Italian stone pine

Pinus pinea

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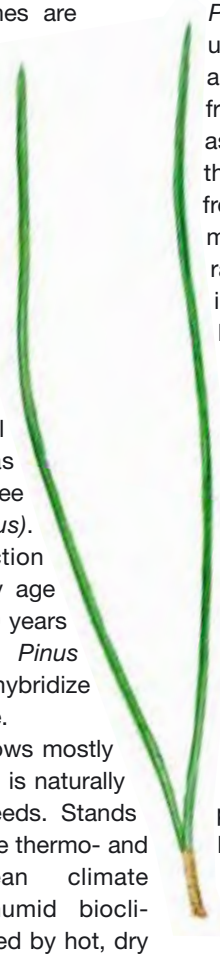
These Technical Guidelines are intended to assist those who cherish the valuable Italian stone pine genepool and its inheritance, through conserving valuable seed sources or use in practical forestry. The focus is on conserving the genetic diversity of the species at the European scale. The recommendations provided in this module should be regarded as a commonly agreed basis to be complemented and further developed in local, national or regional conditions. The Guidelines are based on the available knowledge of the species and on widely accepted methods for the conservation of forest genetic resources.

Biology and ecology

Italian stone pine (*Pinus pinea* L.) is the only representative of the Section *Pinea*, subgenus *Pinus*. A tree 10–25 m tall, it has long horizontally spreading or ascending branches that give its adult crown a characteristic umbrella-like shape.

Twigs are glabrous, first green, then greyish; buds are approx. 1 cm long, with brown scales. Needles are bright green, stiff and born in fascicles of two. They persist for 2–3 years (occasionally 4). Needles are 10–15 cm long with an acute apex and stomata on each side. Male and female flowers are located on the same tree (monoecy). Yellow pollen catkins are located in clusters at the base of the season's shoot; ovulate cones are erect, approx. 2 cm long. Pollen is transported

by wind. Fecundation takes place 2 years after pollination and cones reach maturity in 3 years. Mature cones are large (8–14 cm long) and broadly ovoid, sessile and isolated. Cone scales are flat and bear two large seeds (1.5–2 cm) with an easily detachable small wing. Seeds are heavy and mostly dispersed by gravity or by small mammals such as the frugivorous tree rat (*Rattus rattus)*. Seed production begins at an early age (15–20 years; 5–10 years in isolated trees). *Pinus pinea* does not hybridize with any other pine.



Pinus pinea grows mostly in pure stands and is naturally regenerated by seeds. Stands are found within the thermo- and meso-Mediterranean climate zones and subhumid bioclimates, characterized by hot, dry summers (up to 5 months drought) and rainy, mild winters (mean temperature of the coldest month over 0°C and rainfall of 600–800 mm yr^{-1}). It is light-demanding and prefers acidic or neutral sandy soils although it tolerates slightly calcareous substrates.

Distribution

Pinus pinea is patchily distributed all around the northern and eastern Mediterranean, from Portugal to Syria as well as along some coastal areas of the Black Sea. It can be found from sea level up to 500–600 m in the northern Mediterranean and up to 800–1400 m in the eastern Mediterranean. Because of its economic importance, human impact can be expected to have strongly influenced the current distribution of its geographic and genetic diversity. *Pinus pinea* (formerly named *Pinus domestica*) was extensively planted around the Mediterranean throughout historical times by Etruscans, Greeks, Romans and Arabs because of its edible seeds. Anatolia, Lebanon and the Iberian peninsula are its most probable original areas. Cone and wood charcoal fragments of *P. pinea* approx. 50 000 years old have been found in Spanish Paleolithic settlements.

Pinus pinea has been successfully introduced into North Africa (mostly Tunisia, Algeria and Morocco) as well as Argentina and South Africa. In other places (e.g. California, Scotland, southern England) it is usually confined to parks and gardens.

Importance and use

Pinus pinea has a heavy and very resinous wood with a yellow-reddish heartwood and a whitish-pink extensive sapwood. Although it has been cultivated since the Roman period for timber (construction and ship-building), its most economically important product is its seed, the pine nut (hence its Latin name "*pinea*"). Spain, Portugal, Italy, Tunisia and Turkey are the main countries where pine nuts are traditionally marketed. Other products of economic value include resin, bark (for tannin extraction), and empty pine cone shells (for fuel). *Pinus pinea* is also currently widely cultivated around the Mediterranean for environmental protection: consolidation of coastal dunes, soil conservation and protection of coastal agricultural crops.

