PERFORMANCE OF INTERSPECIFIC HYBRIDS AND EXOTIC PINES IN TEXAS

by

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Abstract: Exotic and hybrid pines have been tested in Texas as part of the Forest Tree Improvement Program of the Texas Forest Service. Some of the oldest test plantations are approximately 20 years old. Survival has been poor due to climatic factors and endemic insect attack. In general none of the exotic species tested have responded favorably to their new environment and none have grown better than native southern pines. Species which have shown good survival and growth include some of the minor southern pines not native to Texas. Species which have had very poor survival or growth include species from Mexico, Europe, Asia, and the Western United States.

A part of the project involved controlled interspecific hybridization of the major southern pines and selected exotic species. The slash-longleaf hybrid has shown the most promise of any hybrids tested. Hybrids between most exotic species have had poor survival, but hybrids between the southern pines have survived and grown well.

INTRODUCTION

When the Tree Improvement Program of the Texas Forest Service was initiated in 1951, a part of the program was devoted to testing hybrids and exotics for possible use in Texas. A test arboretum was established in which pine hybrids and as many exotic pine species as possible were included. In addition to the arboretum a limited number of hybrids and exotics were field planted at two test sites in Central Texas. A test arboretum was also established in Western Louisiana but will not be discussed in this paper.

Because of the success exotics have had in other countries, especially Australia, Africa, and South America and the success of pine hybridization programs in South Korea, the search for a better tree to plant in East Texas and especially in the transitional zone of pine forest to post oak and prairie on the western edge of the southern pine forest, is appealing.

In a 1956 progress report, the performance of hybrids and exotics during their early establishment phase in the nursery and in the field was discussed (Zobel et al. 1956). Since that time the relative performance of many of the species and hybrids tested have been influenced by a wide variety of weather extremes incompassing most conditions to which native species are adapted.

METHODS

Test plantings were established at three locations in Texas. One of the sites is the Arthur Temple Research Area in Cherokee County, well within the western edge of the southern pine forest.* This location has approximately 44 inches of annual rainfall, with an approximate 95° 30' longitude and about 32° 30' latitude. Adjacent stands of commercial forest land appear to be on about a 90+ site index. Typical winters are wet with an abrupt transition from winter into a hot dry spring. Summer temperatures may exceed 110u with low relative humidity and winter temperatures are mild and rapidly fluctuating with mid-winter warm (65-70°F) periods followed by sudden cold weather (20-30°F) common.

A second outplanting was made at the Ragesdale Research Area in Lavaca County. This site is about 100 miles west and 50 miles south of the normal western limits of the southern pines. It is a severe test site with deep sandy soil and about 38 inches of annual rainfall. The longitude is about 97° and latitude about 29° 30'. Adjacent timber stands are predominately post and live oak with some elm, yaupon, hackberry, and mesquite. No commercial timber is grown in the vicinity.

The third outplanting was made at the Lange Research Area in Robertson County. This area is approximately 50 to 75 miles west of the edge of the southern pine forest. The site is on deep sand in a region of about 38 inches of annual rainfall near longitude 96° 30' latitude 31°.

Again, as with the Ragesdale Area, no commercial timber is produced in the area. Adjacent timber stands consist of post and sand jack oak, hackberry, mesquite and various elms. On both the Ragesdale and Lange areas, hybrids and exotics were established in small plantings in conjunction with drought resistance tests of loblolly pine. The plantings consisted of those species in which an excess of seedlings above those required for the main test arboretum were available, thus the main value of both areas has been to reinforce observations made at the Temple area.

On the Temple Research Area about 75 species and varieties of pines were planted in an exotic arboretum. These included species from the Appalachian Region, the South, Southwest, West Coast and Lake States in the United States and from Canada, Japan, China, North and Central Mexico, Canary Islands, Phillippines, Mediterranean Region and Europe. Plots were usually 10 x 10 feet, 49 tree blocks if enough seedlings were available, if not, the block size was reduced.

On both the Ragesdale and Lange areas smaller plots were used. Plant-

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* Loblolly (*Pinus taeda* L.), shortleaf (P. *echinata* Mill.) and longleaf pine (P. *palustris* Mill.) occur naturally in the Texas portion of the southern pine forest while slash pine (P. *elliottii* Engelm.) has been widely planted for over 25 years.

ings were usually row plots with a few small blocks. Spacings were usually 6 x 8 feet. Both of these areas are test centers for drought resistant loblolly pine and exotics and hybrids were made in conjunction with drought resistance tests. Since relatively small numbers and few species and hybrids were planted on these Central Texas areas, the information obtained is less complete but supported that obtained on the Temple Area in East Texas.

Most plantations were established during the 1953-54 or 1954-55 planting seasons.

