TOLERANCE OF SEVEN WOODY ORNAMENTALS TO SOIL-APPLIED SODIUM CHLORIDE

by Michael A. Dirr [1]

Abstract. Two-year-old seedlings of seven woody ornamental species ranging in reported salt tolerance from good to poor were salinized with 250 ml of 0.25 *N* NaCl applied daily to the soil. *Elaeagnus angustifolia* and *Rosa rugosa* were not injured and contained the lowest leaf levels of Na and Cl. *Elaeagnus umbellatus* and *Prunus tomentosa* showed the greatest injury while *Acer platanoides, Prunus besseyi,* and *Rhus glabra* were intermediate in tolerance. Leaf Na contents did not reflect the degree of injury among *Elaeagnus umbellatus, Prunus tomentosa, Acer platanoides, Prunus besseyi,* and *Rhus glabra*. However, leaf Cl content in all injured species was greater than 2.5 percent and more accurately reflected the severity of injury although the most seriously injured species did not contain the greatest leaf Cl levels.

Evaluations of woody plant salt tolerance have been primarily serendipitous in nature (2, 7, 8, 10, 11, 14, 15). Controlled testing for plant salt tolerance has been slow in developing (1, 3, 4, 12) but offers the only logical approach for accurately determining the degree of resistance or susceptibility (5). Several authors (2, 7, 8, 9, 10, 11, 12) have formulated lists of salt tolerant plants and categorized them as showing good, moderate, or poor tolerance. Unfortunately, a particular species was often listed under all three categories. A plant's degree of tolerance to soil salts may be different than its aerial salt tolerance and, therefore, woody plants may have been incorrectly categorized as displaying complete resistance when, in fact, only one type of resistance was actually evaluated.

Evaluations of salt-induced injury *must* be based on salts, application methods (aerial-versus soil-applied), osmotic effects, shoot or leaf Cl levels, and perhaps tissue Na levels (4, 5). This study examined only the effects of soil salts on woody plant species ranging in reported tolerance (9, 12) from good to poor and attempted to further elucidate the relationship between leaf Cl and/or Na content and appearance.

Materials and Methods

Two-year-old seedlings of *Elaeagnus angustifolia* (Russian olive), *Rosa rugosa* (rugosa rose), *Elaeagnus umbellatus,* (autumn-olive), *Prunus tomentosa* (manchu cherry), *Acer platanoides* (Norway maple), *Prunus besseyi* (western sand cherry), and *Rhus glabra* (smooth sumac) were treated daily with 250 ml of soil-applied 0.25 *N* NaCl dissolved in deionized water. All plants were thoroughly established at the time of salinization and were growing in a soil:peat:perlite (v:v:v) medium (pH 5.0 to 5.5) in 15 cm plastic pots. The plants were fertilized with Hoagland's solution (6) 3 times per week prior to salinity treatments and twice per week during the experiment, which was initiated on April 12 and terminated on April 24, 1977. Plants were maintained on a 15-hour photoperiod at 24 deg. C (day) and 20 deg. C (night). All species, except *Prunus tomentosa,* were evaluated (0=dead; 5=vigorous, no necrosis, dark green foliage) and leaves harvested on April 24. *Prunus tomentosa* was harvested and evaluated on April 19, since the majority of the leaves had abscised.

All leaf tissue was thoroughly washed in distilled water and oven-dried for 72 hours at 65 deg. C. The tissue was then ground through a 40-mesh screen in a Wiley mill. Na and Cl were determined as previously described (3). The experiment was a completely randomized design with ten single plant replicates per treatment.

Results and Discussion

Appearance. Soil salinity treatments resulted in marked visual differences among the seven species (Table 1). *Elaeagnus angustifola* and *Rosa rugosa* were the only species not affected by the salinity treatments. These species in most instances were rated among the most salt

