Landscape Plant Lists for Salt Tolerance Assessment

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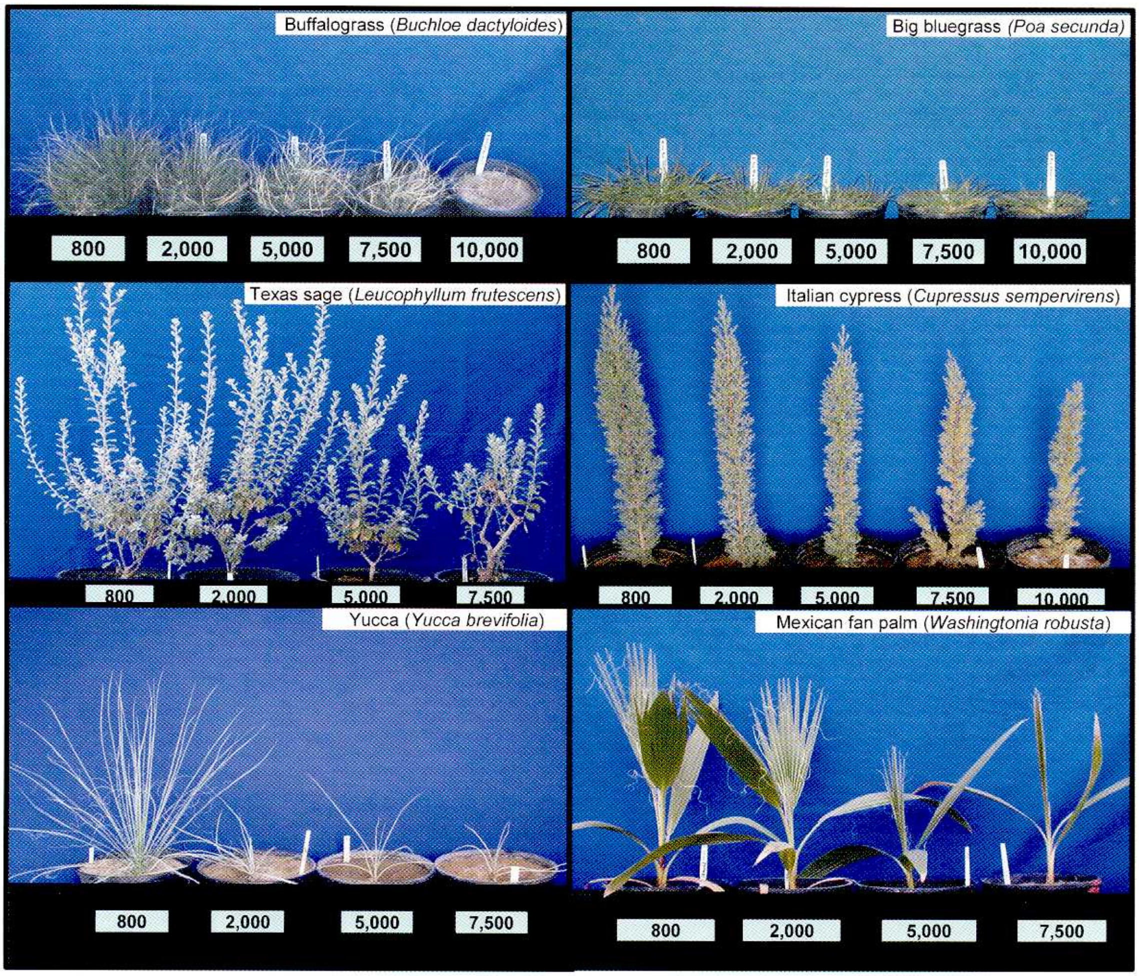

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Contents

How Salt Tolerance Tables were Developed

Plant Responses to Soil Salinity (Table Series A): The experiment to evaluate plant tolerance to soil salinity was conducted in a greenhouse. One gallon size plants were transplanted to 3 gallon pots containing loamy sand, and were irrigated with solutions of five levels of salinity; 800, 2000, 5000, 7500 and 10000 ppm for 6 months. The electrical conductivity (EC) of these solutions was, respectively, 1.2, 4.4, 9.4, 13.7 and 17 dS m^{-1}. About 80% of the salts in these solutions were in the form of NaCl. About 1/3 of the solutions applied was allowed to drain so as to avoid salt accumulation. Under this irrigation regime, salinity of the soil saturation extract (an official method of determining soil salinity) is approximately equal to the salinity of irrigation water used. Plant growth and leaf injury were recorded photographically.

