PHOTO GUIDE
Landscape Plant Response to Salinity

March 2004

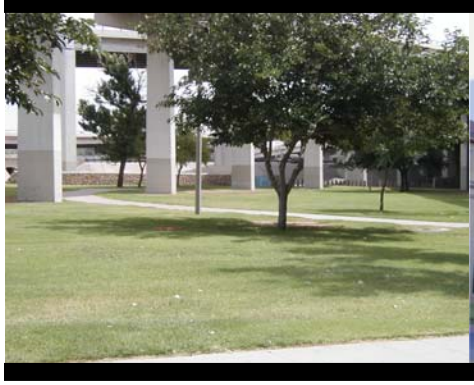

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Photo Guide: Landscape Plant Response to Salinity

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Synopsis

With increasing costs of securing potable water, there is a need to utilize reclaimed or saline nonpotable water for irrigating landscapes. The photo sets shown here were developed from research work performed by Texas A&M University Research and Extension Center at El Paso during the period of 2001 through 2003. The objective of the research was to evaluate salt tolerance of landscape plants common to the Southwest. Photo sets included in this publication are partial results of the research, and may be useful to landscape planners, water managers, and landscape maintenance professionals. A complete list of plant salt tolerance is available in a companion publication entitled "Landscape Plant Lists for Salt Tolerance Assessment."

Contents

How this Document was Developed

Plant Responses to Soil Salinity (Photo 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 as shown in Appendix. 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.

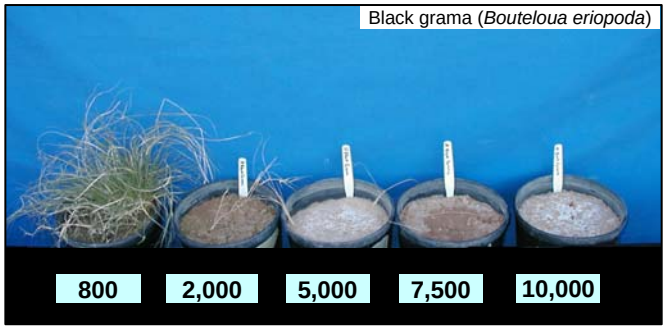
Tolerance against Saline Water Sprinkling (Photo Series B): Test plants (1 gallon size) were transplanted into 3 gallon pots using a highly permeable commercial soil mix. They were taken outdoors in March, and irrigated every other day with overhead sprinklers for 30 min which delivered 1/2 inch of water. Irrigation continued until the end of September for 6 months. The experiment used 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 (Appendix). As soon as sprinkler irrigation was completed, all pots were flushed with tap water.

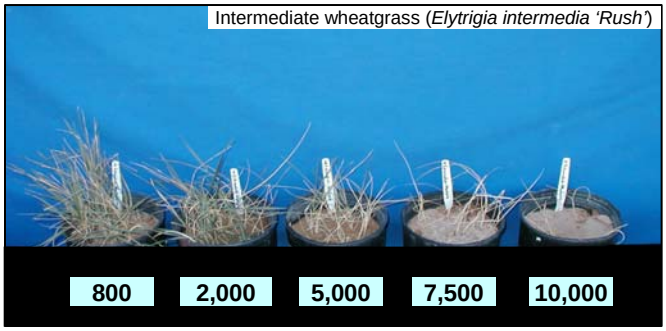
Plant responses to the sprinkler irrigation were evaluated by measuring shoot growth and leaf injuries. Salinity of irrigation water and corresponding Na and Cl concentrations which caused a 25% reduction in shoot growth or leaf injury over 25% of the leaves were determined. Because of the lack of the 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 (Photo Series B – 4 through B – 7) 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).

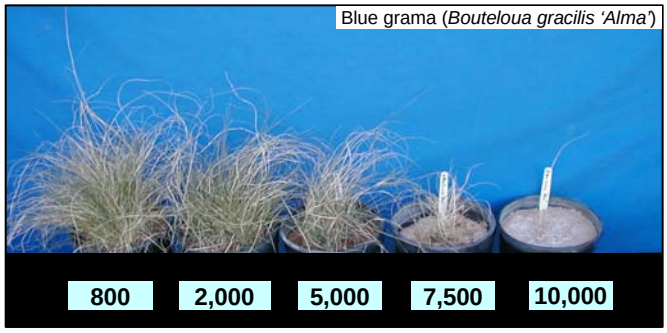
Photo Set A-1. Turf and Ground Cover Grasses (Warm Season Species)

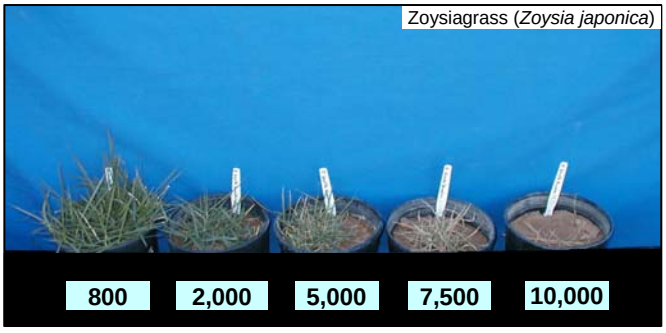
Common Name	Scientific Name	Classification	Common Name	Scientific Name	Classification
Black grama	(*Bouteloua eriopoda*)	S	Intermediate wheatgrass	(*Elytrigia intermedia 'Rush'*)	MT
Blue grama	(*Bouteloua gracilis 'Alma'*)	MS	Zoysiagrass	(*Zoysia japonica*)	MT
Buffalograss	(*Buchloe dactyloides*)	MS	Common bermuda	(*Cynodon dactylon*)	T
Blue grama	(*Bouteloua gracilis 'Bad River'*)	MS	Alkali muhly	(*Muhlenbergia asperifolia*)	HT

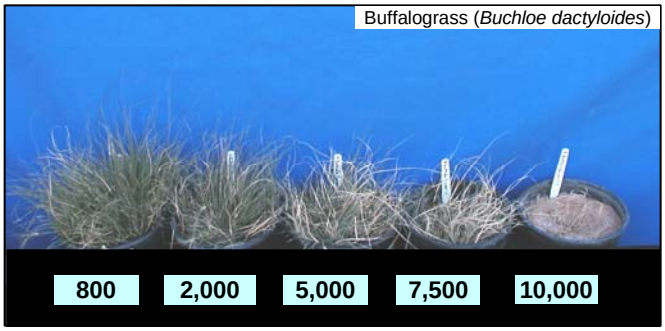
S: sensitive, MS: moderately sensitive, MT: moderately tolerant, T: tolerant, HT: highly tolerant

