechanisation of agricultural practises, increase in water demand, increase of urban and tourist development, increase of soil and water pollution, concentration of human economic activities in coastal areas, fragmentation of landscapes;
– increasing aridity of the climate in the region (according to forecasts from advanced models);
– extensive forest cover losses due to frequent wildfires.

In the Mediterranean region fire has always been part of the ecosystem since its presence was favoured

* and Arabic (in collaboration with the International Plant Genetic Resources Institute).

by dry summer climate characterised by almost absolute lack of rainfall and presence of xeric vegetation. Mediterranean vegetation adapted itself to natural periodic fires with active and passive defence mechanisms but the high frequency of burnings in the last decades in many cases has led to soil degradation accelerated by rainfall water action. In fact, after a rain event there can be a migration of residual organic matter to the underlying horizons where waterproof repellent layers can develop. In presence of a certain slope a sort of slip sheet facilitates the falling down and loss of soil layers.

Chapter 3 deals with post-fire vegetation dynamics and regeneration in Mediterranean ecosystems. Understanding the role of fire in natural plant regeneration, especially the fire stimulation on seed germination, is extremely useful for artificial propagation. Example of this are studies carried out in Australia, South Africa and California which investigate the smoke or smoke extracts responsiveness of some germination patterns in areas with Mediterranean climate.

Deforestation, especially if followed by overgrazing with soil compactation, can be considered as the principal anthropic cause of groundwater loss in Mediterranean areas. Mediterranean woodlands, especially in arid areas, have diminished considerably and in many cases are degraded with large denuded surfaces characterised by thin soils alternating with outcropping rock. This means that the floristic and structural diversity of the natural vegetation, as well as the faunistic species richness and abundance, is constantly been reduced.

Unfortunately, the vulnerability of Mediterranean ecosystems allow a higher negative impact from factors that lead to any form of degradation.

In light of the above, the regeneration and management of woodlands in the Mediterranean needs particular attention: the role of plant cover is essential for mitigating desertification processes because vegetation and connectivity of 'green areas' strongly condition the quality and evolution of soil. Trees and shrubs in the Mediterranean areas show a multiplicity of functions

- supply of organic matter to the soil;
- immediate and effective response to degradation caused by grazing, fire and deforestation;
- watershed protection;
- maintaining of biodiversity;
- production of wood, mushrooms, fruits;
- possibility of balanced extensive grazing;
- conserving landscape features of vast areas.

Mediterranean flora is well described from a botanical point of view. Abundant information is available for what concerns botanical and ecological characteristics, distribution and occurrence, value and use of many species but little is known about their natural and artificial regeneration. The absence of this information is particularly serious because it represents a lack of knowledge to address a multipurpose approach to forestation, restoration and reclamation and may explain the reason why plantings are often limited to a narrow number of species which are easy to grow in the nursery. This practice greatly reduces levels of biodiversity and it is even more worrisome with regard to shrubs and minor hardwood which are the greater part (60 to 70%) of the Mediterranean woody flora.

However, forest and conservation nurseries are being asked to propagate an increasingly number of Mediterranean plants. Learning how to propagate these 'new' plants properly, including those deserving a wider use as drought-tolerant ornamentals, can be a formidable challenge.

The main target of this handbook is to offer information about propagation by seed of 120 Mediterranean trees and shrubs. When available, the following items are focused within plant fact sheets for each species: fruiting and factors that can affect it, seed quality data (number of cleaned seeds per kg, average germination percentage, etc.), seed ripeness, dispersal, storage, dormancy and presowing treatments to enhance and speed germination. Techniques to optimise nursery production, if known, are presented as well.

Gathering and processing these data was not easy because published information on how to propagate Mediterranean species is extremely limited and nursery workers, important sources of knowledge, just do not have the time to document what they know. More than 30 authors have given valuable contributions to the volume, most of them are Italians but also Spanish, English and Australian researchers have participated.