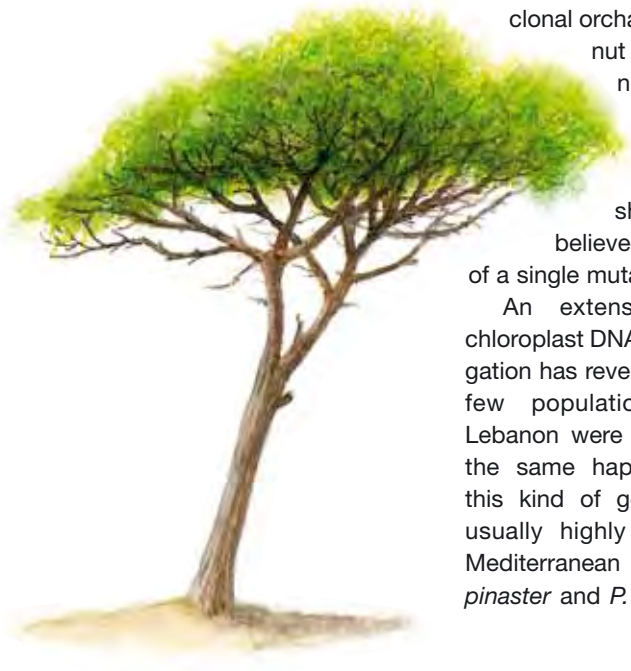
The Italian stone pine is a dramatic ornamental tree, widely planted in parks and gardens throughout the world. In Italy it is a traditional element of the landscape (hence one of its common names, the 'Italian stone pine'). In southern France, it was a symbol of freedom for persecuted Protestants during the religious wars of the Renaissance.

There is a growing worldwide market for pine nuts, boosted by claims supported by the US Food and Drug Administration that eating its nuts reduces the risk of coronary heart disease, an

effect ascribed to their high linoleic acid content. *Pinus pinea* is one of the nine major tree nut species worldwide and its seeds have a high nutritional content, particularly rich in proteins (32%), fats (45%) and vitamins B1 and B2.

Pinus pinea is included in the list of forest tree species in Directive 1999/105/CE of the European Union Council (December 22, 1999) for the commerce of forest reproductive material. Minimum requirements have to be met before *P. pinea* seed can be sold for reforestation.

Wooded dunes with *P. pinea* (and/or *P. pinaster*) are considered a priority habitat for conservation in Europe under the "Habitat" Directive (n° 92/43/CEE of May 21 1992).



Genetic knowledge

A range-wide, 15-site provenance trial network using common material was established in 1994–96 in France, Italy, Morocco, Spain, Tunisia and Turkey to test for adaptive genetic variability of Italian stone pine across as many ecological conditions as possible. Experimental trials have also been installed in Brazil, Portugal, Russia and Zimbabwe.

Pinus pinea is genetically very uniform; there are no descriptions in the literature of geographical races, ecotypes or cultivars. Provenance trials do not indicate any strong geographic structure in adaptive traits such as vigour. High nut production is achieved through the establishment of grafted clonal orchards and classical nut production techniques. One variety, *P. pinea* var. *fragilis*, which produces soft-shelled seeds, is believed to be the result of a single mutation.

An extensive range-wide chloroplast DNA diversity investigation has revealed that all but a few populations located in Lebanon were characterized by the same haplotype, although this kind of genetic marker is usually highly polymorphic in Mediterranean pines (e.g. *Pinus pinaster* and *P. halepensis*). This near-absence of diversity is also confirmed by isozyme analysis.

The stereotypic appearance of its crown, so familiar to the Mediterranean people, could also be attributable to this extremely low degree of genetic diversity, possibly inherited from the Quaternary history of the species. Confined to a narrow distribution range during successive glacial times, *P. pinea* may have experienced a further reduction of its genetic diversity with the advent of traditional agriculture and long-distance trading.

Threats to genetic diversity

Pinus pinea is not considered a threatened species. Although its genetic diversity is low, it is comparatively rarely attacked by pests and diseases.