Results were analyzed to determine the soil salinity which causes a 50% growth reduction or foliar salt damage on at least 25% of the leaves. In the case of turf and ground cover grasses, a 25% reduction in growth, instead of the conventional 50% reduction was used. This reflects field observation that growth of turf in high traffic area is critically important. Tested plant species were then classified into five categories, following the US Salinity Laboratory classification: sensitive (0 – 3 dS m^{-1}), moderately sensitive (3 – 6 dS m^{-1}), moderately tolerant (6 – 8 dS m^{-1}), tolerant (8 – 10 dS m^{-1}), and highly tolerant (>10 dS m^{-1}). The EC values shown in salt tolerance classification must be determined in the soil saturation extract made from soil samples collected from the main root zone.

Tolerance against Saline Water Sprinkling (Table Series B): Test plants (1 gallon size) were transplanted into 3 gallon pots using a highly permeable commercial soil mix. They were taken outdoors in March, and irrigated every other day with overhead sprinklers for 30 min which delivered 1/2 inch of water. Irrigation continued until the end of September for 6 months. The experiment utilized three saline water sources: tap water (800 ppm or 1.1 dS m^{-1}), a blend of tap water and well water (1260 ppm or 2.0 dS m^{-1}), and saline well water (1850 ppm or 3.0 dS m^{-1}). The corresponding concentrations of Na in these water sources were, respectively, 145, 280, and 425 ppm, and that of Cl was 140, 360 and 590 ppm. As soon as sprinkler irrigation was completed, all pots were flushed with tap water.

Plant responses to the sprinkler irrigation were evaluated by measuring shoot growth and leaf injuries. Salinity of irrigation water and corresponding Na and Cl concentrations which caused a 25% reduction in shoot growth or leaf injury over 25% of the leaves was determined. Because of the lack of the standard method of classifying plants for spray resistance, we used the following tentative classification: sensitive (< 1 dS m^{-1}, Na and Cl < 150 ppm), moderately sensitive (1 – 2 dS m^{-1}, Na < 280 ppm, Cl < 360 ppm), moderately tolerant (2 – 3 dS m^{-1}, Na < 425 ppm, Cl < 590 ppm), and tolerant (> 3 dS m^{-1}). Additional observations of plant response to sprinkler irrigation (Table B-2) were made at a golf course where irrigation water used had a dissolved salt content of 1120 ppm (2.1 dS m^{-1}, Na = 350 ppm, Cl = 325 ppm). Tolerance of trees against sprinkler application, shown in Table B-2 is based on daily irrigation using ¼ inch per application. This scheduling is commonly used in golf courses in El Paso.

How to Use Salt Tolerant Tables

Salt tolerant tables have been used by horticulturists and landscape planners to identify salt-sensitive species to avoid damage. They are also used to identify salt tolerant species for saline conditions. Salinity of irrigation water and soils must be known in order to make the full use of salt tolerance tables. Irrigation water analysis should include the determination of Na and Cl concentrations, besides the total dissolved salt contents or the electrical conductivity (EC). Soil salinity has to be measured in the soil saturation extract (Rhodes and Miyamoto, 1990), as plant salt tolerance to soil salinity is given by the salinity of the saturation extract (EC_e). Unfortunately, many laboratories use 1:1 or 1:2 extract, without knowing a way to convert the results to salinity of the saturation extract. Soil samples have to be collected from multiple locations as soil salinity is spatially variable.

