GENETIC IMPROVEMENT OF PECAN FOR WOOD PRODUCTION

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Abstract.--A program involving individual tree and stand selection, provenance and progeny testing of native pecan is in progress at Louisiana State University. Research progress and planning is summarized and preliminary results are presented and discussed.

Additional keywords: genecology, selection, breeding, hybridization, Carya illinoensis, C. x lecontei

Sweet pecan, Carya illinoensis (Wangenh.) K. Koch, has been intensively selected and bred for nut quality and production for many decades but the genetic potential of the species for wood production and quality has remained almost completely unexplored. This is not surprising, however, when one considers that in the recent past, pecan and "other hickories" were underutilized to the extent that a special inter-agency "Task Force" was organized in the mid-1950's to develop uses for the wood. During the past few years, a large market for pecan furniture, panelling and cabinetry has been created and, presently, the demand for these products exceeds the supply of C. illinoensis available to the mills. To help meet this demand, better quality logs of bitter pecan or water hickory (C. aquatica) and some of the more readily-accessible upland hickories are being utilized and marketed as "pecan" in some areas.

While pecan is a natural component of several bottomland forest types, past logging practices have gradually eliminated many of its associates and it is not unusual to encounter nearly pure stands of mature pecan in many areas of the South. With a continued demand for pecan products and the economics of bottomland logging dictating the cutting practices (getting in to the stand is half of the battle and most of the expense), there is a distinct possibility that many of these mature stands may soon be removed by clearcutting.

To insure a continuing supply of quality pecan wood, the School of Forestry and Wildlife Management at Louisiana State University has initiated a genetic improvement project for the species. The program is designed as a continuing series of long-term studies and it is hoped that some phases will eventually be included in the hardwood genetics program of the S-23 Regional Cooperative Research Project. Planning and progress of the LSU research program is summarized below.

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PHENOTYPIC SELECTION AND PROGENY TESTING

Initial parent tree selections were made in 1972 and 1973 from a native pecan population located on Raccourci Island, a 30-square-mile uninhabited bottomland forest located in south-central Louisiana and owned by the Roy 0. Martin Lumber Co. Past logging practices in this area have created an ideal situation for phenotypic selection where large, pure stands of relatively even-aged pecan may be evaluated. Four "stands" or sub-populations were located on the island and, in each of these, 10 parent trees were selected on the basis of form, vigor and general phenotypic appearance in relation to neighboring pecans. A quantitative selection index was not employed. The selected parents average 121 feet in height, 23 inches in diameter and have a mean merchantable height (clear bole) of 60 feet.

In 1973, we collected enough seed from all 40 of our parent trees to establish an open-pollinated progeny test. In addition to the individual selected tree collections, a bulked seed collection from random unselected trees was made in each stand for inclusion in the progeny test. This design was previously used for a northern red oak progeny test (Cech 1971, Thielges 1971) and the inclusion of unselected progenies in the test evaluations should provide information on the relative degree of inbreeding within the populations and on the efficiency of phenotypic selection.

The progeny test is currently in its first growing season in a nursery on the LSU campus and at the Bass Pecan Co., Lumberton, Miss. The latter planting is somewhat unique in that it represents a significant departure from standard forest nursery practices. Nuts were planted directly in the field in a single long furrow (with adequate "blocking" or replication) and the seedlings have received the standard cultural treatments that the Bass Co. applies to their root-stock plantings which are established in this manner for later field grafting.

Survival and growth at both sites has been good and differences among progenies in germination, foliage characteristics and growth rate are evident. The test will be outplanted on at least three sites in the spring of 1975 and one of these tests will be designed to evaluate nursery effects.

Further tree and stand selections will be made in 1975 from a similar pecan population on International Paper Co. land near Natchez, Miss.

PROVENANCE TEST

A study of geographic variation in pecan is presently in the seed collection phase and for this we have requested the assistance of cooperators throughout the range of pecan. This study should be of interest from a genecological standpoint as well as serving to provide information and plant material that may be useful to an applied improvement program.

Like cottonwood, willow and other bottomland species, pecan seed may be disseminated for great distances by flood waters. Additionally, birds and mammals may act to greatly extend the seedling range and thereby modify the patterns of migration among populations of pecan.

Of course, the greatest impact on the distributional and evolutionary patterns of this species have been caused by man and there is evidence that the present "natural" range of pecan reflects an expansion due to human activity. Flack (1970) presented evidence that pecan nuts were collected, transported far out of range, and bartered by American Indian tribes hundreds of years prior to European settlement. Subsequently, 17th century Spanish colonists expanded the range westward and southward from central Texas. There was a heavy trade in pecan nuts and seedlings up and down the Mississippi River Valley by the French in the 18th century, and many nuts and trees were shipped eastward from New Orleans during this period. Hopefully, taxonomic and phenological data from our study will provide information relevant to this problem.

