EVALUATION OF NATIVE AND EXOTIC WOODY PLANTS UNDER SEVERE ENVIRONMENTAL STRESS

by Robert S. Dewers

Abstract. Revegetation and landscaping with trees and shrubs in low maintenance areas of limited rainfall are continuing challenges. A planting of 95 woody species in San Antonio, Texas resulted in survival of 22 natives and exotics after two growing seasons. No irrigation was used beyond initial establishment. There were no significant differences in survival rate between native and introduced species. Survivors are deemed worthy of use in land reclamation and in urban forestry projects requiring drought hardy trees and shrubs in the Southwest.

The primary objective of this study was to determine which native trees and shrubs available for study were most adaptable to local climate and soils. A second objective was to observe any differences in native and exotic species performances. At present there is no *a priori* reason to assume that native trees will outperform introduced (exotic) species and cultivars.

I have found no evidence in the literature that natives perform better than exotics when both are planted off-site. Elias *et al* (1976) described the historical performances of Northeast native and exotic species. He found in Millbrook, N.Y. that chosen exotics apparently outperform traditional natives in that they are reportedly more tolerant of urban stresses.

Perhaps the urban landscape is no longer native because of a site alien to its natural one. It is well accepted in forest genetics that species generally perform better if grown from seed gathered locally (U.S. Forest Service 1974). But as Santamour (1976) pointed out, few nurserymen know the seed source and hence the adaptability range of the cultivars they are growing. So the question arises, "What is a native tree?" For purposes of this study we classified regionally native Texas species as native.

Materials and Methods

The ten-acre study site on the University of Texas at San Antonio (UTSA) campus consisted primarily of silty clay about 20 inches thick over fragmented limestone. It had been a natural savannah of live oak (*Quercus virginiana*), cedar elm (*Ulmus crassifolia*), and Ashe juniper (*Juniperus ashei*). Dominant understory woody plants included Texas mountainlaurel (*Sophora secundiflora*), Texas persimmon (*Diospyros texana*), brasil (*Condalia hookeri*) and Mexican buckeye (*Ungnadia speciosa*).

Two groups of woody plants were selected for the adaptability study: I. species native to central Texas which could be gathered *in situ*, transported from a previous planting, or obtained from a nursery, growing in a container; II. exotic species of North American and foreign sources obtained in the same manner as the native species. Of necessity, the plants came in container sizes from sleeve to 3-gallon.

Climatic information was available through weather bureau records (U.S. Dept. of Commerce 1975-1977) at the San Antonio International Airport, the nearest recording station. In order to arrive at potential evapotranspiration rates during the study, a regression formula devised by Moe and Griffiths (1965) for San Antonio was used. It was correlated with mean maximum monthly temperatures.

Results and Discussion

Planting took place during the late fall and winter of 1975-1976. The first evaluation was made April 30, 1976. Of 201 individuals planted, 183 survived the initial planting. These were made up of 95 species and cultivars of which 91 survived the planting. By July 25, 1976, 35 more had died. During this inspection, deer browse damage was noted on the pinyon pine (*Pinus cembroides*), Spanish oak (*Quercus texana*), Lacey oak (*Q. glaucoides*), chinkapin oak (*Q. muhlenbergii*), Gambel oak (*Q. gambelli*), pear (*Pyrus communis*), loquat (*Eriobotrya japonica*) and hawthorne (*Crataegus* sp.). Mimosa webworm had completely stripped all silktrees (*Albizia julibrissin*) and honeylocust (*Gleditsia triancanthus inermis*).

Harvester ants completely stripped the podocarpus (*Podocarpus macrophylla*). The defoliated plants did not regenerate any new leaf growth.

On March 16, 1977, 100 individuals were alive, representing 61 species or cultivars. The next evaluation on October 13, 1977 essentially ended the formal evaluation of species. There were 32 survivors represented by 21 species. These are listed in Table 1.

Soil water deficits during the summer of 1977 may explain the severe mortality of species that had become established during the growing season of 1976. The potential evapotranspiration (ETp) curves in Fig. 1 and Fig. 2 were calculated from the formula $-11.9 + 0.204\,T$ where T is the mean monthly maximum temperature (Moe and Griffiths 1965). Actual evapotranspiration curves were calculated from the water budget scheme as devised by Zahner (1956) and implemented by Dewers and Moehring (1970). Figure 1 demonstrates that soil water deficits during a "normal" growing season began with the high levels of available soil water. These levels were quickly exhausted by lack of recharge. July and August rainfall totaled 0.16 in., while potential evapotranspiration exceeded 7.87 in. during each of these two months.