Once soil and water testing results are obtained, the salt concentration factor (SCF) should be estimated by dividing soil salinity (EC_e) with salinity of irrigation water (EC_w). This parameter is a measure of salt accumulation potential, and varies not only with soil type, but also with soil and irrigation management practices used. Examples are shown in Appendix for municipal parks and golf courses in the El Paso area. If the SCF determined for a given site exceeds what is shown in the appendix, the causes of high levels of salt accumulation should be investigated prior to attempting to look for salt tolerant plants. The common causes include inadequate irrigation, high clay contents, and soil compaction.

Tolerance to Soil Salinity (Table A-1 through A-6): Soil salinity measured in the soil saturation extract can be compared directly with the plant salt tolerant values shown in salt tolerance tables. If soil salinity is determined only at one location of an area of concern, a factor of 1.3 should be multiplied to account for typical spatial variation, then compare against the plant salt tolerance level.

If salinity of irrigation water is expected to change, soil salinity upon conversion can be estimated by multiplying the projected salinity of the irrigation water to the SCF. If no soil salinity data are available, determine SCF in a similar soil type under a similar land use, or use Appendix for an estimate. The SCF increases with increasing clay contents of the soil (or the saturation water content) and with soil compaction.

Tolerance to Sprinkling (Tables B-1 and B-2): Salinity of irrigation water used for sprinkler irrigation can be compared directly with the salt tolerance levels shown in Tables B-1 and B-2. In some cases, reclaimed water is stored in a reservoir during winter months, and salinity of the supply can increase. If Na and Cl data are available, use them, instead of the conductivity value. These ions affect plant growth and increase leaf injury. In the case of pines and junipers, Cl damage occurs first as Cl ions are more mobile than Na. In broad leaf plants with rapid ion uptake, both Na and Cl seem to affect almost equally. Calcium ions usually do not affect foliar salt damage, as they precipitate on leaf surfaces upon water evaporation. Actual ion absorption through foliage and leaf salt damage will be affected by irrigation scheduling, climate, types of sprinklers used (Miyamoto and White, 2002). For visual identification of salt damage of various plant species, refer to a companion paper entitled "Photo Guide: Landscape Plant Response to Salinity".

Salt Tolerance Tables
(Tables A-1 through A-6)

Table A-1. Salt tolerance of warm and cool season grass species.

Warm Season		Cool Season	
Sensitive (<3 dS m^{-1})			
Black grama	(*Bouteloua eriopoda*)	Kentucky bluegrass	(*Poa pratensis*)
		Rough bluegrass	(*Poa trivialis*)
		Colonial bentgrass	(*Agrostis capillaris*)
Moderately Sensitive (3 - 6 dS m^{-1})			
Bahiagrass	(*Paspalum notatum*)	**Plains bluegrass**	(*Poa arida*)
Blue grama	(*Bouteloua gracilis 'Alma'*)	**Big bluegrass**	(*Poa secunda*)
Buffalograss	(*Buchloe dactyloides*)	Creeping bentgrass	(*Agrostis palustris*)
Blue grama	(*Bouteloua gracilis 'Bad River'*)	Annual ryegrass	(*Lolium multiforum*)
		Intermediate wheatgrass	(*Elytrigia intermedia 'Rush'*)
Moderately Tolerant (6 - 8 dS m^{-1})			
Zoysiagrass 'Zenith'	(*Zoysia sp. hybrid*)	**Intermediate wheatgrass**	(*Elytrigia intermedia 'Topar'*)
		Streambank wheatgrass	(*Elymus lanceolatus*)
		Crested wheatgrass	(*Agropyron desertorum*)
		Red fescue	(*Festuca rubra*)
		Perennial ryegrass	(*Lolium perenne*)
Tolerant (8 - 10 dS m^{-1})			
Bermudagrass	(*Cynodon dactylon*)	Tall fescue	(*Festuca arundinacea*)
St. Augustinegrass	(*Stenotaphrum secundatum*)	**Wild ryegrass 'Rio'**	(*Elymus triticoides*)
Highly Tolerant (>10 dS m^{-1})			
Alkali muhly	(*Muhlenbergia asperifolia*)	**Tall wheatgrass**	(*Thinopyrum ponticum*)
Desert saltgrass	(*Distichlis spicata*)	**Fults alkaligrass**	(*Puccinellia distans*)

* Species with bold print were from our experiment.

