Urban & Community Forestry Assistance Program

6 TECHNOLOGY BULLETIN

JULY 2000 FORESTRY REPORT R8-FR 63

USDA FOREST SERVICE
SOUTHERN REGION
1720 PEACHTREE RD., NW ATLANTA, GA 30367
SOUTHERN RESEARCH STATION
320 GREEN STREET, ATHENS, GA 30602

**This technology bulletin is based on the article, *Evaluating Trees for Saltwater Spray Tolerance for Oceanfront Sites*, that is published in the Journal of Arboriculture, Volume 25, Number 4, July 1999, and written by Bonnie Appleton (Virginia Tech), Roger R. Huff (City of Virginia Beach) and Susan C. French (Virginia Tech).**

# *The Search for Salt-Tolerant Trees*

## THE SEARCH FOR SALT-TOLERANT TREES

The City of Virginia Beach, VA has a problem that is common to all the coastal cities in the South. As a major tourist center, it is important that the city be as attractive as possible, especially in the resort areas that border the Atlantic Ocean and Chesapeake Bay. The problem is that salt spray, blowing in from the Atlantic, deforms or kills the landscape trees planted along the main street of the resort areas.

Salt and trees generally do not mix. So-called salt-tolerant plants can withstand up to 40,000 parts per million (ppm) of salt water. The Atlantic Ocean contains more than 32,000 ppm of salt, so 1 or 2 heavy deposi-tions or several moderate ones can easily exceed the critical level of sodium or chloride concentration in tree leaves and stems.

Whether inherent in the soil, blown on as sea spray, splashed on in the form of de-icing material, or applied in irrigation water, salt can damage trees in two ways. Salt within the soil can adversely affect soil structure and damage a tree's roots, causing the crown to thin; however, aerial deposition of salt on the above-ground parts of a plant causes the most damage. And ocean spray is the primary culprit. During extreme conditions, such as hurricanes, salt spray can affect plants as far as 50 miles inland, although most damage occurs within 1,000 feet of the shore.

*Saltwater desiccated leaf margins and tips of London planetree on exposed sites in Virginia Beach.*

*Where trees are taller than adjacent buildings, the tree tops are subject to salt spray defoliation.*

## EVIDENCE OF DAMAGE

Salt damage may take various forms: delayed bud break, reduced leaf size, desiccated (dehydrated) leaf margins and tips, premature fall coloration and leaf fall, bud and stem dieback, and reduced shoot growth. "Witches' brooms" may also develop after terminal buds are killed. Salt produces these symptoms by altering osmotic pressure and, where soil is salty, upsetting the mineral nutritional balance. Most damage occurs on the tree's windward side or on crowns that grow taller than adjacent protective buildings. This gives the trees an unbalanced, misshapen appearance. The trees closest to the shore suffer the most damage.

Damage to trees from de-icing products can be avoided or minimized by using chemicals less toxic than sodium chloride. But, obviously, the salt content of ocean spray cannot be changed. It is therefore essential that species selected for landscape planting in areas exposed to ocean spray be able to survive and remain attractive in such environments.

## THE VIRGINIA BEACH DILEMMA

All of this is of special concern to the City of Virginia Beach, one of the largest cities on the Atlantic Coast, where tourism is a major industry. In 1997, about 2.5 million overnight visitors spent more than half a billion dollars in Virginia Beach. Atlantic Avenue, the major artery through the resort area, runs parallel to the shore and is separated from it and the boardwalk by hotels, restaurants and shops. Trees in this area are subject to salt spray from "nor'easters" (winds that blow up to 65 miles per hour from the northeast, especially in spring).

Landscaping along the boardwalk consists mainly of salt-tolerant shrubs, ornamental grasses, and perennials, while the "greenscape" along Atlantic Avenue and its side streets is restricted to 600 in-ground pits intended for tree planting. Trees planted in these pits have limited growing space and are subject to soil compaction, automobile emissions, and vandalism. In addition, the City imposes several restrictions on trees planted along Atlantic Avenue. They


*Trees along Atlantic Avenue have different amounts of damage depending upon their exposure to ocean spray.*

must provide shade but must not produce hazardous or unsightly litter, and they cannot obstruct pedestrian or vehicular traffic. All of this, plus the necessity for salt tolerance, makes species selection extremely difficult. Since 1988 Virginia Beach has mainly planted Bloodgood London planetree (*Platanus X acerifolia* 'Bloodgood'). This species was reputed to be moderately salt tolerant, but about 150 of these trees had to be replaced each year because of salt damage, at a cost to the City of more than $10,000. Thus the search for more suitable species.

