

EXOTIC TREES UNSATISFACTORY FOR FORESTRY IN SOUTHERN ARKANSAS AND NORTHERN LOUISIANA

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Among 140 species, mainly pine and eucalyptus, the best performers in forest plantings were slash, pond, and Virginia pine, and the longleaf-loblolly cross. None were as large as native loblolly pine after 9 to 12 years in the field, however. A few species showed promise for urban and environmental forestry and for Christmas trees.

Trees of many exotic species have been successfully planted as ornamentals in the Southern United States. For forestry, however, plantings of introduced species have usually been unsatisfactory. This paper reports the performance of nonnative species under plantation conditions in southern Arkansas and northern Louisiana. As in studies in Florida (1), Mississippi (2), and Texas (3), most species failed.

METHODS

Forty-nine pine and 91 other miscellaneous nonnative species were planted on 20 sites with soils ranging from clays to sandy and gravelly loams. Latitude ranged from 32 degrees 45' to 33 degrees 45' N. and longitude from 92 degrees 00' to 93 degrees 30' W. The region's mean annual precipitation of 52 inches is fairly well distributed throughout the year. Growing season rainfall averages 24 inches. The number of frost free days ranges from 220 to 230.

Plantings were made in 25-tree square plots when there was enough trees. Otherwise, plots contained rows of five or 10 trees. When sufficient seedlings were available, plots were replicated 12 times, but seedlings were scarce in many instances. An average of 29 trees were tested on two to three sites. Spacings were 8 by 8 feet and 6 by 10 feet. Cultural treatments were withheld to determine the ability of exotics to withstand natural competition.

RESULTS

Nonnative pine of 18 species survived (table 1). Twelve of these are indigenous to the United States. The most promising were three southern pines, slash (*P. elliotii*), pond (*P. serotina*), and the longleaf-loblolly cross (*P. X sondergeri*), and an Appalachian Mountain-Piedmont species, Virginia pine (*P. virginiana*).

Native loblolly pine (*P. taeda*) was superior to all nonnative species in height growth, but pond, Virginia, spruce (*P. glabra*), and Sondergerger pines excelled it in survival. Three nonnatives grew taller than native shortleaf pine (*P. echinata*) and five survived better. Loblolly outscored shortleaf on both counts. Survival of loblolly and shortleaf was hardly half of that normally expected for these species.

The 12 surviving miscellaneous natives and exotics are also listed in table 1. Four are native to the test area, four are indigenous to the United States, and four are exotic.

Miscellaneous exotics that showed some promise included *Cupressus arizonica*, *Zelkova serrata*, and *Chamaecyparis thyoides*. *C. arizonica* is a Christmas tree species. It grew satisfactorily on several sites and attained salable size in 3 to 5 years. It has been determined that by propagating the best trees by rooted cuttings the proportion of salable *C. arizonica* Christmas trees in a plantation - normally about one in three - can be raised considerably. *Z. serrata* withstands native competition well, is often multistemmed, and is shade tolerant. *C. thyoides* grows well on wet sites, is more tolerant to competition than the southern pines, and will undoubtedly grow at a closer spacing than the pines.

Only 11 *Cryptomeria japonica* were tested. Although all of these were winter-killed, a single tree in a demonstration plot survived. It is well developed and fast growing, but the new growth is occasionally killed by low winter temperatures. Visitors from the Orient report that *C. japonica* does well in areas of Japan where winters are much colder than any encountered in the present study. Strains from those areas may perform well here.

Soil textures on which some of the species survived best are given in table 2. Several species survived equally well on three or four soils, but most did best on fine sandy loams. Next best survival was obtained on silty clay loams and clays. In general silty clay loams or coarser textures were best.

Thirty-two pine and 79 other species failed in the trials. Sixteen of the unsatisfactory pines are nonnative to the test area but are indigenous to the United States. The others are native to Mexico, Central America, the Caribbean, Europe, and Asia. Failure of all 46 eucalyptus species was caused mainly by winter kill either in the nursery or during the first year in the plantation. The species that failed, along with their geographic seed sources, are listed at the end of this note.

DISCUSSION

Complete failures of species were probably due to weed and grass competition and unfavorable temperature, humidity, and rainfall. As expected, most mortality occurred during the year of outplanting.

The effects of weather on survival of promising species were unclear. Survival was generally highest in 1954, when annual rainfall was lowest and summer temperatures were highest (table 3). During August 1954, there were 18 consecutive days with a maximum temperature of 100 degrees F. or more. Survival was poorest in 1957, when annual rainfall was considerably above average and summer temperatures were below average. That year was the only one in which growing-season rainfall departed radically from normal--plus 14.41 inches. Although many of the successful nonnatives are from areas south of the plantations, it seems unlikely that dry, hot weather in the summer directly improved the survival of newly planted seedlings. Perhaps heavy rains during the growing season decreased survival indirectly by increasing weed and grass competition.