Species that died before March 16, 1977 could be considered least adaptable to local site. Species that were planted from plastic sleeves or small pots should not be seriously considered because of the fragile root system with which they started. Bottomland species planted such as silver maple (*Acer saccharinum*), pondcypress (*Taxodium distichum* var. nutans), baldcypress (*Taxodium distichum*) and other mesic species should

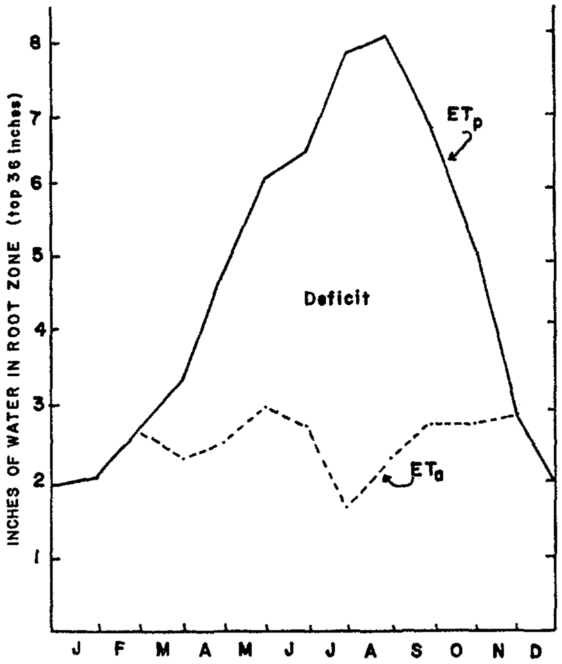

Fig. 1. Chart demonstrating mean soil water deficits over 93 years at San Antonio, Texas. The space between the two curves emphasize the "normal" summer water stress, i.e., the difference between potential evapotranspiration and actual evapotranspiration. These curves are based on data from the mean high temperatures and rainfall. Values are computed from weather records and the formula $-11.9 + 0.204\,T$ where T is the mean maximum temperature for the particular month. Normal soil water deficits during the normal July 1-November 1 period were computed to be 18.61 inches.

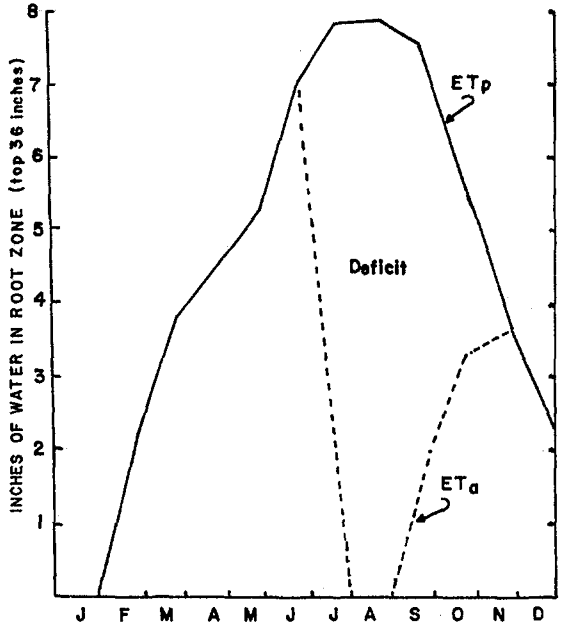

Fig. 2. Chart demonstrating soil water deficits in 1977 at San Antonio, Texas. The theoretical curves indicate no available soil water for plant growth in late summer. This severe water deficit may explain the high loss of test species during the 1977 growing season. Soil water deficits during the July 1-November 1 period were computed to be 22.73 inches.

not have been expected to survive without irrigation. The species that survived the growing season of 1977 listed in Table 1 could be considered the most adaptable. Of the 21 surviving species, six were exotics. The other 15 were native to the near Edwards Plateau region of Texas or to the Trans-Pecos. No east Texas species survived. Chi-square tests revealed no significant differences in survival of native and exotic species at the 0.05 level.

Of the surviving exotics, Chinese tallow has escaped cultivation in Texas, the common pear is a well-recognized survivor on abandoned homesteads, and jujube is a persistent species that root sprouts unwanted in some home plantings. The Kentucky coffeetree, a native of eastern U.S. and the Chinese pistachio had long been accepted as desirable shade trees.

A more valid study would involve more replicates of each species that had been previously grown in containers of equal dimension. Because more adequate replication of many species was not possible, it was decided to screen as many species and cultivars as could be gathered. Thus, this study provided a screened list of drought hardy trees and shrubs for future work even though some deserving species may have missed the list because of initial size or improper handling.

All survivors are worthy of attention relative to propagation and selection studies for superior native ornamentals. The information should be helpful in land reclamation plantings in Texas and in urban areas where summer drought is common.

TABLE 1. Species surviving no maintenance — severe drought conditions.