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tolerant (5, 9, 12); however, *Rosa rugosa* has been rated as resistant and susceptible to aerial salts (9). *Elaeagnus umbellatus,* although taxonomically closely related to *Elaeagnus angustifolia,* was severely injured as was *Prunus tomentosa.* Our results with soil-salt tolerance of *Elaeagnus umbellatus* agreed closely with those of Buschboom (1) who rated the species as susceptible to aerial-applied salts. Generalizations concerning the salt tolerance of members of the same genus or family are a mistake and have led to erroneous evaluations (14, 15). *Acer platanoides, Prunus besseyi,* and *Rhus glabra* were injured but not as seriously as *Prunus tomentosa* or *Elaeagnus umbellatus.* There are conflicting evaluations of the degree of salt tolerance displayed by *Acer platanoides* and *Rhus glabra.* Several authors (9, 12) have ascribed good soil and spray tolerance to *Acer platanoides*; however, based on the results of this study, moderate tolerance to soil salts appeared a more realistic evaluation. *Rhus glabra* (9) was rated as tolerant to soil and spray salts but again a moderate rating appeared more accurate. *Prunus besseyi* should be rated as moderate to poor in degree of soil-salt tolerance while *Prunus tomentosa* and *Elaeagnus umbellatus* were severely susceptible.

Table 1. Effect of soil-applied NaCl on the appearance of seven woody plant species.

Species	*Appearance index*[z]	
	Control	*0.25N NaCl*
Acer platanoides	5.0a[y]	2.6b
Elaeagnus angustifolia	4.8a	4.2a
Elaeagnus umbellatus	4.8a	0.6cd
Prunus besseyi	4.4a	1.6bc
Prunus tomentosa	5.0a	0d
Rhus glabra	4.4a	2.2b
Rosa rugosa	5.0a	5.0a

[z]5-healthy, vigorous, no leaf necrosis; 0-dead.

[y]Mean separation, within control and NaCl, by Duncan's multiple range test, 0.05 level.

Prunus tomentosa developed significant leaf necrosis after 3 days, and after 7 days all leaves were completely necrotic. *Acer platanoides* leaves developed a marginal necrosis that covered about one-half of the leaf area at the end of the 12-day period. *Elaeagnus umbellatus* leaves were completely necrotic and most had abscised after 12 days. *Rhus glabra* and *Prunus besseyi* exhibited no leaf necrosis, but the leaves showed wilting, pronounced fall coloration, and abscised from the basal portion of the plant. Among all injured species, injury progressed in an acropetal pattern. *Elaeagnus angustifolia* and *Rosa rugosa* appeared similar to control plants in all respects. These symptomatic differences in plant response to soil-applied salts illustrate the problem with using appearance (leaf characteristic response) as the sole criterion for assessing salt damage. If control plants are not included, accurate assessment of salt damage to plants is difficult. For example, *Prunus tomentosa* showed extensive foliar necrosis but *Rhus glabra* did not. Only comparison with the control-treated *Rhus glabra* permitted an accurate assessment of the soil-salt treatment effects. Growth data (fresh weight, dry weight) were not determined in this experiment since the treatment period was so short (12 days) and negligible growth would have occurred.

Sodium Content. Leaf Na content did not vary among the control-treated species; however, pronounced differences occurred among NaCl treated plants (Table 2). The two species which exhibited the greatest visual tolerance (*Elaeagnus angustifolia* and *Rosa rugosa*) contained the lowest leaf Na levels. In fact, there were no significant differences in leaf Na content between control and NaCl-treated plants for either species. Leaves of *Prunus besseyi* contained the greatest levels of Na followed by *Prunus tomentosa, Elaeagnus umbellatus, Acer platanoides,* and *Rhus glabra.* The leaf Na levels did not reflect the degree of visual injury except for the two resistant species. *Acer platanoides, Elaeagnus umbellatus,* and *Prunus tomentosa,* although similar in Na content, varied markedly in appearance (Table 1). *Prunus besseyi* did not differ in appearance index from *Acer platanoides* or *Rhus glabra* although the leaf Na content was greater. Previous work (3, 4) with honey locust and English ivy has shown that leaf Na content was not a consistent indicator of the degree of soil-applied NaCl-induced injury.

Table 2. Leaf Na content of seven woody plant species.

	Na, percent dry wt	
Special	*Control*	*0.25N NaCl*
Acer platanoides	0.03e[z]	1.02bc
Elaeagnus angustifolia	0.12de	0.30de
Elaeagnus umbellatus	0.16de	1.03bc
Prunus besseyi	0.3e	2.20a
Prunus tomentosa	0.5e	1.45b
Rhus glabra	0.3e	0.77bcd
Rosa rugosa	0.5e	0.52cde

[z]Mean separation, within control and NaCl, by Duncan's multiple range test, 0.05 level.