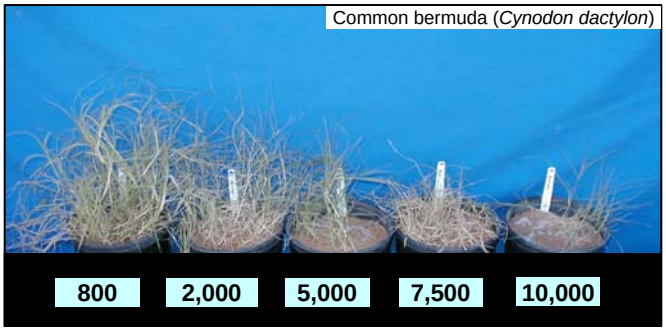


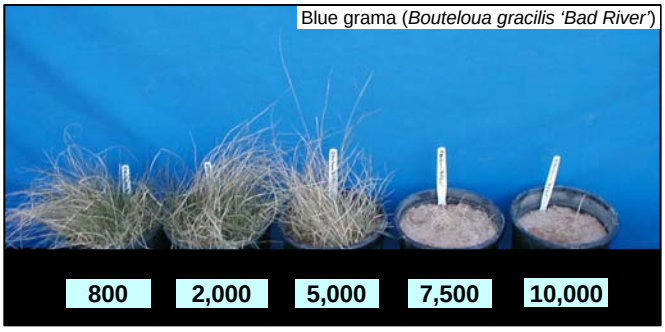












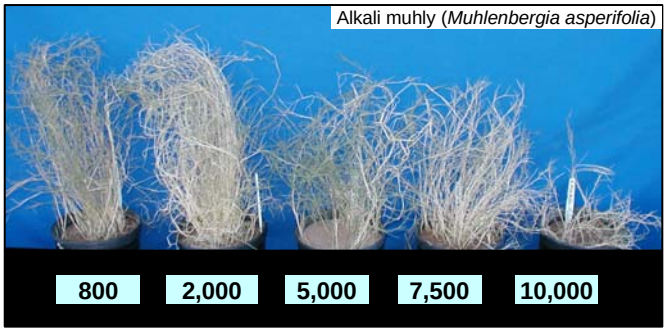
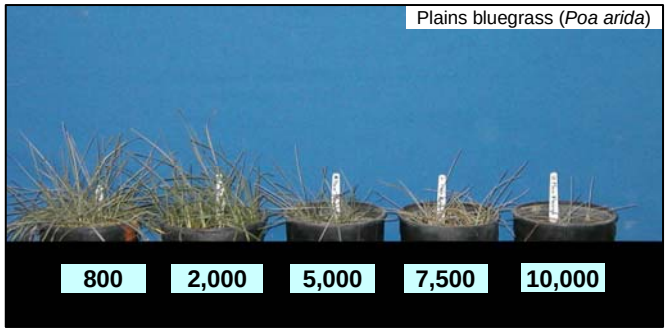
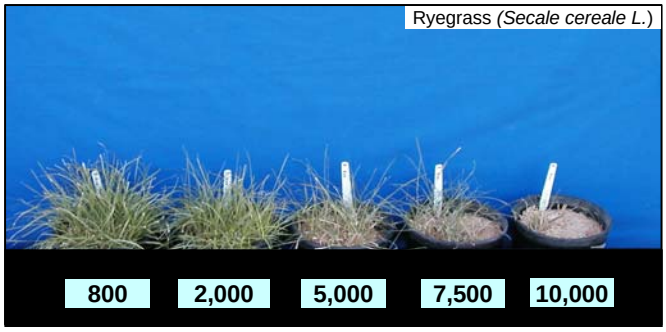


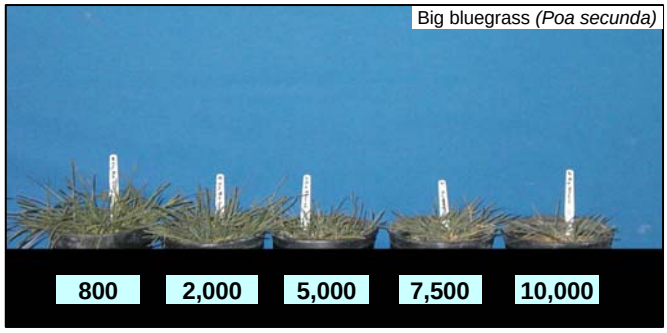
Photo Set A-1. Turf and Ground Cover Grasses (Cool Season Species)

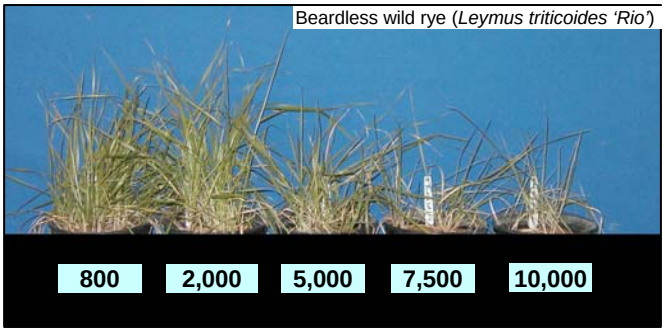
Common Name	Scientific Name	Classification	Common Name	Scientific Name	Classification
Plains bluegrass	(*Poa arida*)	MS	Ryegrass	(*Secale cereale L.*)	MT
Big bluegrass	(*Poa secunda*)	MS	Beardless wild rye	(Ley*mus triticoides 'Rio'*)	T
Intermediate wheatgrass	(*Elytrigia intermedia 'Topar'*)	MT	Tall wheatgrass	(*Thinopyrum ponticum*)	HT
Red fescue	(*Festuca rubra*)	MT	Fults alkaligrass	(*Puccinellia distans*)	HT