Table A-2. Salt tolerance of evergreen shrubs and trees, and conifers.

Shrubs		Trees	
Sensitive (<3 dS m^{-1})			
Rose	(*Rosa sp.*)	**Holly oak**	(*Quercus ilex*)
Nandina	(*Nandina domestica*)	**Leyland cypress**	(*Cupressocyparis leylandii*)
Red tip photinia	(*Photinia fraseri*)	Japanese yew	(*Podocarpus macrophyllus*)
Burford holly	(*Ilex cornuta, 'Burfordii'*)	**Texas Mt. laurel**	(*Sophora secundiflora*)
Chinese holly	(*Ilex cornuta*)		
Pyrenees cotoneaster	(*Cotoneaster congestus*)		
Cotoneaster	(*Cotoneaster buxifolius*)		
Texas Mt. laurel	(*Sophora secundiflora*)		
Moderately Sensitive (3 - 6 dS m^{-1})			
Oriental arborvitae	(*Thuja orientalis*)	**Rocky Mt. juniper**	(*Juniperus scopulorum*)
Japanese boxwood	(*Buxus microphylla*)	**Eastern red cedar**	(*Juniperus virginiana*)
Glossy privet	(*Ligustrum lucidum*)	**Southern live oak**	(*Quercus virginiana*)
Indian hawthorn	(*Raphiolepis indica*)	**Southern magnolia**	(*Magnolia grandiflora*)
Yaupon holly	(*Ilex vomitoria*)	Japanese black pine	(*Pinus thunbergiana*)
Dwarf pittosporum	(*Pittosporum tobira*)		
Blue point juniper	(*Juniperus chinenses*)		
Hollywood juniper	(*Juniperus chinenses*)		
Spreading juniper	(*Juniperus chinenses*)		
Pyracantha	(*Pyracantha fortuneana*)		
Silverberry	(*Elaeagnus pungens*)		
Moderately Tolerant (6 - 8 dS m^{-1})			
Rosemary	(*Rosmarinus officinalis*)	Aleppo pine	(*Pinus halepensis*)
Spreading acacia	(*Acacia redolens*)	Russian olive**	(*Elaeagnus angustifolia*)
Bottle brush*	(*Callistemon viminalis*)	White pine	(*Pinus strobus*)
Bougainvillea*	(*Bougainvillea spectabilis*)	Arizona cypress	(*Cupressus arizonica*)
Coyotebush	(*Baccharis pilularis*)	**European olive**	(*Olea europaea*)
Japanese euonymus	(*Euonymus japonica*)	**Afghan pine**	(*Pinus eldarica*)
Oleander	(*Nerium oleander*)	**Piñon pine**	(*Pinus edulis*)
Texas sage	(*Leucophyllum frutescens*)	**Italian cypress**	(*Cupressus sempervirens*)
European olive	(*Olea europaea*)		
Tolerant (8 - 10 dS m^{-1})			
Four-wing saltbush	(*Atriplex canescens*)		
Highly Tolerant (>10 dS m^{-1})			
		Italian stone pine	(*Pinus pinea*)

* Subject to freeze damage unless protected

** Invasive, not recommended

Species with bold print are from our experiment.

Table A-3. Salt tolerance of deciduous trees.