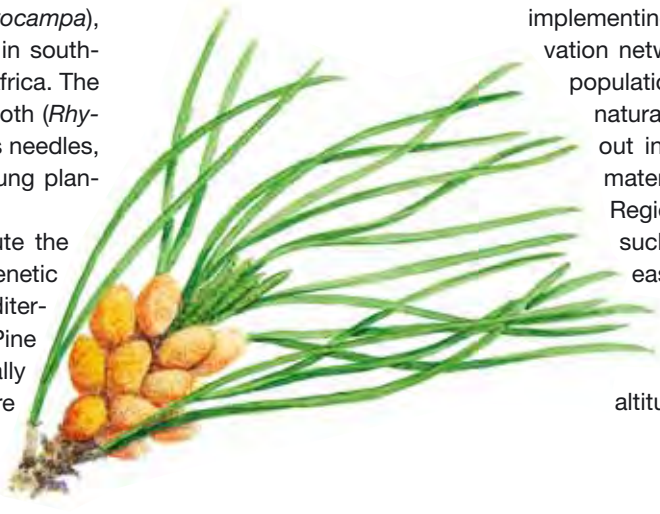
However, diseases such as blister rust (*Cronartium flaccidum*), twisting rust (*Melampsora populnea* f.sp. *pinitorqua*) and needle rust (*Coleosporium tussilaginis*) can sometimes cause serious damage to seedlings and young plantations. *Diplodia pinea*, generally considered a pathogen of weak trees, may be responsible for some severe attacks after water stress. *Heterobasidion annosum* can sometimes produce extensive losses through decay and root rot.

Some insects are also known to provoke localized but severe damage. Phytophagous insects such as the red-black spittle bug (*Haematoloma dorsata*), can be responsible for needle drying. The pine processionary caterpillar (*Thaumetopoea pityocampa*), can cause defoliations in southern Europe and North Africa. The European pine shoot moth (*Rhyacionia buoliana*), mines needles, buds and shoots in young plantations.

Forest fires constitute the major threat to the genetic diversity of most Mediterranean forest species. Pine ecosystems are especially prone to fire and entire stands can be wiped out in a single fire. *Pinus pinea* is considerably less fire-sensitive than other species, given its thick bark and high crown devoid of low branches. A unique feature among pines, up to 90% of the canopy of *P. pinea* can be burned without killing the tree. *Pinus pinea* forests also regenerate well from seeds after fire.

Populations of *P. pinea* are highly sensitive to air pollution, especially when combined with other environmental stresses such as drought.

Because *P. pinea* was so highly valued for its seeds, it is very likely that the same genetic material was used for planting in different regions of the Mediterranean. This would explain its low genetic diversity. It is also a source of concern as genetic uniformity increases the risk of extinction when environmental conditions change.



Guidelines for genetic conservation and use

The conservation of forest genetic resources in the Mediterranean basin is a very complex task, as ecological and socio-economic conditions are highly variable among countries. Because of their history of over-exploitation since agriculture emerged some 10 000 years ago, assessing whether current Mediterranean forests are really well adapted and truly natural is challenging, although necessary for any careful conservation strategy.

This is the case for *P. pinea*, in particular. A number of scientific gaps should be filled. The past history and ecology of this species need to be understood to outline the areas of autochthony. Knowing its current adaptive diversity is also a prerequisite to outlining its potential distribution area and the consequences it may suffer from environmental changes. As in other forest tree species, implementing an *in situ* conservation network where selected populations are allowed to naturally regenerate without introduction of exotic material is recommended. Regions of autochthony such as Spain and the eastern Mediterranean, areas where ecological conditions are extreme (high altitude, low rainfall, high

salinity etc.), and areas where extensive populations currently exist, should be the primary targets for such a network.

Appropriate silvicultural and management strategies should include the leaving of the highest possible number of seed trees before regeneration to promote maximum outcrossing and pollen flow. This might mean not cutting severely burned trees after wild fires. It should also include, in areas that are not designated for seed production, letting natural selection (rather than managed thinning) sort out young trees after regeneration. Wild fires and overgrazing being the most important risks for *P. pinea* forests, fire protection and social measures that might reduce these hazards should also be addressed for the effective conservation of this typically Mediterranean pine.

EUFORGEN

These Technical Guidelines were produced by members of the EUFORGEN Conifers Network. The objective of the Network is to identify minimum genetic conservation requirements in the long term in Europe, in order to reduce the overall conservation cost and to improve the quality of standards in each country.

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