Pinus greggii Engelm. ex Parl.

W.S. DVORAK
Central America and Mexico Coniferous Resources Cooperative (CAMCORE)
Department of Forestry, North Carolina State University

PINACEAE (PINE)

No synonyms

Ocote, ocote chino, pino garabatillo, pino garabato, pino prieto
(Flores 1996, López-Upton 1996, Perry 1991)

Pinus greggii is a closed-cone pine that occurs in two distinct geographic regions in Mexico: the States of Coahuila and Nuevo Leon (24° to 25° N latitude) in the northern part of the country (northern population), and in the States of Puebla, San Luis Potosi, Hidalgo, Queretaro, and Veracruz (20° to 21° N) in the central region (southern populations). The reason for the 360-km gap in the species distribution between *P. greggii* trees in the north and south is not readily understood because other pines, like closely related *Pinus patula* Schiede & Schltdl. & Cham., are found in the transition area (Donahue and López-Upton 1996).

Trees from northern and southern populations differ in external needle and cone morphology, flowering patterns, seed size, and monoterpene percentage their native environment (Donahue and López-Upton 1996, Donahue and others 1995, López-Upton and Donahue 1995). Morphologic differences and differences in growth rates between trees from northern and southern populations are even more pronounced when the trees are grown as exotics (Dvorak and others 1996b, Kietzka and others 1996).

Pinus greggii trees from the northern populations occur in small (20 ha), degraded stands on shallow calcareous soils with pH 6.8 to 7.7 (Donahue and López-Upton 1996). These populations exist at elevations from 1900 to 2600 m with annual rainfall between 650 and 750 mm, and the trees are cold and drought tolerant. Trees average only 6 to 15 m in height and 22 to 40 cm d.b.h. at maturity and are often limby and poorly formed. Growth rates of trees in this harsh environment probably average 1 to 2 m^3 per ha per year. *Pinus greggii* trees in northern populations, seldom found with other pines, are more often associated with *Abies spp.*, *Quercus spp.*, and *Pseudotsuga flahaulti* Flous.

The southern populations of *P. greggii* occur in stands of 20 to 5,000 ha on predominantly acidic soils with pH 4.2 to 6.1 (Donahue 1990, Perry 1991). Trees in these populations are found at elevations of 1250 to 2380 m and receive between 1465 to 2380 mm of annual precipitation. *Pinus greggii* from southern populations are as cold tolerant and probably more drought tolerant than *P. patula* but seem less hardy than *P. greggii* from northern populations when planted as an exotic based on early results from progeny tests (Kietzka and others 1996). Trees from southern populations range from 9 to 20 m in height and 25 to 40 cm d.b.h and are of regular to excellent phenotypic quality. Growth rates of 3 to 6 m^3 per ha per year are common. Southern populations are found in close proximity to *P. patula, P. teocote* Schiede ex Schlectendal & Chamisso, and a number of *Quercus spp*. (Donahue and others 1995).

Pinus greggii is thought to naturally hybridize with *P. patula* at Jalameco and Carrizal Chico, Hidalgo (Donahue and López-Upton 1996). Artificial hybrids between the two species have been successfully made (Fielding 1960).

In its native environment, the wood of *P. greggii* is whitish to pale yellow in color and of moderate density (0.450 g per cm^3 to 0.550 g per cm^3) based on results from trees assessed between 25 and 30 years of age (Murillo 1988). The wood is used locally for fuel, fence posts, and construction.

Pinus greggii was tested in species trials in approximately 10 countries in the subtropics between the 1960's and 1980's (Dvorak and others 1996b). These introductions apparently included genetic material from the southern populations only. Range-wide provenance and progeny tests of both northern and southern populations of *P. greggii* were carried out in Brazil, Colombia, New Zealand, South Africa, and Zimbabwe in the late 1980's (Dvorak and others 1996b, Kietzka and others 1996). Preliminary results suggest the provenances of northern *P. greggii* should be planted on sites too cold and dry for *P. pat-*

ula; southern sources should be established on sites too dry for *P. patula* (Dvorak and others 1996b, Kietzka and others 1996).

Both northern and southern sources of *P. greggii* are being planted on a limited commercial scale (1000 ha per year) in South Africa, and the tree's popularity as a plantation species is growing (Kietzka 1997). In South Africa, wood from 16-year-old trees of southern sources had properties very similar to *P. patula* in terms of density (0.480 g per cm^3) and percent extractives, and was found to be acceptable for mechanical pulp (Dommisse 1994). Trees of southern sources also had excellent structural quality for saw timber, but poor stem form and high concentrations of knots reduced board quality (Malan 1994).