Winter cold caused many failures. The minimum temperature during the study was -3 degrees, but only three times did winter temperature drop below 11 degrees.

Most pines, except slash and longleaf, were attacked by the Nantucket pine tip moth (*Rhyacionia frustrana* Comst.). Slash, Sonderegger, loblolly, and pond pines were attacked by fusiform rust (*Cronartium fusiforme* Hedgc. and Long), no other diseases were observed on shortleaf pine.

LITERATURE CITED

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Table 1.-- *Surviving species*

Species and origin	Sites planted	Years planted	Trees planted	Survival	Weighted average height ¹
PINES	No.		No.	Percent	Feet
<i>Pinus clausa</i> (Chapm.) Vasey--N. Fla.	14	1955-57	386	2.1	17.5
<i>P. densiflora</i> Sieb. & Zucc.--Japan	3	1955	42	9.5	12.2
<i>P. echinata</i> Mill.--Ark.	18	1955-57	544	27.2	28.0
<i>P. echinata</i> X <i>P. taeda</i> --Placerville, Calif.	5	1956-57	50	20.0	30.2
<i>P. echinata</i> X <i>P. taeda</i> X X wind--Placerville, Calif.	1	1954	12	33.3	23.5
<i>P. elliotii</i> var. <i>densa</i> Little & Dorman--S. Fla.	6	1954-57	166	1.2	27.0
<i>P. elliotii</i> Engelm.--S. Miss.	15	1954-57	455	29.7	29.1
<i>P. glabra</i> Walt.--S. Miss.	6	1955-56	51	47.1	23.6

<i>P. massoniana</i> Lamb.--China	7	1954-56	105	19.0	13.5
<i>P. nigra</i> Arnold--Italy	16	1955-56	419	.7	7.6
<i>P. palustris</i> Mill.--S. Miss.	17	1954-57	405	15.3	18.6
<i>P. pinaster</i> Ait.--No. 9, No. 10, Italy, France, Morocco, Spain, Portugal	13	1954-57	581	.5	19.3
<i>P. pinea</i> L.--Italy	11	1954-56	133	2.3	8.7
<i>P. ponderosa</i> X <i>P. montezumae</i> --Mexico	2	1954-55	7	42.9	16.2
<i>P. pungens</i> Lamb.--N. Ga.	9	1955-57	72	18.1	14.7
<i>P. rigida</i> Mill.--Ga.	1	1954	12	8.3	14.8
<i>P. serotina</i> Michx.--N. Fla.	11	1955-56	121	54.5	28.7
<i>P. X sondereggeri</i> H. H. Chapm.--S. Fla., E. Tex.	16	1954-57	330	38.2	29.4
<i>P. strobus</i> L.--N.C., Ga.	1	1957	24	33.3	7.5
<i>P. taeda</i> L.--Ark.	16	1954-57	582	31.8	33.1
<i>P. taeda</i> X X <i>P. echinata</i> X <i>P. taeda</i> --Calif.	1	1957	3	100.0	31.0
<i>P. thunbergiana</i> Franco--Japan	16	1954-57	614	21.0	9.8
<i>P. virginiana</i> Mill.--N. Ala., N. Ga.	13	1954-57	249	52.6	24.9
MISCELLANEOUS NATIVES & EXOTICS					
<i>Chamaecyparis thyoides</i> (L.) B.S.P.--N.C.	2	1957	53	35.8	14.6
<i>Cupressus arizonica</i> Greene--S. Ariz.	4	1954-57	84	36.9	13.2
<i>Cupressus sempervirens</i> L.--Italy	2	1954-55	22	4.5	9.0

<i>Cupressus thurifera</i> (<i>C.lusitanica benthami</i> Carr.)--Herbst Seed	3	1957	62	1.6	6.0
<i>Cupressus torulosa</i> Don--Himalayas	1	1955	6	33.3	17.1
<i>Juniperus virginiana</i> L.--E. Okla.	11	1956-57	236	26.3	12.5
<i>Populus robusta</i> --S. Europe	2	1957	21	42.9	31.1
<i>Salix nigra</i> Marsh.--Ark.	1	1957	10	20.0	11.5
<i>Taxodium distichum</i> var. <i>nutans</i> Ait.--N. Fla.	5	1954-57	94	37.2	4.7
<i>Taxodium distichum</i> var. <i>distichum</i> ---S. Ark.	8	1954-57	142	44.8	7.3
<i>Thuja japonica</i> --Japan	2	1955-57	9	11.1	3.0
<i>Zelkova serrata</i> Mak.--Calif.	3	1957	93	44.1	14.7

¹ Average height, weighted by age, at the end of the 1966 growing season.