## 10 SPECIES TESTED FOR SALT TOLERANCE

In an effort to identify tree species that could withstand salt deposition without being deformed, a group of allegedly salt-resistant trees was tested in the tree pits along Atlantic Avenue. Trees that naturally grow in salty environments have special attributes that help them stave off "salt attacks." Some have salt-secreting glands, others have resinout buds, waxy leaves and stems, sunken buds, or low surface-to-volume ratios (e.g. pine needles) that exclude salt. A list of such species was derived from an extensive search of the literature. Unfortunately, many of the references did not specify whether trees were resistant to salty soil or salt spray. Many species that can tolerate salt in the soil may not be resistant to salt in the air.

The original list was reduced to those species reported to be hardy for USDA Hardiness Zone 8a and that met the Atlantic Avenue street-tree requirements. This process eliminated 17 potentially salt-spray-resistant species: for example, some were too large, others were not sufficiently heat resistant, still others produced too much litter.

On a windy day in October all Atlantic Avenue tree pits were rated for wind exposure:

- 9 % were rated low exposure (protected by buildings)
- 8 % moderate exposure (some wind blockage)

*Trees were rated low, moderate and high for wind exposure.*

- 83% high exposure (no protection)

The tunneling effect of buildings created some higher exposure ratings than expected.

City blocks containing at least three pits of each wind-exposure rating were selected for planting. The original planting was done from November 1995 to February 1996 and consisted of one block each of four species: loquat (*Eriobotrya japonica*), goldenraintree (*Koelreuteria paniculata*), fruitless sweetgum (*Liquidambar styraciflua* 'Rotundiloba'), and lacebark elm (*Ulmus parvifolia* 'King's Choice'). Two more species were added in early 1997: a block of dwarf southern magnolia (*Magnolia grandiflora* 'Little Gem') in January and a block of thornless honeylocust (*Gleditsia triacanthos* var. *inermis* 'Shademaster') in March. Finally, three partial blocks were planted to sweetbay magnolia (*Magnolia virginiana*) in November 1997. All trees were planted according to City of Virginia Beach specification and irrigated regularly.

## DISAPPOINTING RESULTS

By December 1996, the loquats had been heavily damaged and replaced with Chinese flametree (*Koelreuteria bipinnata*). The latter species suffered similar damage and so was also deemed unacceptable. Goldenraintree, lacebark elm, and sweetgum in moderate and high exposures also fared poorly the first year. Nor'easters from August through October 1996 defoliated the trees before they became dormant, resulting in partial releafing. This new growth was killed by cold in November and December, leaving dead terminal buds and twigs and sparse foliage the following spring. Several early spring nor'easters repeated the first year's scenario and by the end of that second year all three species were too deformed to be acceptable.

Although honeylocust is considered one of the most salt-tolerant species because of its waxy stems and sunken buds, the trees suffered severe damage as the buds broke dormancy the year they were planted. The resulting dieback required heavy pruning, which deformed the crowns, thus rendering the species unacceptable. The southern magnolias are alleged to be somewhat resistant to aerial salt, but neither the 'Little Gem' not the sweetbay magnolia proved adequately tolerant to salt-water spray.

## THE RELUCTANT CONCLUSION

Clearly, none of the 10 species tested in this study is sufficiently resistant to salt-spray damage to be recommended for planting in this harsh environment. Moreover, cultural treatments to prevent or reduce salt deposition on trees have proved to be ineffective. Antidessiccants (chemicals to prevent dehydration), even when applied at high dosages, did not prevent salt injury. Washing off salt deposits after storms was tried and deemed to be impractical, and frequent replanting is economically prohibitive.

In view of all this, the authors recommend that tree planting where wind exposure is moderate to high be abandoned in favor of shrubs, ground cover, and annuals that have proven to be salt tolerant. Providing the desired amount of tree shade in Virginia Beach seems to be impossible under the prevailing conditions.