In its native environment, *P. greggii* begins flower and cone production at approximately 4 to 5 years of age. Trees from the northern populations flower in May or June; those from southern populations in April and May (López-Upton and Donahue 1995). When planted in Brazil and South Africa as an exotic, *P. greggii* trees from northern populations produce a heavy female flower crop 18 months after field planting. The female flowers on trees from northern populations are usually larger and more reddish than those from southern populations. Trees from southern populations may flower as early as 18 months, but more often a light-to-moderate crop of female flowers emerges approximately 24 months after field planting. In southern Brazil, initial heavy flowering at approximately 2 years of age was followed by relatively little flowering for 4 years. Heavy flowering began again at approximately 6 years of age. In South Africa, *P. greggii* flowers twice during the year. The northern sources flower from November to January; information on a second flush is currently unavailable. The main flowering time for the southern populations is September through November and a second flush of predominantly female strobili occurs in February and March (Kietzka 1997). At the Institute of Forest Genetics, Placerville, California, *P. greggii* flowers twice: once in November and again in June (Critchfield 1967).

In Mexico, cones ripen in December and January, approximately 21 months after pollination. Coning is prolific with clusters of 8 to 10 cones common in many portions of the crown (Donahue and López-Upton 1996). Because the species is a serotinous pine, mature cones may stay closed on the tree for several years. In studies conducted in natural stands in Mexico, trees from northern populations were found to have slightly longer cones than those from southern populations (115 mm vs. 105 mm) but had a lower seed potential (92 vs. 116) (López-Upton and Donahue 1995).

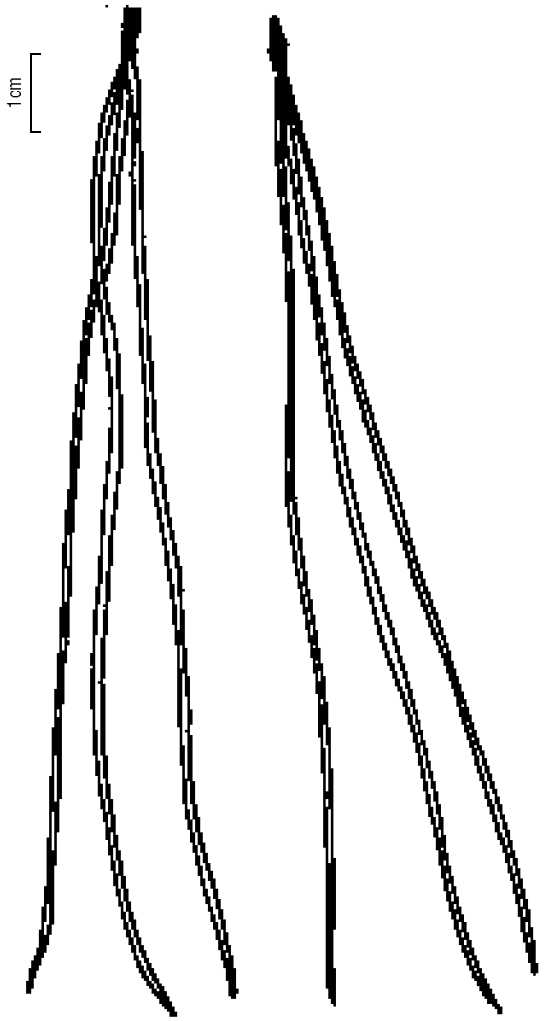
The average number of filled seeds per cone was less for trees in northern populations than in southern populations (46 vs. 74). Trees from northern populations appear to be much more infested with cone and seed insects in natural stands than those of the southern populations, which may explain lower seed yields (López-Upton and Donahue 1995). In South Africa, cones usually ripen in August. Cones from a *P. patula x P. greggii* cross matured 33 months after flowers were pollinated (Kietzka 1997). Future studies will accurately determine reproductive cycles for *P. greggii* across its many new environments.