Chloride Content. Leaf tissue Cl corresponded closely with the visual indices of soil-salt induced damage (Table 3). Although there were no significant differences in leaf Cl content among the control-treated species, *Rosa rugosa* contained lower leaf Cl levels than other species. Leaf Cl contents of *Elaeagnus angustifolia* or *Rosa rugosa* control and NaCl-treated plants were not significantly different. *Prunus besseyi* showed the greatest leaf Cl pattern while the other four species were similar. The severely damaged species showed significantly greater leaf Cl levels than resistant species. Previous investigations (5, 12, 13) have shown that Cl is more abundantly accumulated in leaf tissue than Na and more accurately reflected the degree of injury. Although *Prunus besseyi* accumulated the greatest levels of Na and Cl, it was not the most severely injured species.

Apparently, specific plants are able to accumulate greater levels of Cl (possibly Na) and pool the ions in non-metabolic areas. The critical Cl level (that which induces necrosis or some other form of visual injury) often ranges from 2 to 3 percent of dry weight (5, 13). When the Cl levels of the 5 severely injured species progressed beyond 2 percent, severe injury resulted. Na leaf content did not exhibit a consistent critical range among the injured species. The species which exhibit the greatest salt resistance are those which effectively preclude Cl and Na (5).

Table 3. Leaf Cl content of seven woody plant species.

	Cl, percent dry wt	
Species	*Control*	*0.25N NaCl*
Acer platanoides	0.44c[z]	2.65b
Elaeagnus angustifolia	0.40c	0.70c
Elaeagnus umbellatus	0.32c	2.63b
Prunus besseyi	0.23c	4.35a
Prunus tomentosa	0.30c	2.72b
Rhus glabra	0.23c	3.29b
Rosa rugosa	0.11c	1.04c

[z]Mean separation, within control and NaCl, by Duncan's multiple range test, 0.05 level.

Future work will attempt to determine the biochemical and anatomical factors responsible for the pronounced salt-resistance of *Elaeagnus angustifolia* and *Rosa Rugosa* compared to the other species. Presently, selected conifers (*Abies, Cedrus, Juniperus, Picea, Pinus, Pseudotsuga, Taxus, Tsuga*) and *Ilex* species and cultivars are being screened for their tolerance to soil-and aerial-applied salts.

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JOHN BARTRAM: BOTANIST & HORTICULTURIST[1]

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Abstract. John Bartram (1699-1777) was one of colonial America's foremost botanists, horticulturist and plant explorers. Collecting plants throughout Eastern North America, he was responsible for the introduction of between 150 and 200 new American species to England. In his garden on the Schuylkill River, Bartram grew the plants he collected in the wild as well as those sent to him from Europe utilizing the latest horticultural techniques of his time. Today his house and garden have been preserved and are now operated as part of Fairmount Park system in conjunction with the John Bartram Association.

The city of Philadelphia has a long established horticultural heritage. From the earliest plans invisioned by William Penn, Philadelphia was to be a green city. Today, besides having the largest city park in the country, the greater Philadelphia area has no fewer than nine public gardens and arboretums which are open to the public for study and passive recreation.

One of the foremost founding fathers of this horticultural and botanical tradition was a Philadelphian, John Bartram. Born in 1699 to English parents who had immigrated to Penn's colony, he was a farmer, botanist, horticulturist and plant explorer.

As a child he had little formal education besides the rudiments of reading and writing. He had, however, a strong curiosity about the natural world which surrounded him. Later in life he observed:

I had always, since ten years old a great inclination to plants and knew all that I once observed by sight, though not by the proper names having no person or books to instruct me.

His knowledge of plants' medicinal properties was often utilized when he treated sick neighbors who were unable to visit a physician in Philadelphia.

To further this interest, Bartram obtained botany books then written in Latin from friends in Philadelphia. Since his education was meager, he hired the local school master to teach him Latin. By the late 1720's he was botanizing throughout the surrounding countryside whenever he could free himself from his farming.

Sometime before 1732 Bartram became friendly with Joseph Breintnall, a Philadelphia merchant. Breintnall, a member of Benjamin Franklin's junto, was well connected in the Philadelphia intellectual community. He also had dealings with

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