Table 2.-- *Survival in relation to soils*

<i>Species</i>	Soil textures on which survival was best								
	Clay	Silty clay	Clay loam	Silty clay loam	Silt loam	Fine sandy loam	Sandy loam	Fine sand	Gravelly loam
<i>Pinus clausa</i> (Shapm.) Vasey						x			
<i>P. echinata</i> Mill.	x					x			x
<i>P. elliotii</i> Engelm.				x					
<i>P. elliotii densa</i> Little & Dorman						x			
<i>P. nigra</i> Arnold						x			
<i>P. palustris</i>				x					
<i>P. pinaster</i> Ait.								x	
<i>P. pinea</i> L.		x				x			
<i>P. pungens</i> Lamb.					x	x			
<i>P. serotina</i> Michx.	x			x		x			
<i>P. X sondereggeri</i> H. H. Chapm.				x	x			x	
<i>P.taeda</i> L.	x				x		x	x	
<i>P. thunbergiana</i> Franco						x			
<i>P. virginiana</i> Mill.						x	x		x
<i>Juniperus virginiana</i> L.	x			x		x			
<i>Taxodium distichum</i> var. <i>nutans</i> Ait.	x								
<i>Taxodium distichum</i> var. <i>distichum</i>	x			x					

Table 3.--Rainfall and temperatures, 1954-57

Year	Rainfall				Temperature	
	April-September		Total for year		Maximum	Minimum
	Actual	Departure	Actual	Departure		
-----Inches-----		-----F. degrees-----				
1954	20.25	-2.81	38.09	-12.72	108	16
1955	20.87	-2.19	47.66	-3.15	98	12
1956	19.38	-3.68	47.23	-3.58	104	16
1957	37.47	+14.41	74.52	+23.71	97	13

SPECIES THAT FAILED AND THEIR SEED SOURCES	
PINES	SOURCE
<i>Pinus attenuata</i> Lemm	Calif.
<i>P. attenuata</i> X <i>P. radiata</i>	Calif.
<i>P. bahamensis</i> (<i>P. caribaea</i>)	Bahamas
<i>P. banksiana</i> Lamb	Minn.
<i>P. caribaea</i> Morelet	Br. Honduras
<i>P. coulteri</i> D. Don	Calif.
<i>P. ellottii</i> X <i>P. palustris</i>	Gulf South
<i>P. excelsa</i> (<i>P. griffithii</i>)	Himalayas
<i>P. griffithii</i> McClelland	Himalayas
<i>P. haepensis</i> Mill	Italy
<i>P. hondurensis</i> (<i>P. caribaea</i>)	Br. Honduras
<i>P. jeffreyi</i> Grev. & Balf.	Calif.
<i>P. khasya</i> Royle	Burma
<i>P. lambertiana</i> Dougl.	Calif.
<i>P. longifolia</i> (<i>P. roxburghii</i> Sarg.)	India
<i>P. luchuensis</i> Mayr	Okinawa
<i>P. lumholtzii</i> Robins. & Fern.	Mexico
<i>P. merkussi</i> Jungh. & de Vriese	Burma
<i>P. michoacana</i> Martinez	Mexico
<i>P. montezumae</i> Lamb.	Mexico
<i>P. muricata</i> D. Don	Calif.
<i>P. patula</i> Schiede & Deppe	Mexico