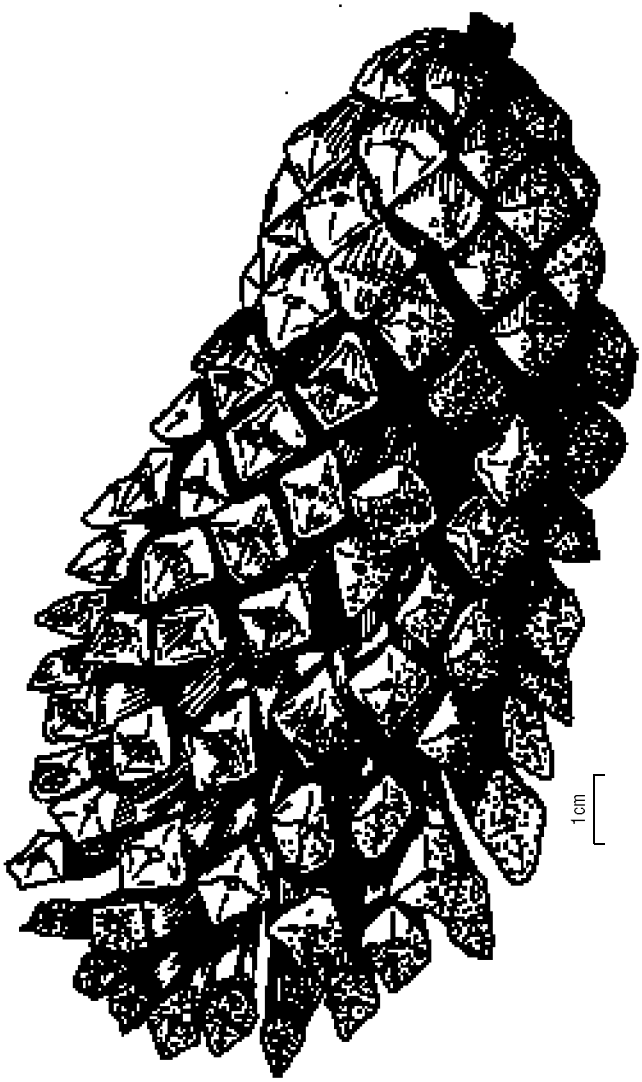
Cones should be collected when they are light brown, and old cones that are gray should not be harvested. Cones are held tightly on branches and care is needed when removing cones from the trees to avoid damage to future cone crops. In Mexico, cones are removed from branches by tree climbers. Cones that can be reached are pulled off the branches by hand. Cones at the end of long branches are removed using an aluminum or wood pole. The pole has a curved blade at the end that pries or cuts the cones from the branches.

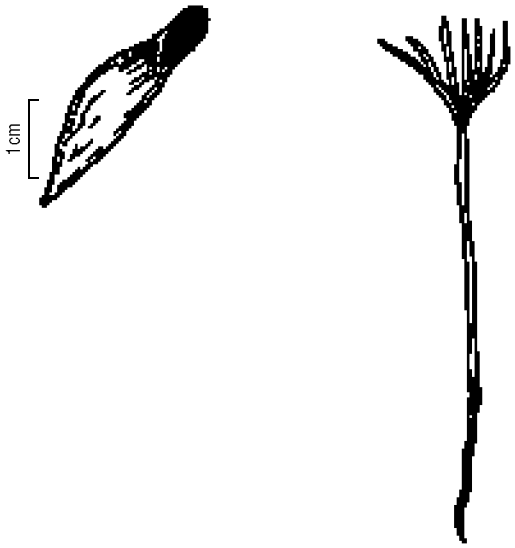
Cones can be air-dried in the sun for several days or placed in a kiln at 45 to 48 °C for 24 to 48 hours. The seeds from trees in northern populations are significantly larger than those from southern populations. Average seed yields for trees in natural stands from northern populations was 55,500 seeds per kg; from southern populations, 67,100 seeds per kg. From a seed orchard in South Africa, 68,000 seeds per kg were obtained from clones of southern sources. No information is available on seed quantities from trees of northern sources when planted as an exotic.

The seeds of *P. greggii* germinate well in moist sand or similar media. Even though cold stratification is not necessary for good germination, studies by Donahue (1990) indicates that a 30-day cold stratification increased the rate of germination for trees from southern populations but had no effect on trees from northern ones. Germination rates of 30 to 70 percent have been found for seeds collected from natural stands in Mexico. In large commercial nurseries in South Africa, *P. greggii* seed is placed in a porous cloth bag in a water bath, pH 5.6, at 28 °C, and compressed air is bubbled through for 24 hours (Kietzka 1997). Excess moisture is toweled off and the seed is sowed.

Seedlings of *P. greggii* from both southern and northern populations intended for outplanting at 10 cm height can be produced in most nurseries in 5 to 6 months. Planting seedlings at this height succeeds in harsh environments in South Africa and lessens the chance for subsequent J-root problems. Seedlings from southern sources will reach shoot heights of 20 to 25 cm in 7 to 8 months, especially in tropical and subtropical environments in Brazil and Colombia. Seedlings from northern sources may take two growing seasons in the nursery to reach these heights because the plants set a resting bud sooner than those from southern provenances.


1 cm


1 cm


1 cm