Small Trees		Large Trees	
Sensitive (<3 dS m^{-1})			
Apple*	(*Malus sylvestris*)	**Arizona sycamore**	(*Platanus wrightii*)
Pear*	(*Pyrus communis*)	American sycamore	(*Platanus occidentalis*)
Plum*	(*Prunus domestica*)	Pecan*	(*Carya illinoensis*)
White dogwood	(*Cornus florida*)	Cherry *	(*Prunus avium*)
Crape myrtle	(*Lagerstroemia indica*)	Persimmon*	(*Diospyros virginiana*)
Japanese pagoda	(*Sophora japonica*)	**Green ash**	(*Fraxinus pennsylvanica*)
Desert willow	(*Chilopsis linearis*)	**Bur oak**	(*Quercus macrocarpa*)
Chitalpa	(*Chitalpa tashkentensis*)	Pin oak	(*Quercus palustris*)
Texas vitex	(*Vitex agnus-castus*)	**Red oak**	(*Quercus shumardii*)
		Willows	(*Salix sp.*)
Moderately Sensitive (3 - 6 dS m^{-1})			
Purple cherry plum	(*Prunus cerasifera*)	**Cottonwood**	(*Populus fremontii*)
Mimosa silk tree	(*Albizia julibrissin*)	**Pistacia atlantica**	(*Pistacia atlantica*)
Desert olive	(*Forestiera neomexicana*)		
Bolleana poplar	(*Populus alba*)		
Moderately Tolerant (6 - 8 dS m^{-1})			
Pomegranate	(*Punica granatum*)	**Black gum**	(*Nyssa sylvatica*)
Pistache, texas	(*Pistacia texana*)	Sweet gum	(*Liquidambar styraciflua*)
Pistache, chinese	(*Pistacia chinensis*)		
Siberian elm	(*Ulmus pumila*)		
Tolerant (8 - 10 dS m^{-1})			
Honey mesquite	(*Prosopis glandulosa*)	**Chilean mesquite**	(*Prosopis chilensis*)
Black locust	(*Robinia pseudoacacia*)	Honey locust	(*Gleditsia triacanthos inermis*)
Salt cedar	(*Tamarix sp.*)**		
Highly Tolerant (>10 dS m^{-1})			
Screwbean mesquite	(*Prosopis pubescens*)		

* These ratings are for fruit production.

** Highly invasive, not recommended

Species with bold print are from our experiment.

Table A-4. Salt tolerance of plants native to the Southwest.

Shrubs/Agave		Trees	
Sensitive (<3 dS m^{-1})			
Yucca	(*Yucca brevifolia*)	Western red bud	(*Cercis occidentalis*)
Bird of paradise	(*Caesalpinia mexicana*)	**Arizona sycamore**	(*Platanus wrightii*)
Texas Mt. laurel	(*Sophora secundiflora*)	**Desert willow**	(*Chilopsis linearis*)
Guayule	(*Parthenium argentatum*)	**Texas vitex**	(*Vitex agnus-castus*)
Moderately Sensitive (3 - 6 dS m^{-1})			
		Cottonwood	(*Populus fremontii*)
Silverberry	(*Elaeagnus pungens*)	**Desert olive**	(*Forestiera neomexicana*)
		Seep willow	(*Baccharis salicifolia*)
Moderately Tolerant (6 - 8 dS m^{-1})			
Coyotebush	(*Baccharis pilularis*)		
Agave	(*Agave parryi*)		
Tolerant (8 - 10 dS m^{-1})			
Texas sage	(*Leucophyllum frutescens*)	**Piñon pine**	(*Pinus edulis*)
Century plants	(*Agave americana*)	Honey mesquite	(*Prosopis glandulosa*)
Highly Tolerant (>10 dS m^{-1})			
Pickleweed	(*Allenrolfea occidentals*)	Screwbean mesquite	(*Prosopis pubescens*)

Table A-5. Salt tolerance of palm species.