<i>P. ponderosa</i> Laws.	Ariz., Calif.
<i>P. ponderosa</i> var. <i>arizonica</i> (Engelm.) Shaw	Ariz.
<i>P. ponderosa</i> x <i>P. engelmannii</i>	Calif.
<i>P. pseudostrobus</i> Lindl.	Mexico
<i>P. radiata</i> D. Don	Calif.
<i>P. reflexa</i> Engelm.	Mexico
<i>P. sabiniana</i> Dougl.	Calif.
<i>P. sylvestris</i> L.	Spain
<i>P. taeda</i> L.	Tex.
<i>P. teocote</i> Schiede & Deppe	Mexico
<i>P. torreyanna</i> Parry	Calif.
MISCELLANEOUS EXOTICS	
<i>Ailanthus glandulosa</i> Desf.	Herbst Seed
<i>Araucaria angustifolia</i> (Bert.) O. Kuntze	Brazil
<i>Callitris calcarata</i> A. Cunn. ex Mirb.	Australia
<i>C. robusta</i> R. Br.	Australia
<i>Casuarina cunninghamia</i> Miq.	Ark.
<i>C. equisetifolia</i> Forst.	Australia
<i>C. spp.</i> Forst.	Herbst Seed
<i>Cedrus atlantica</i> Manetti	Morocco
<i>Cryptomeria japonica</i> (L. F.) D. Don	Taiwan
<i>Cunninghamia lanceolata</i> (Lamb.) Hook.	Taiwan
<i>Cupressus funebris</i> Endl.	China
<i>C. lusitanica</i> Mill.	Mexico
<i>C. macnabiana</i> A. Murr.	Calif.
<i>C. macrocarpa</i> Hartw.	Calif.
<i>Eucalyptus alba</i> Reinw.	Australia
<i>E. andrewsi</i> Maiden	Australia
<i>E. astringens</i> Maiden	Australia
<i>E. bicostata</i> Maiden Blakely & Simmonds	Australia
<i>E. botryoides</i> Sm.	Brazil
<i>E. bridgesiana</i> R. T. Baker	Australia
<i>E. calophylla</i> Lindl.	Australia

<i>E. camaldulensis</i> Dehn.	Brazil
<i>E. cinerea</i> F. v. M.	Australia
<i>E. citriodora</i> Hook.	Australia
<i>E. considiniana</i>	Australia
<i>E. cornuta</i> Labill	Australia
<i>E. crebra</i> F. v. M.	Australia
<i>E. dalrympleana</i> Maiden	Australia
<i>E. diversicolor</i> F. v. M.	Australia
<i>E. fastigata</i> Deane & Maiden	Australia
<i>E. ficifolia</i> F. v. M.	France
<i>E. globulus</i> Labill	Australia via Calif.
<i>E. gomphocephala</i> A. DC.	Australia
<i>E. grandis</i> Hill ex Maiden	Brazil
<i>E. gunni</i> Hook. f.	Australia
<i>E. haemastoma</i> Sm.	Australia
<i>E. macarthuri</i> Deane & Maiden	Australia
<i>E. macrorrhyncha</i> F. v. M.	Australia
<i>E. maculata</i> Hook.	France
<i>E. melanophloia</i> F. v. M.	France
<i>E. melliodora</i> A. Cunn.	Australia
<i>E. nitens</i> Maiden	Australia
<i>E. paniculata</i> Sm.	Brazil, France
<i>E. paulistana</i>	Brazil
<i>E. pilularis</i> Sm.	Australia
<i>E. polyanthema</i> x <i>populifolia</i>	France
<i>E. populifolia</i> Hook. f.	France
<i>E. propinqua</i> Deane & Maiden	Brazil
<i>E. punctata</i> DC.	Australia
<i>E. racemosa crebra</i>	Brazil
<i>E. radiata</i> Sieb. ex DC.	Australia
<i>E. resinifera</i> Sm.	Brazil
<i>E. robusta</i> Sm.	Australia
<i>E. rostrata</i> Schlechtend	France
<i>E. saligna</i> Sm.	Brazil
<i>E. siderophloia</i> Benth.	Australia
<i>E. sideroxylon</i> A. Cunn. ex Benth. partim.	Australia

<i>E. triantha acmenioides</i> Link.	Brazil
<i>E. umbra</i> R. T. Baker	Brazil
<i>E. viminalis</i> Labill.	Brazil
<i>Ginkgo biloba</i> L.	Japan
<i>Grevillea robusta</i> A. Cunn.	Australia
<i>Koelreuteria</i> spp.	China
<i>Leucaena glauca</i> (L.) Benth.	Taiwan
<i>Bibocedrus decurrens</i> Torr.	Calif.
<i>Liriodendron tulipifera</i> L.	Ark.
<i>Melia azedarach</i> L.	La.
<i>Phellodendron amurense</i>	Orient
<i>P.</i> spp.	Orient
<i>Phyllocladus trichomanoides</i>	New Zealand
<i>Phyllostachys bambusoides</i>	Japan
<i>Platanus occidentalis</i> L.	Ark.
<i>Populus heterophylla</i> L.	Miss. River Delta
<i>Pseudolarix kaempferi</i>	China
<i>Pseudotsuga macrocarpa</i> Mayr	Calif.
<i>P. taxifolia</i> (Pori.) Britt	Calif.
<i>Pterocarya</i> spp.	Japan
<i>Sequoia sempervirens</i> (Lamb.) Endl.	Calif.
<i>Tamarix aphylla</i> (L.) Karst.	Unknown