The study design follows that used in NC-99 hardwood tests wherein individual tree seed collections are made at each geographic location and the material serves as a combination provenance and open-pollinated progeny test. If adequate seed is collected in 1974, the study will be replicated in the field in 1976.

MISCELLANEOUS STUDIES

Since orchard varieties of pecan are propagated by grafting and there has been little demand for seedling pecans for reforestation, there is a lack of information on seed storage and treatment and general nursery practices. A germination test with several methods of pre-treatment indicated that cold, wet storage for 60 or 90 days was effective in promoting rapid, uniform germination (Table 1).

Table 1.--Mean daily germination, peak values, germination values and percent germination for several pecan seed treatments

Treatment	Mean daily germination	Peak value	Germination value	Percent germination
wet sand (5°C)-90 days	1.03	2.46	2.53	62.0
wet sand (5°C)-60 days	1.10	1.70	1.87	70.9
H_2O Soak (24°C)-10 days	1.20	1.48	1.78	72.0
H_2O Soak (24°C)-15 days	1.03	1.68	1.73	62.0
wet sand (5°C)-30 days	1.25	0.86	1.07	48.4
H_2O Soak (5°C)-15 days	0.83	0.86	0.71	54.3
Dry Storage (5°C)-60 days	0.73	0.74	0.54	46.3
H_2O Soak (24°C)-5 days	0.63	0.55	0.35	48.7
Dry Storage (5°C)-5 days	0.63	0.56	0.35	42.6
H_2O Soak (5°C)-10 days	0.65	0.53	0.34	47.5
Control (no pre-treatment)	0.62	0.45	0.28	46.8

Dry, cold storage resulted in a decrease in germinative energy. Apparently, pecan is similar to oaks and other large-seeded species in requiring a high moisture content to maintain embryo viability. Immersing the seed in water at room temperature for 10 to 15 days was also a very effective treatment and seems to be a suitable substitute for cold stratification for longer periods. This result is of practical significance as it provides a method for germinating pecan almost immediately after collection. This technique could be used to grow tubelings for outplanting the following spring or to lengthen the growing season by several months to produce larger 1-0 seedlings.

In wild populations of pecan, there is substantial variation between parent trees for seed characteristics such as color, size, shape and weight. Early seedling growth rate is positively correlated with seed size or weight in wild populations but the relationship does not hold for the large, improved (paper-shell) varieties. An interesting aspect of the seed size-seedling growth study was found in the performance of progenies derived from the hybrid Carya x lecontei Little which has been well-documented as the F1 hybrid between C. aquatica and C. illinoensis (Stone et al. 1964). The open-pollinated seed for our study had characteristics distinctly intermediate between the two species and was most probably the progeny of a backcross of the F1 with C. illinoensis. The hybrid seedlings showed a distinct trend to be among the largest in the population at all seed weights, i.e., they consistently plotted above the seedling size-seed weight regression function. The C. x lecontei hybrid also appears to be much more widely distributed than previously reported (Brown 1945), and we have encountered several excellent phenotypes during our selection procedure. Further studies of the morphology, growth rate and wood properties of these hybrids and their progenies will be included in our program.

We have tentative plans to establish a small research seed orchard near LSU. This will most probably be a grafted orchard including clones of our initial selections.

We anticipate problems in the establishment and maintenance of test plantings. Weed control after initial establishment of pecan is critical, especially on bottomland sites. Information on cultural practices for pecan nut orchards is available but may be limited in its applicability to the higher, better-drained sites upon which these orchards are usually established. We have initiated a series of herbicide tests on poorly-drained, heavy soils in the bottomlands.

Like black walnut, sweet pecan is commercially valuable for nuts as well as wood. However, it is highly improbable that the program of dual-use management which has been widely employed by walnut growers will gain acceptance with pecan growers. Pecan bears at a relatively early age and the general practice is to culture grafts to produce a maximum number of large branches at 4-6 feet and thereby develop a "vase-like" crown. Furthermore, the peak bearing age of pecan extends from 75 to 225 years of age and an orchard is therefore a rather permanent enterprise. This time factor precludes the development of much interest in culturing pecan trees for veneer logs despite the good market for these.

It seems more likely that interest in planting pecan may develop in those enterprises where wood production has priority. Our experience has been that a well-stocked pecan stand is capable of simultaneously producing quality timber, maintaining large populations of game animals and providing fairly regular nut crops for which there is a ready market. These factors could provide an interim income from sale of nuts and hunting leases and serve to make pecan a species well-suited for multiple-use management in bottomlands.

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