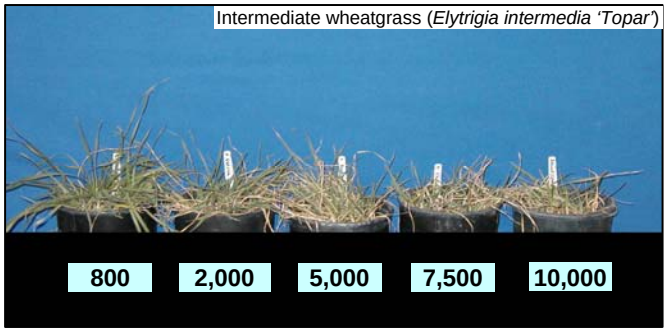
MS: moderately sensitive, MT: moderately tolerant, T: tolerant, HT: highly tolerant

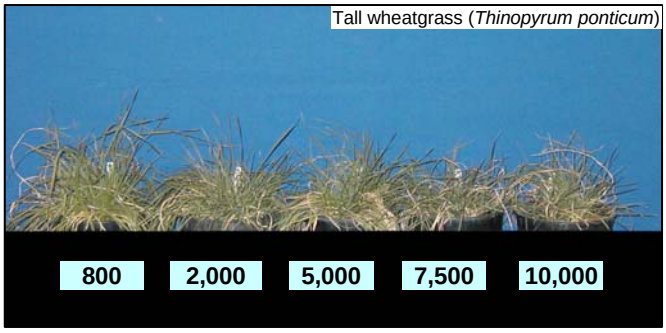


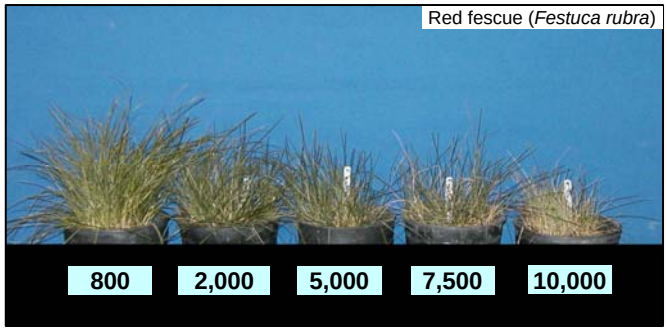












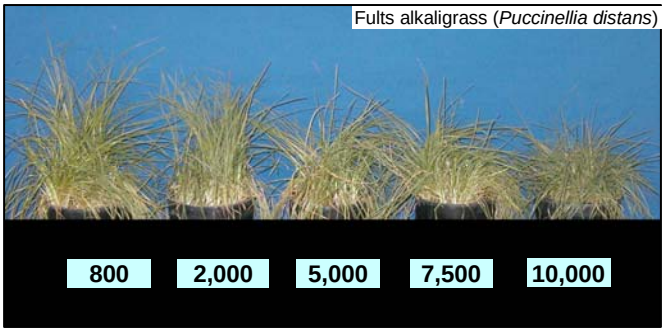
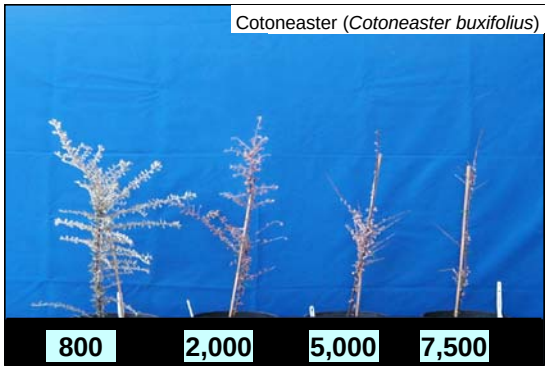
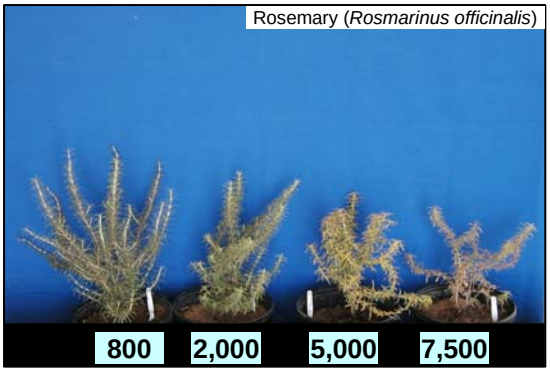


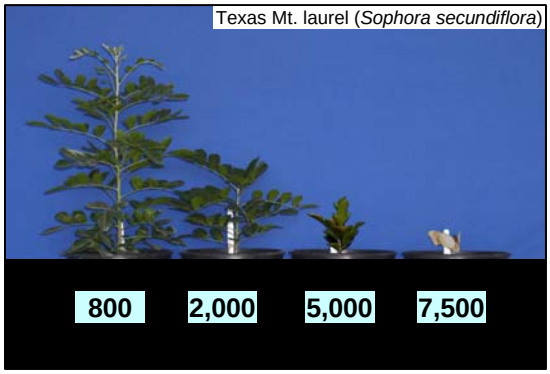
Photo Set A-2. Evergreens and Conifers (Shrubs)

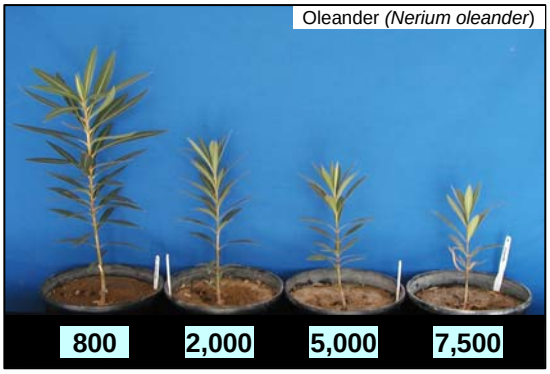
Common Name	Scientific Name	Classification	Common Name	Scientific Name	Classification
Cotoneaster	(*Cotoneaster buxifolius*)	S	Rosemary	(*Rosmarinus officinalis*)	MS
Texas Mt. laurel	(*Sophora secundiflora*)	S	Oleander	(*Nerium oleander*)	MT
Yaupon holly	(*Ilex vomitoria*)	MS	Texas sage	(*Leucophyllum frutescens*)	MT
Dwarf pittosporum	(*Pittosporum tobira*)	MS	European olive	(*Olea europaea*)	MT