Species		Foliar injuries[1]
Sensitive (<3 dS m^{-1})		
Cabbage palm	(*Sabal palmetto*)	Recognizable
Pindo palm	(*Butia capitata*)	Minimal if any
Chinese windmill palm	(*Trachycarpus fortunei*)	Recognizable
Moderately Sensitive (3 - 6 dS m^{-1})		
Mexican blue fan palm	(*Brahea armata*)	Minimal
Brazilian fan palm	(*Trithrinax brasiliensis*)	Recognizable
Dwarf blue palmetto	(*Sabal minor 'Riverside'*)	Minimal
Moderately Tolerant (6 - 8 dS m^{-1})		
Mexican fan palm	(*Washingtonia robusta*)	None
California fan palm	(*Washingtonia filifera*)	None
Tolerant (8 - 10 dS m^{-1})		
Canary Island date palm	(*Phoenix canariensis*)	None
Date palm	(*Phoenix dactylifera*)	None

[1] Projected leaf injury at the upper limit of applicable salinity
Species with bold print are from our experiment.

Table A-6. Salt tolerances of vines, ground cover and bedding plants.

Sensitive (<3 dS m^{-1})			
Virginia creeper	(*Parthenocissus quinquefolia*)	**Vinca**	(*Vinca major*)
English ivy	(*Hedera helix*)	**Asian jasmine**	(*Trachelospermum asiaticum*)
Star jasmine	(*Trachelospermum jasminoides*)	**Carolina jasmine**	(*Gelsemium sempervirens*)
Japanese honeysuckle	(*Lonicera japonica*)	**Spring cinquefoil**	(*Potentilla tabernaemontanii*)
Lily of the Nile	(*Agapanthus africanus*)	**Mexican primrose**	(*Oenothera berlandieri*)
Begonia	(*Begonia sp.*)*		
Gerbera	(*Gerbera jamesonti*)		
Moderately Sensitive (3 - 6 dS m^{-1})			
Coleus	(*Coleus hybridus*)*	**Trailing lantana**	(*Lantana montevidensis*)
Carnation	(*Dianthus sp.*)*	Lantana	(*L. camara*)
Aster	(*Aster sp.*)	**Spreading acasia**	(*Acacia redolens*)
Moderately Tolerant (6 - 8 dS m^{-1})			
Germanium	(*Pelargonium sp.*)*	**Fountaingrass**	(*Pennisetum setaceum*)
		Juniper	(*Juniperus chinensis*)
		Coyote brush	(*Baccharis pilularis*)
		Spider plant	(*Chlorophytum comosum*)*
Tolerant (8 - 10 dS m^{-1})			
		Bougainvillea	(*Bougainvillea spectabillis*)*
		Creeping boobialla	(*Myoporum parvifolium*)
		Ice plant	(*Carpobrotus chilensis*)
		Trailing ice plant	(*Lampranthus spectabilis*)

* Subject to freeze damage without protection or used as annual.
Species with bold print are from our experiment.

Spray Resistant Tables

(Tables B-1 and B-2)

Table B-1. Spray Resistance: Ground Covers, Shrubs and Tree Seedlings.

Plant Name		
Common	Scientific	Classification[1]
Flowering Annuals and Perennials		
Tea rose	*Rosa sp. Hybrid Tea*	S
Lily of the Nile	*Agapanthus africanus*	S
Crape myrtle	*Lagerstroemia indica*	S
Gazania	*Gazania sp.*	MS
Texas sage	*Leucophyllum frutescens*	MS
"Lady Banks" Rose	*Rosa banksiae*	MT
Trailing lantana	*Lantana montevidensis*	MT
Verbena	*Verbena sp.*	MT
Sunflower	*Helianthus sp.*	T
Vines and Ground Covers		
Vinca	*Vinca major*	S
Grape	*Vitus sp.*	S
Japanese honeysuckle	*Lonicera japonica*	MS
Liriope	*Liriope muscari*	MS
Star jasmine	*Trachelospermum jasminoides*	MS
Asian jasmine	*Trachelospermum asiaticum*	MS
Carolina jasmine	*Gelsemium sempervirens*	MS
English ivy	*Hedera helix*	MT
Strawberry	*Fragaria sp.*	T
Shrubs		
Nandina	*Nandina domestica*	S
Photinia, "Red Tip"	*Photinia fraseri*	S
Pyracantha	*Pyracantha fortuneana*	MS
Dwarf rosemary	*Rosmarinus officinalis*	MS
Wild lilac	*Ceanothus thyrsiflorus*	MS
Yaupon holly	*Ilex vomitoria*	MT
Euonymous	*Euonymus japonica*	MT
Indian hawthorne	*Raphiolepis indica*	MT
Buffalo juniper	*Juniperus sabina 'Buffalo'*	MT
Cotoneaster	*Cotoneaster buxifolius*	MT
Japanese boxwood	*Buxus micropylla*	T
Oleander	*Nerium oleander*	T
Tree Seedlings		
Pistachie 'UCB-3'	*Pistacia spp.*	S
Plum	*Prunus domestica*	S
Apricot	*Prunus americana*	S
Mexican buckeye	*Ungnadia speciosa*	S
Chinese pistache	*Pistachia chinensis*	S
Sweet gum	*Liquidambar* styraciflua	S
Wax-leaf Ligustrum	*Ligustrum japonicum*	MS
Afghan pine	*Pinus eldarica*	MT
Mexican stone pine	*Pinus cembroides*	T

