

STRESS TOLERANT TREES FOR THE SOUTHERN GREAT PLAINS

by John C. Pair

Abstract. The continental climate of the southern Great Plains is often extreme, and many deciduous forest trees do not adapt well to a prairie site. Nevertheless, through proper selection from climatic analogues in other countries and capitalizing on stress-tolerant native species, many adapted trees are available for urban plantings. Selection criteria include tolerance to summer heat, drought and sudden changes in winter temperatures. Matching species preference with soil and other site characteristics can improve tree survival and add diversity to the urban landscape.

The southern Great Plains generally is defined as the area between the 98th meridian and the Rocky Mountains and from the Arkansas River, in central Kansas, to the southern boundary of New Mexico. The climate is characterized as often hot and dry in summer with desiccating cold winters, often with little snow cover in mid-winter. Precipitation varies from 12 to 32 inches annually, with high evapotranspiration rates imposing considerable stress on plant materials.

Trees are valued highly in the plains, and various testing programs date back to early windbreak trials in the 1920's at the USDA experiment station at Woodward, Oklahoma (4). Other testing and introduction programs, such as the one conducted by Kansas State University at the Horticulture Research Center in Wichita, Kansas, began in the early 1970's. Many tree species from countries with similar climates, such as Yugoslavia, are performing well in the Great Plains (9,16).

Pioneers brought such species as the American elm (*Ulmus americana*) from the deciduous forest to line streets in many cities like Wichita but Dutch elm disease has taken its toll during the past several years. New, resistant elm hybrids have been developed in recent years (11,15) but often are attacked heavily by elm leaf beetle. Where winters are mild enough, the Asiatic lacebark elm (*Ulmus parvifolia*), which is resistant

to both of these pests, is suggested. The species is hardy to -21 to -30°C, depending on the cultivar (5). In a search for superior forms with greater hardiness, considerable work is being done on selecting and releasing new cultivars (2,3). The U.S. National Arboretum is including *U. parvifolia* in breeding programs to improve elm leaf beetle resistance in interspecific hybrids such as 'Frontier' (14). *Ulmus wilsoniana* 'Prospector' also displays resistance to this insect pest (13).

Other Asiatic species, such as the Shantung maple (*Acer truncatum*) received through the USDA Regional Plant Introduction Station at Ames, IA, are tolerant of both drought and cold. Selections are being evaluated, propagated, and introduced in the southern Great Plains (8). Depending on the seed source, it can be hardy throughout zone 5 and as far north as Ames, IA. Hybrids of *A. truncatum* x *platanoides* have been less tolerant of heat than the species.

Another maple performing well under stressful conditions is the Caddo sugar maple, a southern ecotype of *Acer saccharum* subsp. *saccharum* native to central Oklahoma (12). Among southwestern maples compared at Texas A & M Research and Extension Center in Dallas, Texas it performed as well or better than sugar maples from the Wichita Mountains Wildlife Refuge near Chickasha, Oklahoma, or its western relative, the maple (*A. grandidentatum*) from west Texas. At the Kansas State University Horticulture Research Center in Wichita, KS, the Caddo maples showed superior growth and tatter resistance when compared with eight other cultivars of *A. saccharum*.

An evaluation of 10 *A. saccharum* and *A. nigrum* selections included tolerance to summer drought. The moisture status was measured by means of a pressure bomb using terminal twigs to check the xylem water potential, reported as negative pres-

Table 1. Leaf scorch and corresponding xylem water potential of various maple selections.

Acer species and cultivars	Leaf scorch ^{1/}	Xylem water potential (MPa) ^{2/}	
		Pre-dawn	Mid-day
<i>A. saccharum</i>			
'Bonfire'	23.0 e	-1.10 bcd	-1.45 ab
'Commemoration'	8.0 ab	-0.96 cd	-1.91 a
'Legacy'	3.2 a	-0.80 de	-1.32 ab
'Green Mountain'	22.0 de	-1.54 a	-1.64 a
'Fairview'	31.0 f	-1.14 bcd	-1.45 ab
'Wright Brothers'	34.0 f	-1.34 abc	-1.73 a
'Endowment'	14.0 bc	-1.02 bcd	-1.72 a
Caddo	6.8 a	-0.54 e	-0.84 b
<i>A. nigrum</i>			
'Green Column'	16.0 cd	-1.30 abc	-1.71 a
	16.0 cd	-1.30 abc	-1.84 abc

^{1/} Rated visually and expressed as percent of leaf area affected.

