

PINUS CARIBAEA CONE MATURATION IN PUERTO RICO

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Abstract.--Plantations of Pinus caribaea var. hondurensis located on a variety of sites in Puerto Rico provide an opportunity to study the effects of topography, soils, climate and tree age on cone production.

Factors which appear to favor the production of viable seeds are well-drained soil, a seasonal rainfall pattern and wide spacing in plantations. Adequate pollen production and dispersion are rarely found in the moist and wet forest zones where annual rainfall exceeds 80 inches (2032 mm).

Additional keywords: Tropical pines, seed production, pollen dispersion.

INTRODUCTION

Puerto Rico is a U. S. Commonwealth and a part of the Southern Region of the USDA Forest Service. The Forest Service involvement in Puerto Rico includes:

--The Caribbean National Forest: 28,000 acres of land including the only tropical rain forest in National Forest ownership.

--The Institute of Tropical Forestry: a branch of the Southern Forest Experiment Station.

--State and Private Forestry: the technical assistance and training branch of the Forest Service.

The work reported here was done as a part of the tree improvement training and technical assistance provided to the Puerto Rico Department of Natural Resources - Forest Service.

Puerto Rico shares a history of land exploitation similar to the United States. By 1935 85% of the natural forest had been cut-over. The continual pattern of small ownerships, cut and burn agriculture and unstable economy have combined to create a tremendous need for reforestation. Also the uncertain future of both sugar cane and coffee has provided an increasing demand for reforestation on many sites.

SITES - SPECIES

Due to the tremendous variation in elevation (sea level to over 1,000 meters), rainfall (36-180 inches:900-4600 mm) and soils (volcanic, granitic, limestone and serpentine) a great variety of sites exist on the island. Since the native species have been severely depleted a good opportunity exists for exotics. Notable among these are mahogany (Swietenia macrophylla, S. mahogoni, and the putative hybrid S. macrophylla x mahogoni), teak (Tectona grandis) mahoe (Hibiscus elatus), Eucalyptus alba, grandis, robusta, and deglupta, Pinus oocarpa and Pinus caribaea.

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PINUS CARIBAEA

Plantations of tropical pines were established in the early 1960's in Puerto Rico with provenance tests, spacing studies and some unreplicated species trials. Honduras pine (Pinus caribaea var hondurensis) has been the best overall performer when all pine sites are considered. The Belize Mountain Pine Ridge source has consistently outgrown other sources of Honduras pine in Puerto Rico as it has in many other tropical areas.

- Honduras pine:
- a. survives and grows well on a variety of soils within the rainfall zones of 50 to 120 inches (1270 to 3048 mm).
 - b. produces wood of acceptable quality for posts, poles and lumber.
 - c. can be regenerated at reasonable cost with seedlings grown in plastic bags or styroblocks in shade houses.

SEED QUALITY

Early efforts at Honduras pine cone collection and seed processing were discouraging with yields of 10, 15 or 20 seeds per cone. Venator (1973) found 68% empty seeds in local collections in Puerto Rico. Recent cone collections on the island (1982) have resulted in an average of less than 10 seeds per cone with only 50% filled seeds. Many of the cones contained primarily first year aborted ovules (Bramlett et al 1977).

FLOWERING OF PINUS CARIBAEA

Puerto Rico is located at 18° N latitude. This is well within the latitudinal band of 9-27° N which Gallegos (1980) identified as the optimum environment of Honduras pine for seed production. In Puerto Rico however multiple sets of female flowers are often produced in the high rainfall areas (>80"-2032 mm) but male flowers are erratic in appearance. Ibrahim (1977) commented on a similar situation in Malaysia (3° N) where pollen production often occurred too late to be effective. In addition, the lack of air movement in the humid tropical environment limited pollen dispersal. Attempts at controlled pollination failed, perhaps due to excessive temperature (32° C). Ibrahim extracted only 3-6 viable seeds per cone.

The association of flowering with type of climate was recently mentioned by Delwaulle (1982) referring to the flowering of Honduras pine in the Congo (5° S). In the southern Congo Honduras pine produces good seed crops from plantations and seed orchards even though it is in a "non-productive" latitudinal zone. Delwaulle's explanation for this is the marked dry season (4-5 months) during which flowering and seed production occur. Mean annual precipitation is 47" (1194 mm) which with the dry season places this area in a köppen climatic type Aw (Tropical Savannah climate). The natural range of Honduras pine in Belize falls in this climatic type as does other areas of good seed production such as northern Nigeria and Uganda.

The Anasco area of Western Puerto Rico averages 2090 mm (82") of rainfall but a dry period occurs from December to March during which time flowering occurs.

In this area flowering and seed production appear to follow a more "normal" development as attested by abundant natural regeneration on the edges of 10 to 18 year-old plantations. It would appear therefore that this area fits Delwaulle's hypothesis.

The higher rainfall areas of eastern Puerto Rico referred to earlier fall into a Köppen type Af (rain forest, wet tropical lowlands) where conditions are continuously wet and there is no definite dry period. Other areas in this climatic type are French Guiana, the Phillipines and parts of Brazil (Delwaulle 1982).

Fiji (17° S) would appear to be an exception to Delwaulle's hypothesis since flowering and seed production of Honduras pine has been outstanding in an area of high annual precipitation. However, the climate does include a dry season, corresponding to a Köppen type Am (Monsoon climate). Cone maturation progresses from high elevation (450 m) in mid-December to low elevation (30-100 m) in mid March (Dvorak 1977). Cones from the high elevation plantation have the highest percent of good seed (95%) and also the highest germination percentages (57-72%).

CONE MATURATION STUDIES

Young plantations on a variety of sites in Puerto Rico have been selected for conversion to seed production areas. In the process of establishing these seed production areas the following procedures will be followed:

- a. 10 trees per month will be cut (June to September).
- b. observations will be recorded of phenological events such as growth stage, flower, conelet, and cone development.
- c. 5 cones per tree will be collected, measured, and checked for floatation in water, kerosene and SAE 20 motor oil.
- d. these cones will be retained in individual tree lots for drying, recording of cone opening and seed extraction, and germination test results.

Permanent flowering and cone observation stations will be established in several of these seed production areas and in an 11 year-old seedling seed orchard.

CONCLUSIONS

The production of viable seed by Honduras pines in Puerto Rico appears to be linked to a pronounced dry season which favors good pollen dispersal. The high elevation wet sites produce abundant female flowers throughout the year but male flowering is sporadic. When anthesis does coincide with female flower receptivity the continuously wet conditions often limit pollen dispersal. This results in a large number of first year aborted ovules - the characteristic "wings without seeds" (Bramlett et al 1977).

Studies in process are designed to develop a better understanding of the phenology of Honduras pine in Puerto Rico. The cone maturation process will be observed by a series of monthly cone collections and phenological observations throughout the island.

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