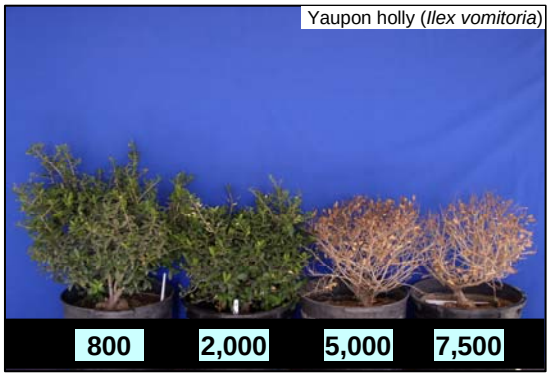
S: sensitive, MS: moderately sensitive, MT: moderately tolerant

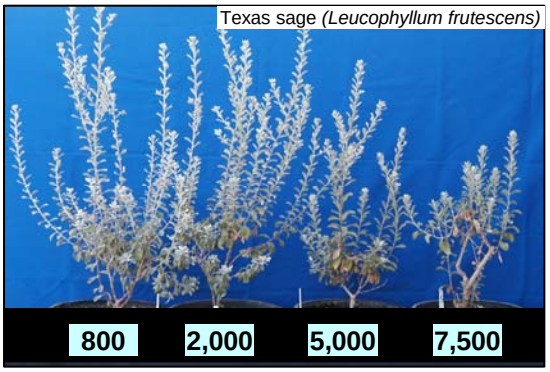


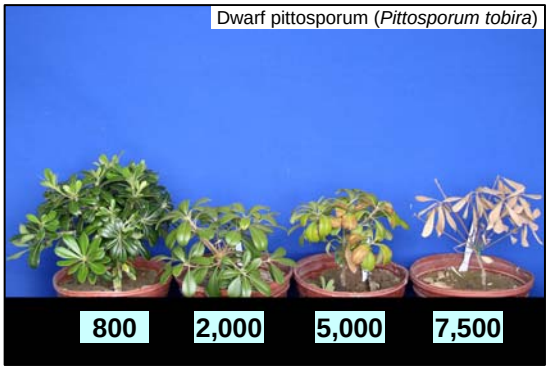












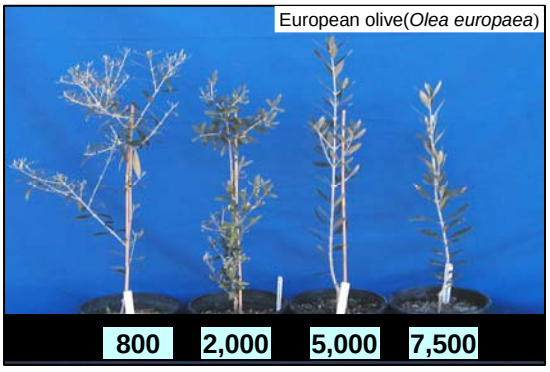
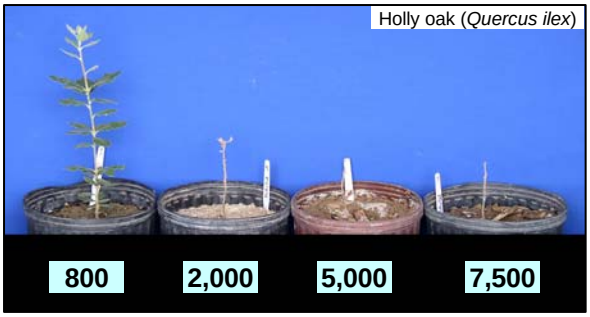
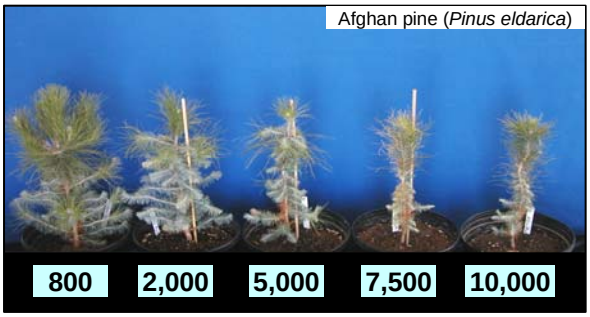


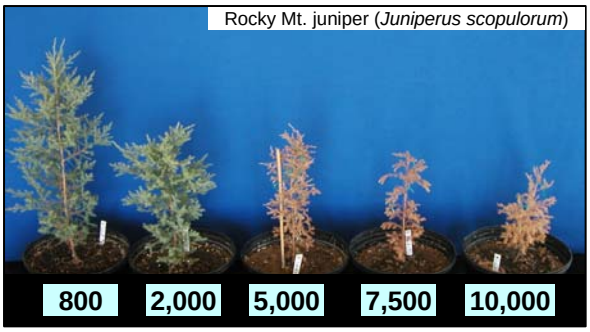
Photo Set A-2. Evergreens and Conifers (Trees)

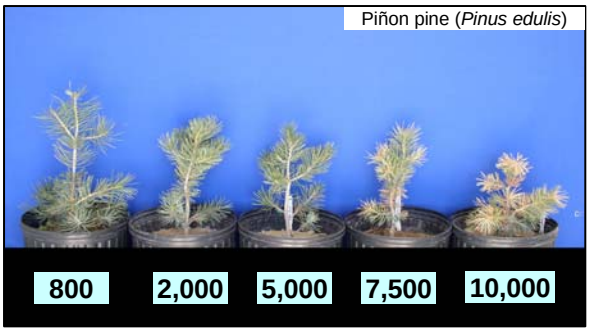
Common Name	Scientific Name	Classification	Common Name	Scientific Name	Classifcation
Holly oak	(*Quercus ilex*)	S	Afghan pine	(*Pinus eldarica*)	MT
Rocky Mt. juniper	(*Juniperus scopulorum*)	MS	Piñon pine	(*Pinus edulis*)	MT
Eastern red cedar	(*Juniperus virginiana*)	MS	Italian cypress	(*Cupressus sempervirens*)	MT
Southern magnolia	(*Magnolia grandiflora*)	MS	Italian stone pine	(*Pinus pinea*)	HT
Leyland cypress*	(*Cupressocyparis leylandii*)	S	Southern live oak*	(*Quercus virginiana*)	MS