^{2/} Measured on Sept. 4, 1991, mean of 5 replications. Means followed by a common letter are not significantly different at LSD_{.05}.

sure (Table 1). An analysis of variance was performed on the data with mean separation by Fisher's Least Significant Difference at the .05 level.

Caddo maple had the highest water potential (least negative) during pre-dawn and mid-day under drought conditions and less leaf scorch than most other cultivars except 'Commemoration' and 'Legacy' (Table 1).

A real pioneer of the prairie dating back over 100 years, when windbreaks and shelterbelts were planted widely, is the Osage orange or hedge tree (*Maclura pomifera*). It was once used as a living fence before the invention of barbed wire. In recent years, it has been suggested for use as an urban tree for difficult planting sites because of its drought tolerance and pest resistance. Male (fruitless) thornless cultivars with desirable ornamental features have been selected during the past 20 years (6,7). Its drought tolerance is attributed, at least partially, to its wide, extensive root system. Therefore, it should be used where ample space is available for the competitive root system.

The Kansas Urban Forestry Council has developed a list of preferred tree species and cultivars to encourage the planting of stress-tolerant and pest-resistant trees. Trees are categorized by size and the guide also provides information on

site preference, pH tolerance, ornamental features, and other information relevant to tree performance. The preferred tree list for south central Kansas includes over 35 selections well adapted to the region (Table 2).

Although not included on the list because it is not hardy throughout the region, an extremely drought-tolerant species for the southern states (zones 6 through 9) is the Chinese pistache (*Pistacia chinensis*). For over 30 years, this small to medium size, pest-resistant tree (25 to 30 feet) has produced unexcelled fall color in Wichita parks. Although it is dioecious, the robin egg-colored fruit of the female is very attractive and seldom a nuisance even in urban areas, and the tree is used in downtown street plantings. Few cultivars exist because of propagation difficulties, although 'Keith Davey' was introduced as a male selection (1).

Callery pear (*Pyrus calleryana*) and its many cultivars continue to be among the top spring-flowering attractions. However, as was learned all too suddenly in the winter of 1989-90, some selections are more adapted than the most frequently planted cultivar 'Bradford', which is hardy to only -15°F. Freezing tests in Minnesota by Pellett and McNamara at the University of Minnesota, (10) show that 'Aristocrat', 'Autumn Blaze', or 'Redspire' are hardy to -33°, -29°, and -26°

Table 2. Preferred tree species for south central Kansas.

Common name	Genus, species and/or cultivar
Small deciduous trees (under 20 feet)	
Amur maple	<i>Acer ginnala</i>
Eastern redbud	<i>Cercis canadensis</i>
Oklahoma redbud	<i>Cercis reniformis</i> 'Oklahoma'
Cockspur hawthorn	<i>Crataegus crusgalli</i>
Washington hawthorn	<i>Crataegus phaenopyrum</i>
Winterberry euonymus	<i>Euonymus bungeanus</i>
Flowering crabapple	<i>Malus</i> 'Donald Wyman', 'Indian Magic', 'Prairifire', 'Snowdrift' and zumi 'Calocarpa'
Japanese Tree Lilac	<i>Syringa reticulata</i>
Medium deciduous trees (20 to 40 feet)	
Trident maple	<i>Acer buergeranum</i>
Hedge maple	<i>Acer campestre</i>
Shantung maple	<i>Acer truncatum</i>
Winter King hawthorn	<i>Crataegus viridis</i> 'Winter King'
Imperial honeylocust	<i>Gleditsia triacanthos</i> var.inermis
Goldenrain tree	<i>Koelreuteria paniculata</i>
Thornless Osage orange	<i>Maclura pomifera inermis</i> (male)
Flowering crabapple	<i>Malus baccata</i> 'Jackii', 'Centurian', 'Spring Snow and 'Red Splendor'
White mulberry	<i>Morus alba</i> (fruitless)
Hophornbeam (Ironwood)	<i>Ostrya virginiana</i>
Callery pear	<i>Pyrus calleryana</i> 'Aristocrat', 'Autumn Blaze', 'Chanticleer', and 'Redspire'
Sawtooth oak	<i>Quercus acutissima</i>
Chinkapin oak	<i>Quercus muehlenbergii</i>
Western soapberry	<i>Sapindus drummondii</i>
Large deciduous trees (40 to 60 feet and over)	
Red maple	<i>Acer rubrum</i>
Sugar maple	<i>Acer saccharum</i>
River birch	<i>Betula nigra</i>
Sugar hackberry	<i>Celtis laevigata</i>
Hackberry	<i>Celtis occidentalis</i>
Persimmon	<i>Diospyros virginiana</i>
White ash	<i>Fraxinus americana</i>
Green ash	<i>Fraxinus pennsylvanica</i>
Ginkgo	<i>Ginkgo biloba</i>
Thornless honeylocust	<i>Gleditsia triacanthos</i> var.inermis
Kentucky coffee tree	<i>Gymnocladus dioica</i>
Swamp white oak	<i>Quercus bicolor</i>
Shingle oak	<i>Quercus imbricaria</i>
English oak	<i>Quercus robur</i>
American linden	<i>Tilia americana</i>
Littleleaf linden	<i>Tilia cordata</i>
Lacebark elm	<i>Ulmus parvifolia</i>
Sweetgum	<i>Liquidambar styraciflua</i>
London plane tree	<i>Platanus x acerifolia</i>