[1] **S: Sensitive** (< 1 dS m^{-1}, Na and Cl < 150 ppm), **MS: moderately sensitive** (1 – 2 dS m^{-1}, Na < 280 ppm, Cl < 360 ppm), **MT: moderately tolerant** (2 – 3 dS m^{-1}, Na < 425 ppm, Cl < 590 ppm), and **T:tolerant** (> 3 dS m^{-1}).

Species with bold print are from our experiment.

Table B-2. Spray Resistance: Mature Trees.

Highly Sensitive: (Significant Damage at 150 to 200 ppm of Na and Cl)		
Pecans	*Carya illinoensis*	Tip then margin burn
Cottonwood	*Populus fremontii*	Margin burn then defoliation
Sycamore	*Platanous acerifolia*	Margin then entire leafburn
Western Soapberry	*Sapindus drummondii*	Tip-burn
Sensitive (Severe damage at 350 ppm of Na or Cl)		
Silverberry	*Elaeagnus pungens*	Margin burn and defoliation
Pomegranate	*Punica granatum*	Margin burn and defoliation
Honey Locust	*Gleditsia triacanthos*	Tipburn, then defoliation
Black Locust	*Robina pseudoacacia*	Tipburn, then defoliation
Chinese Pistache	*Pistacia chinensis*	Tipburn, then defoliation
Shumard Red Oak	*Quercus shumardii*	Tipburn, then defoliation
Bur Oak	*Quercus macrocarpa*	Tipburn, then defoliation
White Mulberry	*Morus alba*	Margin burn then defoliation
Poplar	*Populus sp.*	Margin burn then defoliation
Mimosa	*Acacia baileyana*	Tipburn then defoliation
Arizona Cypress	*Cupressus arizonica*	Defoliation
Oriental Arborvitae	*Thuja orientalis*	Defoliation
Osage Orange	*Maclura pomifera*	Defoliation
Ornamental Pears	*Pyrus communis*	Defoliation
Arizona, Ash	*Fraxinus velutina*	Tipburn then defoliation
Moderately Sensitive (Recognizable damage at 350 ppm of Na or Cl)		
Raywood Ash	*Fraxinus angustifolia*	Tipburn, then defoliation
Globe Willow	*Salix matsudana 'umbraculifera'*	Tipburn then defoliation
Corkscrew Willow	*Salix matsudana 'tortuosa'*	Tipburn then defoliation
Weeping Willow	*Salix babylonica*	Tipburn then defoliation
Japanese Pagoda Tree	*Sophora japonica*	Tipburn then defoliation
Live Oak	*Quercus virginiana*	Tipburn, then defoliation
Chittamwood	*Bumelia lanuginosa*	Tipburn, then defoliation
Texas Vitex	*Vitex agnus-castus*	Tipburn, then defoliation
Moderately Tolerant (Slight or occasional damage at 350 ppm of Na or Cl)		
European Olive	*Olea europaea*	Tipburn
Desert Willow	*Chilopsis linearis*	Tipburn
Holly Oak	*Quercus ilex*	Slight to no injury
Alligator Juniper	*Juniperus deppeana pachyphlaea*	Slight to no injury
Juniper	*Juniperus chinensis*	Slight to no injury
Rocky Mt. Juniper	*Juniperus scopulorum*	Slight to no injury
Honey Mesquite	*Prosopis grandulosa*	Slight to no injury
Tolerant (No damage at 350 ppm of Na or Cl)		
Italian Cypress	*Cupressus sempervirens*	No injury
Hollywood Juniper	*Juniperus chinensis 'Torulosa'*	No injury
Dwarf Pittosporum	*Pittosporum tobia, compacta*	No injury
Oleander	*Nerium oleander*	No injury
Ligustrum	*Ligustrum japonica*	No injury
Euonyomus	*Euonyomus japonica*	No injury
Japanese Black Pine	*Pinus thunbergiana*	No injury
Afghan Pine	*Pinus eldarica*	No injury
Aleppo Pine	*Pinus halepensis*	No injury
Italian Stone Pine	*Pinus pinea*	No injury