RESULTS

Exotics

Most exotics from outside the South have had a low survival and growth rate on all three areas. Many of those which have survived have poor form and low vigor. Repeated attacks by endemic insects have caused some of the surviving individuals to virtually stop growing. The exact cause of death is not known in most cases but is assumed to be the result of a combination of factors.

In some instances seed failed to germinate after planting in the nursery and this was attributed to the sudden onset of summer with its attendant high temperatures (Zobel, et al. 1956). Even with native loblolly pine this abrupt transition from cold to hot can cause germination failures of seed planted late in the spring.

Another cause of failure was seedling death attributed to hot summer weather after establishment in the nursery beds (Zobel, et al. 1956). There are periods of extremely high light intensity which may combine with the high summer heat to cause seedling death.

After outplanting in the test arboretum or in the Central Texas test sites, the cause of failure is usually more difficult to ascertain. For some species it seems to have been due to a lack of synchrony with the photoperiodicity at the planting site and periods of warm winter weather followed by abrupt changes to cold weather. The high light intensities of late winter combined with unseasonable warm weather met the species requirement for initiation of spring growth. After new growth had started the trees were extremely susceptible to cold and were often subjected to below freezing temperatures for several days.

The intense summer heat combined with summer drought undoubtedly took a heavy toll of young trees for the first few years after outplanting. A more gradual attrition followed and was due to a combination of heat, low humidity, drought, severe planting sites and failure of species to adjust to new photoperiodic regimes combined with abrupt temperature changes.

Whatever the factor or combination of factors were that caused failure of most exotics the result has been the complete decimation of many species while many of those which survived are stunted and malformed.

Some exotics from within the South have shown some promise or at least have been able to survive and grow with reasonable success. There has been a non-uniform response to environment by seedlots from different areas within a region. This response is similar to that of different seed lots reported in the geographic seed source study (Wells and Wakely 1966)

Exotics planted at the Temple Research Area are listed in Table I. All common and species names follow Critchfield and Little 1966.

Hybrids

The performance of hybrids has more or less paralleled the performance of exotics. Hybrids resulting from crosses between parents from outside the South have survived poorly. A partial listing of hybrids planted at the Arthur Temple Research Area is included in Table II.

The best hybrids have been those involving the major southern pines. In most cases these have not approached either parent as desirable forest trees because of poor form, excessive limbs, or various other reasons including slower growth. A hybrid which has shown promise is a polymix cross of slash x longleaf which has exhibited excellent growth rate, form, and limb characteristics.

CONCLUSIONS

After approximately 20 years of field testing most exotics tested have shown little promise for potential use in replacing any of the four major southern pines as planting or reforestation stock either within the pine forest of East Texas or in the transition zone of scrub hardwoods west of the pine forest.

The minor southern pines, specifically P. *clausa* (Chapm.) Vasey, P. *serotina* Michx., P. *glabra* Walt. and P. *virginiana* Mill. have grown and survived well in East Texas but have not survived well on the two Central Texas sites. P. *glabra* and P. *clausa* have the best survival and growth of any of the exotics tested. P. *seudostrobus* Lindl. and P. *durangensis* Martinez, two Mexican sources, have the best survival and growth of any sources from outside the South.

Most species which were surviving and showing promise at four or five years have gradually failed because of the combined effects of heat, cold, rapid temperature changes, photoperiod and endemic insects and diseases.

TABLE I

Partial list of pine species planted at Temple Research Area

Species	Common Name	Percent Survival
P. armandii Franch.	Armand pine	0
P. attenuata Lemm.	knobcone pine	0
P. ayacahuite Ehrenb.	Mexican white pine	0
P. barksiana Lamb.	Jack pine	0
P. canariensis C. Smith	Canary Island pine	0
P. caribaea Morelet	Caribbean pine	0
P. cembroides Zucc.	Mexican pinyon pine	0
P. clausa (Chapm.) Vasey	sand pine	56
P. contorta Dougl.	lodgepole pine	0
P. cooperi C.E. Blanco	Cooper pine	0
P. coulteri D. Don	Coulter pine	0
P. densiflora Sieb. & Zucc.	Japanese red pine	9
P. douglasiana Martinez	Douglas pine	0
P. durangensis Martinez	Durango pine	32
P. edulis Engelm.	pinyon pine	0
P. elliottii var. densa Little & Dorman	South Florida slash pine	0
P. engelmannii Carr.	Apache pine	41
P. glabra Walt.	spruce pine	61
P. griffithii McClelland	blue pine	0
P. halepensis Mill.	Aleppo pine	0
P. hartwegii Lindl.	Hartweg pine	0
P. jeffreyi Grev. & Balf.	Jeffrey pine	0
P. leiophylla Schiede & Deppe	Chihuahua pine	0
P. luchensis Mayr	Okinawan pine	0
P. lumholtzii Robins & Fern.	Lumholtz pine	0
P. massoniana Lamb.	Masson pine	0
P. michoacana Martinez	Michoacan pine	0
P. montezumae Lamb.	Montezuma pine	16
P. monticola Dougl.	western white pine	0