White oak	<i>Quercus alba</i>
Bur oak	<i>Quercus macrocarpa</i>
Red oak	<i>Quercus rubra</i>
Shumard oak	<i>Quercus shumardii</i>
Bald cypress	<i>Taxodium distichum</i>
Evergreens	
Chinese juniper	<i>Juniperus chinensis</i> 'Admiral', 'Hetzi Columnaris', 'Keteleeri', 'Spartan' and 'Wintergreen'
Eastern redcedar	<i>Juniperus virginiana</i> 'Canaerti', 'Hilspire' and 'Oxford'
Black Hills spruce	<i>Picea glauca</i> var. <i>densata</i>
Pinyon pine	<i>Pinus edulis</i>
Limber pine	<i>Pinus flexilis</i>
Austrian pine	<i>Pinus nigra</i>
Scotch pine	<i>Pinus sylvestris</i>

Table 3. Lowest temperature tested (°F.) that did not result in severe injury of stem tissue of *Pyrus taxa* 1/.

Taxa	Date tested		
	10/22	11/14	01/14
<i>Pyrus calleryana</i>			
'Aristocrat'	+ 6.8	- 4.0	-32.8
'Autumn Blaze'	+ 6.8	- 4.0	-29.2
'Bradford'	+24.8	+ 3.2	-14.8
'Capital'	+21.2	- 7.6	-18.4
'Chanticleer'	+ 3.2	- 7.6	-22.0
'Redspire'	+17.6	+ 3.2	-25.6
'White House'	+21.2	+ 3.2	-22.0
<i>Pyrus calleryana fauriei</i>	+14.0	- 4.0	-25.6
<i>Pyrus Regellii</i> 'Angel Wing'	+14.0	-14.8	-32.8

1/ Pellett, Harold and Steve McNamara. 1991. Landscape Plant News 2(1):4-5)

respectively, and would be better choices. 'Chanticleer' and 'Whitehouse' were hardy to -22°. Acclimation is very important in the fall and 'Bradford' was hardy only to 25°F in late October (Table 3). In addition to their flowers, many cultivars provide exceptional leaf color in extended fall seasons.

The treeless prairie is an often hostile environment in which to plant trees, but many species thrive when given adequate care. The list of species and cultivars that tolerate the stresses of the heat, drought, and cold, occurring in the region continues to grow.

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Résumé. Le climat continental du sud des Prairies est souvent constitué d'extrêmes et plusieurs arbres de forêt à feuilles caduques ne s'adaptent pas facilement à un milieu de prairie. Néanmoins, par une sélection judicieuse à partir de régions aux conditions climatiques semblables et en misant sur des espèces indigènes tolérantes à la sécheresse, plusieurs espèces d'arbres adaptées sont disponibles pour les plantations en milieu urbain. Les critères de sélection incluent la tolérance à la chaleur et à la sécheresse estivale ainsi qu'aux changements soudains de températures en hiver. Sélectionner les espèces en fonction du type de sol et des autres caractéristiques du site peut permettre d'améliorer les chances de survie des arbres et créer une diversité dans le paysage urbain.

Zusammenfassung. Das kontinentale Klima der südlichen Großen Ebenen ist oft extrem und viele sommergrüne Waldbäume passen sich nicht gut an den Prairie-Standort an. Trotz alledem, durch sorgfältige Selektion aus analogen klimatischen Bedingungen in anderen Ländern und Eingrenzung auf stresstolerante einheimische Arten, sind nun viele der getesteten Baumarten für städtische Pflanzungen geeignet. Die Kriterien der Selektion schließen Toleranz gegenüber Sommerhitze und Dürre und ebenso gegen plötzliche Temperaturwechsel im Winter ein. Ein Zusammenspiel der Artenansprüche mit dem Boden und anderen Standortmerkmalen kann die Überlebensrate der Bäume verbessern und Vielfältigkeit in städtische Anlagen hineinbringen.