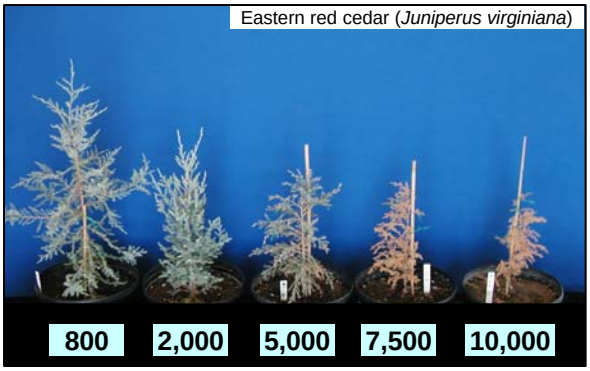
S: sensitive, MS: moderately sensitive, MT: moderately tolerant, HT: highly tolerant
*Not shown

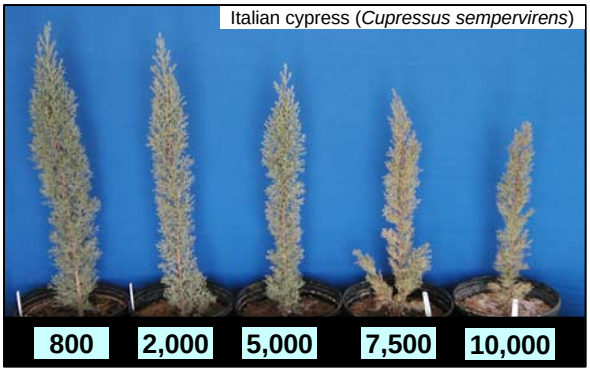


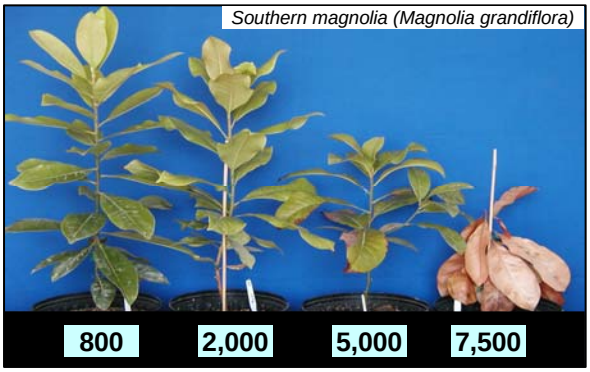












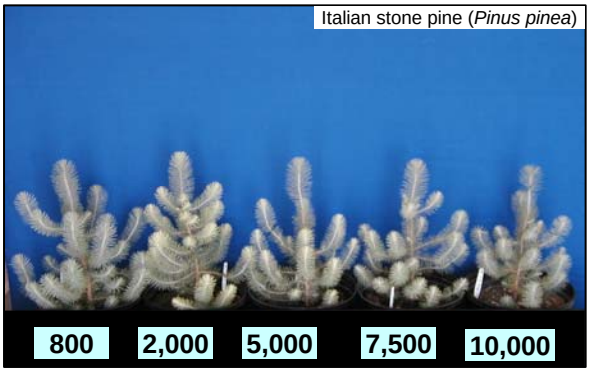
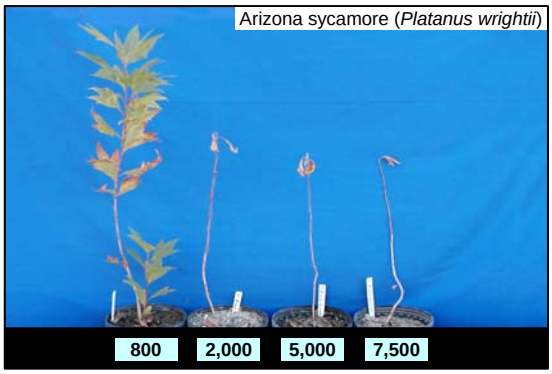
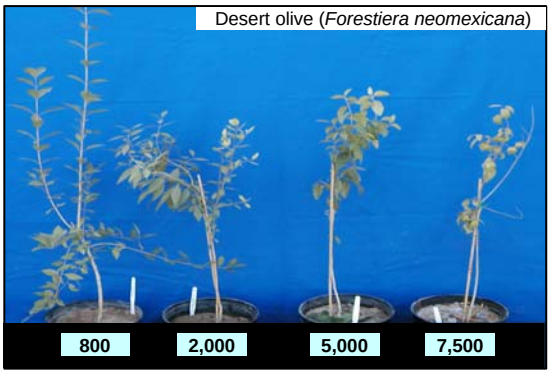


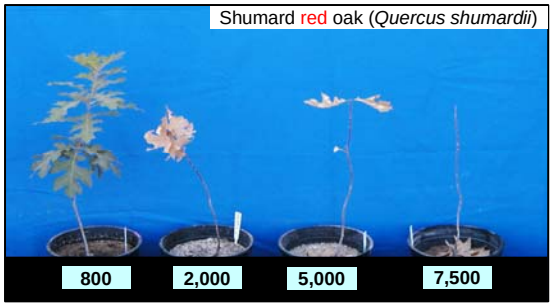
Photo Set A-3. Deciduous Trees

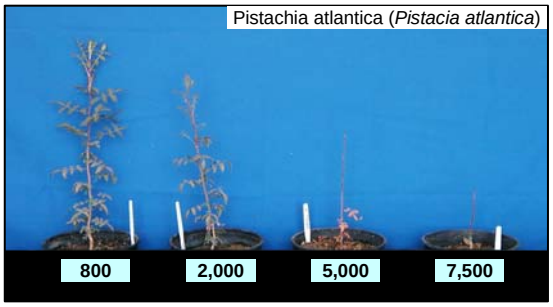
Common Name	Scientific Name	Classification	Common Name	Scientific Name	Classification
Arizona sycamore	(*Platanus wrightii*)	S	Desert olive	(*Forestiera neomexicana*)	MS
Shumard red oak	(*Quercus shumardii*)	S	Pistacia atlantica	(*Pistacia atlantica*)	MS
Japanese pagoda	(*Sophora japonica*)	S	Black gum	(*Nyssa sylvatica*)	MT
Chitalpa	(*Chitalpa tashkentensis*)	S	Chilean mesquite	(*Prosopis chilensis*)	T

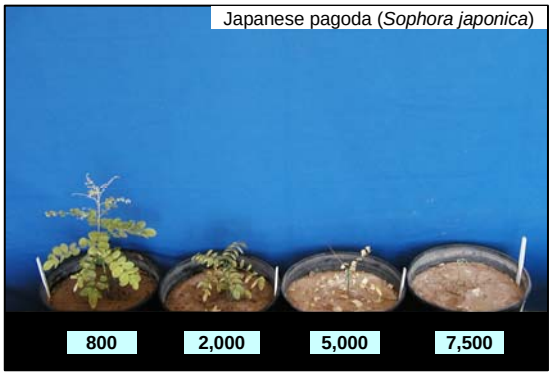
S: sensitive, MS: moderately sensitive, MT: moderately tolerant, T: tolerant