An item needing deep investigation is removal of dormancy in seeds dispersed by birds and small mammals. Seed dispersal by birds and small mammals is quite frequent in shade tolerant Mediterranean plants occurring in the understory (*Lonicera* spp., *Rhamnus alaternus*, *Ruscus aculeatus*, *Smilax aspera*, etc.), this habit being often associated with the presence of seed complex dormancies, removal of which is often unknown.

Storage of seeds has been examined in Chapter 10. Storability can be a great potential or, on the other hand, a heavy limitation for genetic resources conservation. In other words, if seeds of a given species do not allow medium or long term storage, its genetic variability could be threatened.

A large variation in storability is encountered between Mediterranean species. In seed handling terminology, seeds have been classified in two main groups

according to their physiological storage potential: orthodox and recalcitrant seeds. Orthodox seeds can be dried to low (5%) moisture content and can, with low moisture content, be stored at low temperature (+3 to –18°C), generally for long periods. Seeds of recalcitrant species maintain high moisture content at maturity (often > 30–50%) and are sensitive to desiccation below 12–35% (depending on species). They also lose viability rapidly and, for this reason, storability is difficult.

Although the terms 'orthodox' and 'recalcitrant' seem to define opposite conditions, storage physiology of seeds seems to cover a more or less continuous spectrum, ranging from extremely recalcitrant (loss of viability in few days) to extremely orthodox (under optimal conditions viability is maintained for decades or centuries).

Storage of recalcitrant seeds is considered to be the most challenging problem in seed science today.

Success in short-term storage (3–4 years) of recalcitrant seeds of the temperate zone, primarily *Quercus*, has been achieved with both North American and some European species.

Unfortunately, the development of strategies and methodologies for the management and conservation of Mediterranean oaks (*Quercus calliprinos*, *Q. ilex*, *Q. macrolepis,* etc.) genetic resources, including storage of recalcitrant acorns, have been afforded only recently. Within this group of long neglected species (disadvantaged for seed dispersal because of land fragmentation and lack of animal vectors in Mediterranean areas), an urgent priority has given to *Quercus suber* (cork oak). Cork is a regenerative raw material with high technological qualities combined with positive peculiar ecological characteristics; in many cases it has been defined as an *strategic material*. Since a couple of years storage of acorns of *Quercus ilex* (predominant tree in the *climax* phase of the sclerophyllous forest) is being studied as well.

The handbook reports updated current practices of storage of recalcitrant seeds which could be adapted to seeds of Mediterranean oaks. Storage of orthodox seeds is examined as well.

Success of plantation establishment relies heavily on genetic variability, which allows adaptation to countless factors like climate, climate change, site conditions, drought, pests and diseases, thus permitting natural evolution of ecosystems. This is particularly necessary when artificial regeneration (afforestation or reforestation) aims at reclamation of disturbed land or at combating desertification.

Propagation techniques, involving collecting, processing, storing and pre-sowing treatment of seeds, culling seedlings, could erode genetic diversity, if they are not properly used. Risks related to adoption of wrong nursery programmes and, particularly, use of unsuitable propagation techniques are present even in high-developed countries. Nevertheless, many national nursery strategies are focusing on the propagation of a large number of neglected Mediterranean native species and, fortunately, recent research results are having positive effects.

Chapter 11 describes the usual presowing treatments employed in forest nurseries, the risks of genetic erosion that they could imply and the modern techniques that prevent diversity losses. In particular, those methods allowing dormancy breakage to occur in all seeds without ever permitting germination during pre-sowing treatment and avoiding unintentional selection of seeds requiring longer or more complex presowing-treatments.

Other chapters regard the Mediterranean flora (Chapter 1), the degradation of Mediterranean vegetation (Chapter 2), woody plants of Mediterranean melliferous flora (Chapter 5), natural vegetative propagation in Mediterranean plants (Chapter 6), harvesting and processing of seeds (Chapter 8) and seed testing (Chapter 10).