TABLE I - Continued

Species	Common Name	Percent Survival
P. mugo Turra	Swiss Mountain pine	0
P. muricata D. Don	Bishop pine	0
P. nigra Arnold	Austrian pine	0
P. oocarpa Schiede	(unknown)	0
P. patula Schiede & Deppe	Mexican weeping pine	0
P. pinaster Ait.	maritime pine	0
P. pinea L.	Italian stone pine	0
P. ponderosa Laws (& varieties)	ponderosa pine	0
P. pseudostrobus Lindl.	(unknown)	40
P. pungens Lamb.	Table-Mountain pine	12
P. radiata D. Don	Monterey pine	0
P. resinosa Ait.	red pine	0
P. roxburghii Sarg.	chir pine	0
P. sabiniana Dougl.	digger pine	0
P. serotina Michx.	pond pine	57
P. sylvestris L.	Scotch pine	0
P. strobiformis Engelm.	southwestern white pine	0
P. strobus L.	eastern white pine	0
P. teocote Schiede & Deppe	(unknown)	0
P. thunbergiana Franco	Japanese black pine	14
P. virginiana Mill.	Virginia pine	68
P. yunnanensis Franch.	Yunnan pine	0

TABLE Ia

Average height and diameter of the better exotic pine species after approximately 20 years.

Species	Avg. DBH	Height	Percent Survival
P. clausa	11.2	43.5	56
P. durangensis	9.4	34.2	32
P. glabra	9.5	40.5	61

TABLE Ia - continued

Species	Avg. DBH	Height	Percent Survival
P. pseudostrobus	8.3	30.0	40
P. serotina	10.1	39.0	57
P. virginiana	8.0	32.3	68

TABLE II

Partial list of hybrids and checks planted at Temple Research Area approximately 20 years after planting.1

Hybrid	Avg. DBH	Height	Percent Survival
P. echinata (open pollinated)	7.1	41.0	75
P. echinata x P. elliottii	8.2	34.1	100
P. taeda (open pollinated)	11.4	53.6	83
P. echinata x P. sondereggeri	11.3	59.8	100
P. taeda x P. sondereggeri	11.0	52.0	75
P. taeda x P. elliottii	10.8	55.7	41
P. taeda x P. radiata	9.5	48.8	85
P. ponderosa x P. apacheca	0	0	0
P. ponderosa x P. montezumae	0	0	0
P. palustris x P. elliottii	8.0	50.0	90
P. palustris x P. elliottii 1961 [2]	5.9	40.0	60
(P. echinata x P. taeda) x wind lot 10	10.1	40.0	84
(P. echinata x P. elliottii) x P. taeda	11.4	52.0	40
(P. echinata x P. taeda) x P. taeda	9.5	50.0	**33**
P. echinata x (P. echinata x P. elliottii)	8.1	49.1	58
(P. echinata x P. elliottii) x wind	5.9	38.3	**33**
P. taeda x (P. echinata x P. elliottii)	8.1	53.6	55
(P. taeda x P. elliottii) x P. elliottii	10.3	46.6	66

[1] Block sizes are highly variable and sources are not replicated. These data can serve only as an indicator of performance of different hybrids tested and are not suitable for detailed comparison or analysis.

[2] Planted in 1961; average of all crosses. The different parental combinations have survivals ranging from 47 to 84 percent.

Hybrid survival and growth depends on the parental species. Hybrids from exotic parents have not survived well -- almost all died within the first 10 years. Conversely, those hybrids formed by crossing southern pines have had high survival rates and reasonably good growth. Most combinations do not produce progeny comparable in growth or quality to the parental types. An exception to this seems to be the slash x longleaf hybrid which, at 12 years in the field seems to have many of the desirable traits of both parents.

LITERATURE CITED

1 Critchfield, W. B., and E. L. Little Jr. 1966. Geographic distribution of the pines of the world. Misc. pub. 991 USDA, Forest Service.

2 Wells, O. O., and P. C. Wakeley, 1966. Geographic variation in survival, growth, and fusiform-rust infection of planted loblolly pine. Forest Sci. monogr. 11,40 pp.

3 Zobel, B.J., T. E. Campbell, F. C. Cech and R. E. Goddard. 1956. Progress Report - Survival and growth of native and exotic pines, including hybrid pines in Western Louisiana and East Texas. 16 pages. Research Note 17, Texas Forest Service.