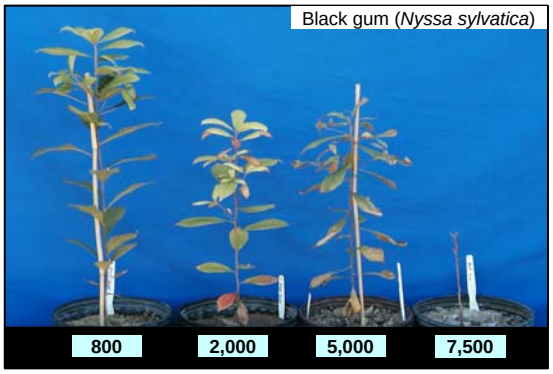


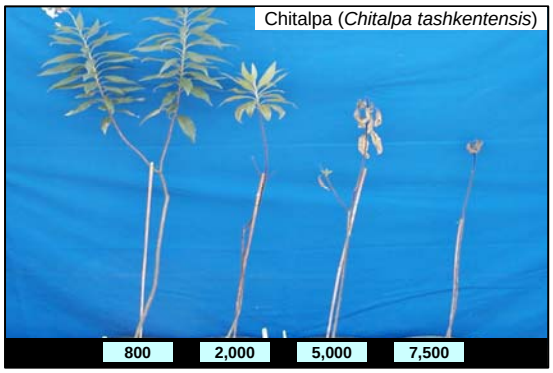












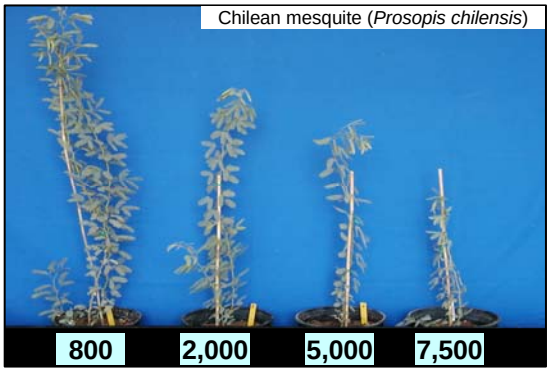
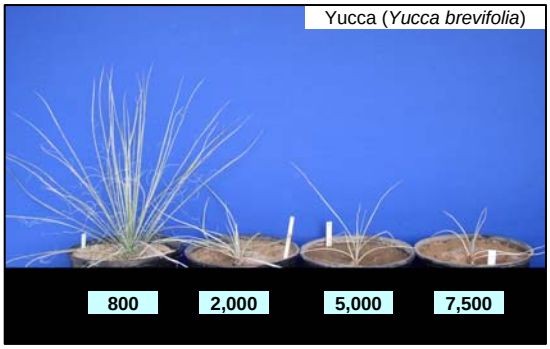
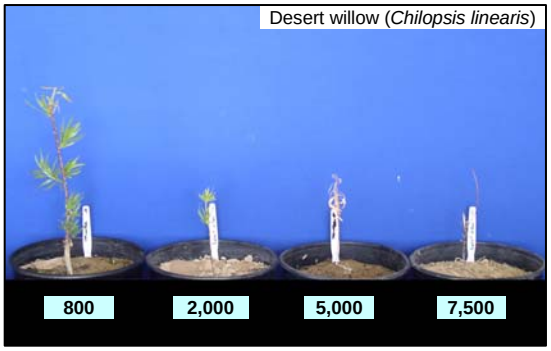


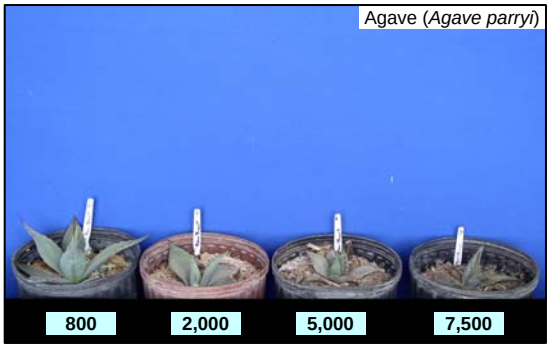
Photo Set A-4. Native Plants

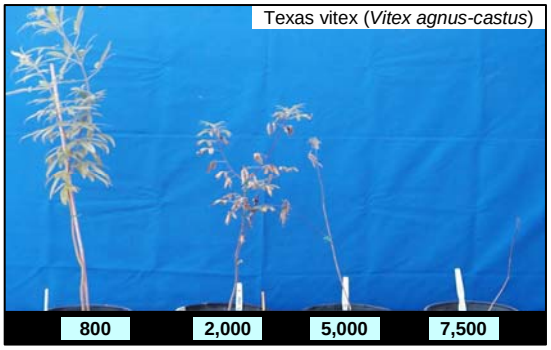
Common Name	Scientific Name	Classification	Common Name	Scientific Name	Classification
Yucca	(*yucca brevifolia*)	S	Desert willow	(*Chilopsis linearis*)	S
Agave	(*Agave parryi*)	MT	Texas vitex	(*Vitex agnus-castus*)	MS
Bird of paradise	(*Caesalpinia mexicana*)	S	Desert olive	(*Forestiera neomexicana*)	MS
Texas sage	(*Leucophyllum frutescens*)	T	Piñon pine	(*Pinus edulis*)	HT

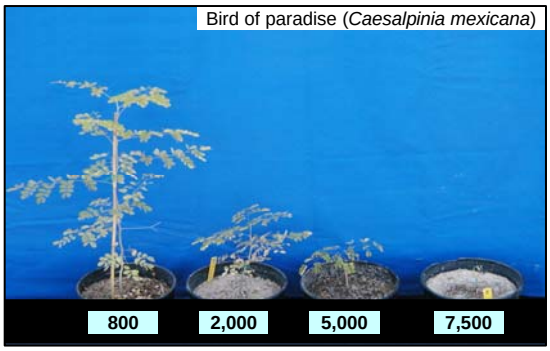
S: sensitive, MS: moderately sensitive, MT: moderately tolerant, T: tolerant, HT: highly tolerant