All the species listed as survivors in this table were living in March 1977 after the winter 1975-1976 planting.

*Species so marked survived the severe drought of summer 1977.

†Species so marked are considered exotic to the region.

A. Species transplanted balled from other sites.

Survivors

Aesculus pavia *	*Eriobotrya japonica* *†
Baccharis texana	*Quercus texana*
Carya pecan	*Quercus virginiana*
Cercis texensis	*Viburnum rufidulum*

Failures

Melia azedarach †	*Quercus sinuata breviloba*
Podocarpus macrophylla†	*Rhus microphylla*
Porlieria angustifolia	*Sabal texana*
Prunus serotina eximia	

B. Species planted from 3- and 4-inch pots.

Survivors

Berberis haematocarpa	*Quercus macrocarpa*
Celtis pallida	*Quercus turbinella*
Chilopsis linearis	*Styrax texana*
Quercus hinckleyi *	

Failures

Cercocarpus montanus	*Quercus mohriana*
Choisya dumosa	*Quercus rugosa*
Juniperus deppeana	*Quercus shumardii*
Pinus nigra†	*Rhus integrifolia*†
Pithecellobium flexicaule	*Schaeferia cuniefolia*
Quercus gravesii	*Sophora formosa*
Quercus intricata	*Taxodium distichum ascendens*

C. Species planted from 1- and 3-gallon containers.

Survivors

Acer grandidentatum sinuosum *	*Morus alba*†
Acer negundo	*Philadelphus ernestii* *
Amyris texana *	*Pinus cembroides*
Aniscanthus wrightii	*Pinus taeda*
Arbutus xalapensis	*Pinus thunbergii*†
Berberis swaseyi *	*Pistacia chinensis* *†
Carya myrsticaeformis	*Pistacia texensis* *
Cercis texensis	*Prunus havardii*
Cornus drummondii	*Prunus minutifolia* *
Crataegus crus-galli	*Pyrus communis* *†
Crataegus texana	*Pyrus ioensis*
Ehretia anaqua *	*Quercus gambelii*
Firmiana simplex†	*Quercus glaucoides* *
Fraxinus texensis	*Quercus muhlenbergii*
Fraxinus velutina *†	*Quercus velutina*†
Garrya lindheimeri *	*Rhamnus caroliniana*
Ginkgo biloba†	*Rhus virens* *
Gymnocladus dioica *†	*Sabium sebiferum* *†
Juglans cordiformis†	*Salix blanda*†
Koelreuteria bipinnata†	*Taxodium distichum*
Leucaena retusa *	*Tilis caroliniana*
Leucophyllum fruticosum *	*Ziziphus jujuba* *†
Maclura pomifera *	
Metasequoia glyptostroboides†	

Failures

Acer saccharinum†	*Lindera benzoin*
Albizia julibrissin†	*Olea europaea*†
Bauhinia congesta	*Platanus occidentalis*
Gleditsia triacanthos	

Fig. 3. The canyon maple (*Acer grandidentatum*), a western sugar maple with outstanding fall leaf color was a survivor in the study.

Fig. 4. Chinese pistachio (*Pistacia chinensis*), an exotic species, displayed its drought hardiness in surviving the severe soil stresses.

Acknowledgment. Land for this study was made available by the Division of Environmental Management, University of Texas at San Antonio. Plant material was made available by the Rare Plant Studies Center, University of Texas at Austin, The Texas A&M University Research and Extension Center at Dallas, the city of San Antonio and Fanick's Nursery of San Antonio.

Literature Cited

Dewers, Robert S. and David M. Moehring. 1980. *Effect of soil water stress on initiation of ovulate primordia in loblolly pine.* For. Sci. 16: 219-221.

Elias, Thomas S. and Howard W. Irwin. 1976. *Urban trees.* Sci. Amer. 225: 111-118.

Moe, Roderick D. and John Griffiths. 1965. A Simple Evaporation Formula for Texas. *Texas Agr. Expt. Sta.* Texas A&M University. 35p.

Santamour, F.S. Jr. 1976. Breeding and selecting better trees for metropolitan landscapes. USDA Forest Serv. Gen. Tech. Rpt. NE-22 p. 1-8.

U.S. Dept. of Commerce. 1975-1978. Climatological Data National Oceanic and Atmos. Administration, Asheville, N.C.

U.S. Forest Service. 1974. Seeds of woody plants in the United States. U.S. Dep. Agric. Hand b 450.

Zahner, Robert. 1956. Evaluating summer water deficiencies. U.S. Forest Service Occ. Paper 150. Southern Forest Expt. Sta. 18p.

Professor of Urban Forestry
Department of Forest Science
Texas A&M University
College Station, Texas