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Related Publications

Miyamoto, S., I Martinez, M. Padilla, A. Portillo and D. Ornelas, 2004. Photo guide: Landscape plant response to soil salinity. Texas A&M Univ. Research Center and El Paso Water Utilities. March, 2004.

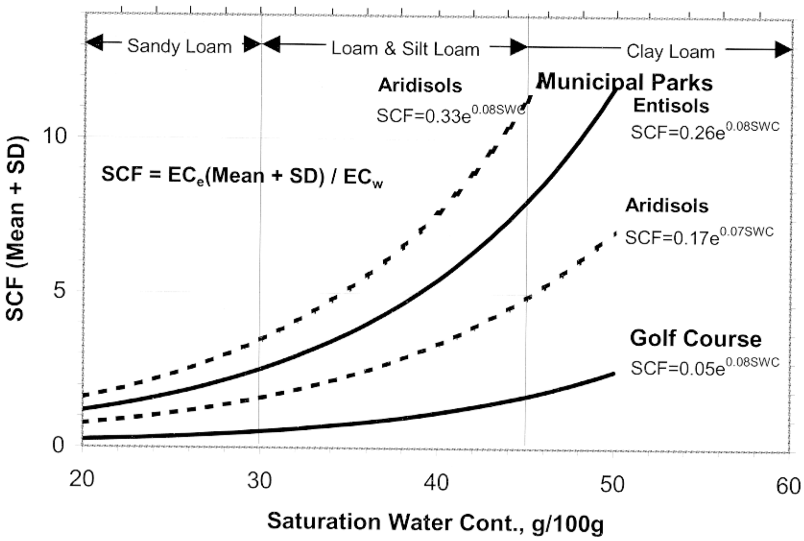
D. Ornelas and S. Miyamoto, 2003. Sprinkler conversion to reduce foliar salt damage. Water Reuse Conference, San Antonio, TX.

Miyamoto, S., and J.M. White, 2002. Foliar Salt Damage of Landscape Plants Induced by Sprinkler Irrigation. Texas Water Resources Institute. Pub. TR-1202. College Station, TX.

Miyamoto, S., 2000. Soil Resources of El Paso; Characteristics, Distribution and Management Guidelines. Texas A&M Univ. Agr. Res. Ctr. at El Paso.

Rhoades, R.J., and S. Miyamoto, 1990. Testing soils for salinity and sodicity. In "Soil Testing and Plant Analysis." Amer. Soc. Of Agronomy, Madison, WI.

Appendix: Salt Concentration Factors



Appendix I. The salt concentration factor (SCF) expressed as the mean plus the standard deviation (SD) as related to the saturation water content or soil textures of golf courses and municipal parks. The lines drawn are the best fit lines based on actual soil salinity measurements.