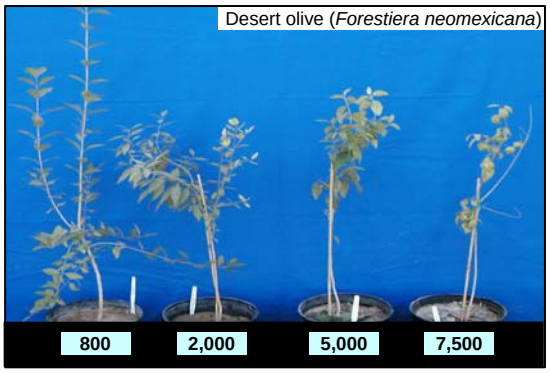


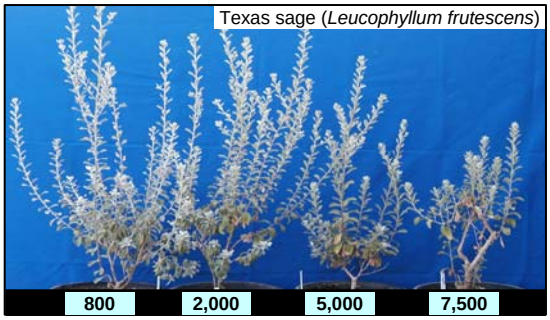












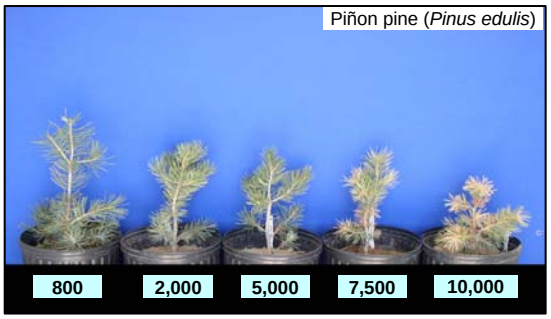
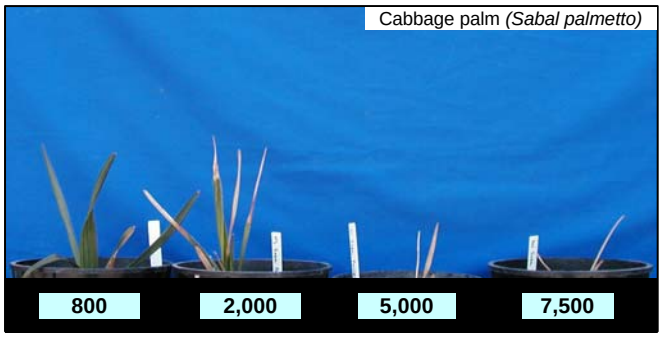
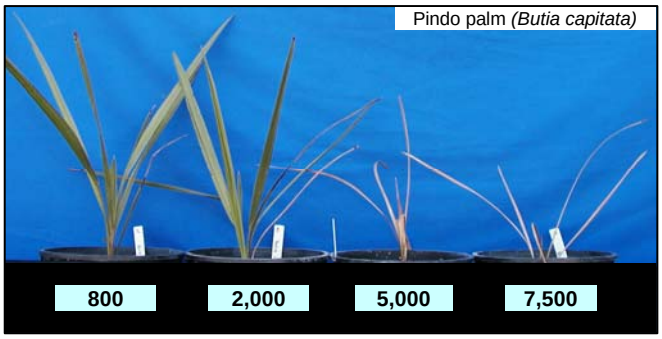


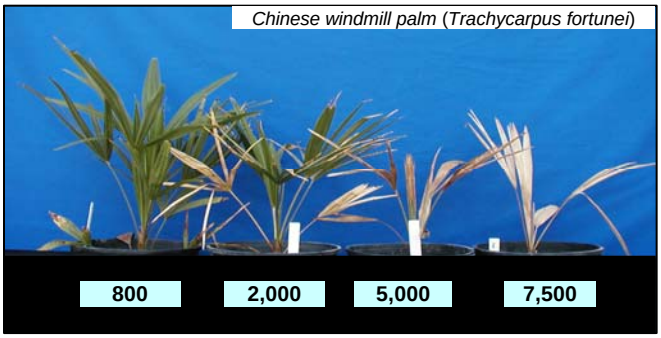
Photo Set A-5. Palm Species

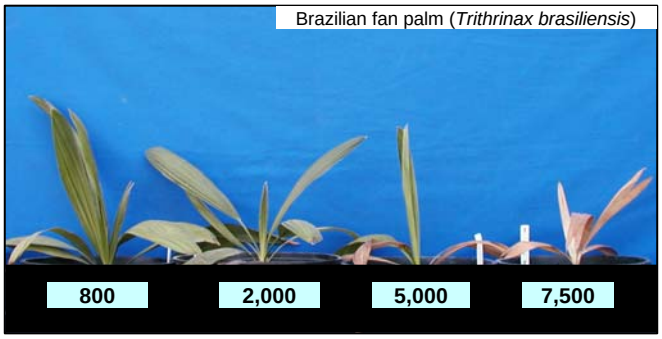
Common Name	Scientific Name	Classifcation	Common Name	Scientific Name	Classification
Cabbage palm	(*Sabal palmetto*)	S	Pindo palm	(*Butia capitata*)	S
Chinese windmill palm	(*Trachycarpus fortunei*)	S	Brazilian fan palm	(*Trithrinax brasiliensis)*	MS
Mexican blue fan palm	(*Brahea armata*)	MS	Dwarf blue palmetto	(*Sabal minor 'Riverside'*)	MS
Mexican fan palm	(*Washingtonia robusta*)	MT	Canary Island date palm	(*Phoenix canariensis 'Dwarf')*	T

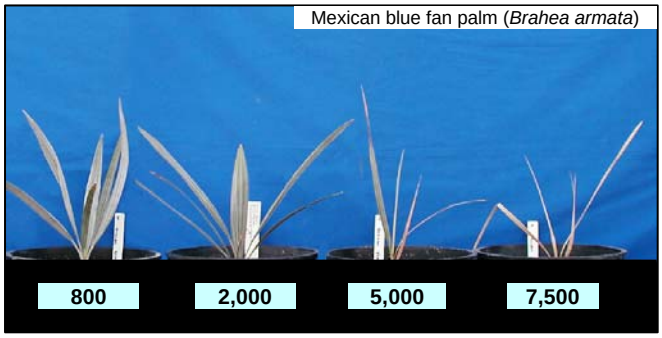
S: sensitive, MS: moderately sensitive, MT: moderately tolerant, T: tolerant