USDA FOREST SERVICE
SOUTHERN REGION
1720 PEACHTREE RD., NW
ATLANTA, GA 30367

SOUTHERN RESEARCH STATION
320 GREEN STREET
ATHENS, GA 30602

## LITERATURE CITED IN ORIGINAL ARTICLE

*Anonymous. 1995. Listing trees shown to be salt-tolerant. Landscape Management. 34: 38.*

*Anonymous. 1999. Marketing overview. Virginia Beach Tourism Fiscal Year 1999.*

*Carter, S.; Yoklic, M.; Schaefer, C. 1989. Landscaping with salt-tolerant material. American Nurseryman. 170: 88-99.*

*Chaplin, L.T. 1994. The Southern gardener's book of lists. Dallas, TX: Taylor Publishing. 186 p.*

*Connors, M.S. 1996. At the ocean's edge. Horticulture LXXIV: 34-38.*

*Delahaut, K.A.; Hasselkus, E.R. 1996. Salt injury to landscape plants. Publication A2970. University of Wisconsin Cooperative Extension.*

*Dirr, M.A. 1976. Selection of trees for tolerance to salt injury. Journal of Arboriculture. 5: 209-215.*

*Flint, H.L. 1983. Landscape plants for eastern North America. New York: John Wiley & Sons. 677 p.*

*Foley, D.J. 1965. Gardening by the sea from coast to coast. Orleans, MA: Parnassus Imprints. 285 p.*

*Gibs, J.N.; Palmer, C.A. 1994. A survey of damage to roadside trees in London caused by the application of de-icing salt during the 1990/91winter. Journal of Arboriculture. 18: 321-343.*

*Gilman, E.F. 1997. Trees for urban and suburban landscapes. Albany, NY: Delmar Publishers. 662 p.*

*Guy, R. 1996. Pour on performance, profits with de-icing salt. Landscape Management. 35: SR17-SR18.*

*Hootman, R.G.; Kelsey, P.D.; Reid, R.; von der Heide-Spravka, K. 1994. Factors affecting accumulation of deicing salts in soils around trees. Journal of Arboriculture. 20: 196-200.*

*Kelsey, P. 1998. Personal communication.*

*Lumis, G.P.; Hofstra, G.; Hall, R. 1973. Sensitivity of roadside trees and shrubs to aerial drift of deicing salt. Hortscience. 8: 475-477.*

*Pirone, P.P. 1959. Tree maintenance. 6th ed. New York: Oxford University Press. 514 p.*

*Russell, A.B. 1995. Coastal plants from A to Z. American Nurseryman. 182: 42-60.*

*Schmidt, R.M. 1983. Gardening on the eastern seashore. Barnegat Light, NJ: Barnegat Light Press. 205 p.*

*Siegendorf, L. 1984. Hurricane tree care. Journal of Arboriculture. 10: 217-221.*

*Sinclair, W.A; Lyon, H.H.; Johnson, W.T. 1987. Diseases of trees and shrubs. Ithaca, NY: Cornell University Press. 575 p.*

*Tenenbaum, F., ed. 1996. Taylor's guide to seashore gardening. Boston, MA: Houghton Mifflin Company. 391 p.*

*Van Arsdel, E. P. 1996. Leaf scorch: detecting the cause. Arbor Age. 16: 22-28.*

*Watson, G.W.; Himelick, E.B. 1997. Principles and practice of planting trees and shrubs. Champaign, IL: International Society of Arboriculture. 199 p.*

*Williams, D.J.; Moser, B.C. 1975. Critical level of airborne sea salt inducing foliar injury to bean. HortScience. 10: 615-616.*

*Wyman, D. 1990. Trees for American gardens. New York: Macmillan Publishing Company. 501 p.*

## ACKNOWLEDGEMENTS

The authors of the original article wish to thank the Virginia Urban and Community Forestry Grant Assistance Program for funding that helped support this research, and crews from Landscape Services, City of Virginia Beach, for tree installation and maintenance.

This bulletin is available in electronic format on the Southern Region Urban and Community Forestry web site (http://www.urbanforestrysouth.org). For more information on the technology bulletin series call (706) 559-4225.

Forestry Report R8-FR 63 July 2000