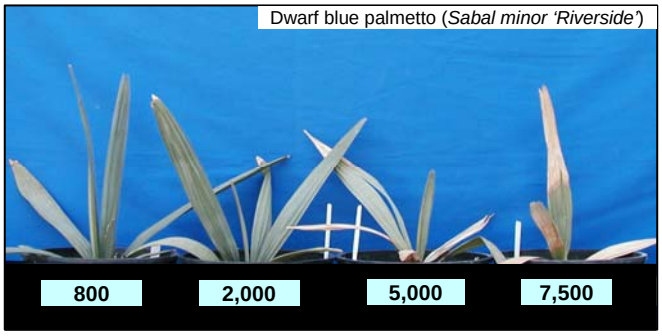


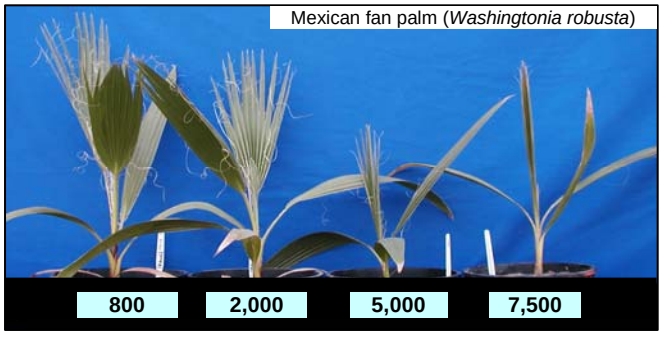












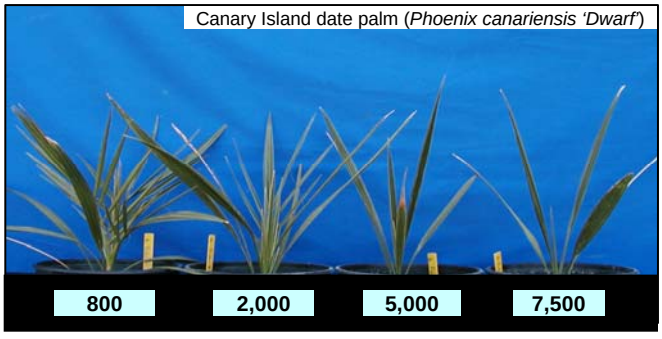
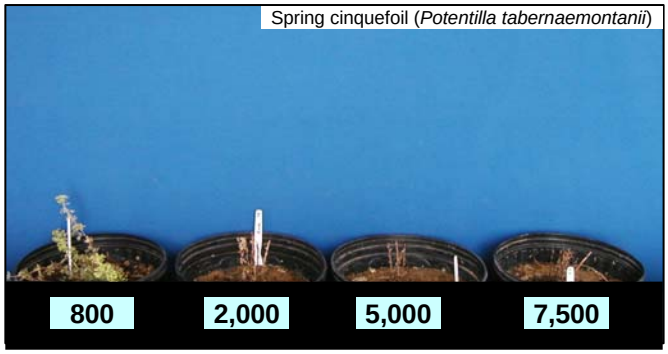
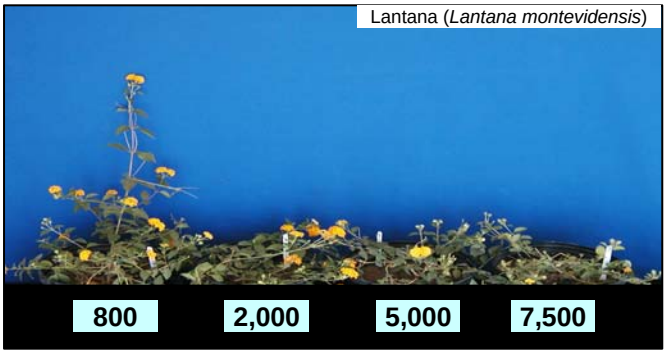


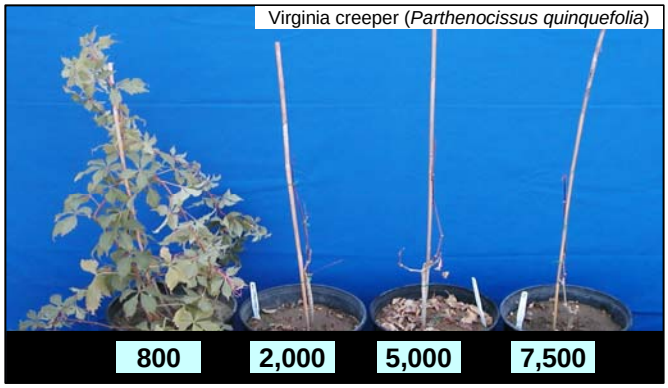
Photo Set A-6. Vines and Ground Cover Plants

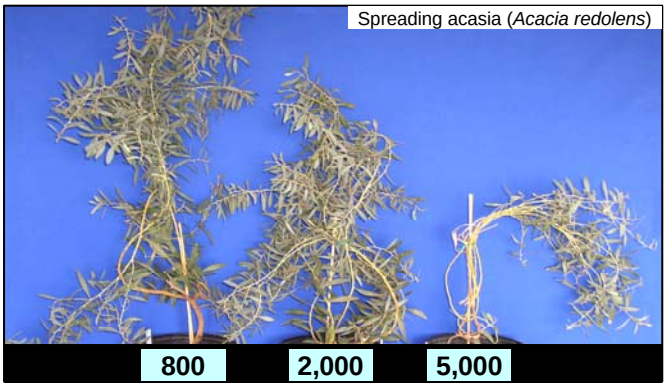
Common Name	Scientific Name	Classification	Common Name	Scientific Name	Classification
Spring cinquefoil	(*Potentilla tabernaemontanii*)	S	Lantana	(*Lantana montevidensis*)	MS
Virginia creeper	(*Parthenocissus quinquefolia*)	S	Spreading acasia	(*Acacia redolens*)	MS
Mexican primerose	(*Oenothera berlandieri*)	S	Fountaingrass	(*Pennisetum setaceum*)	MT
Japanese honeysuckle	(*Lonicera japonica*)	S	Creeping boobialla	(*Myoporum parvifolium*)	T

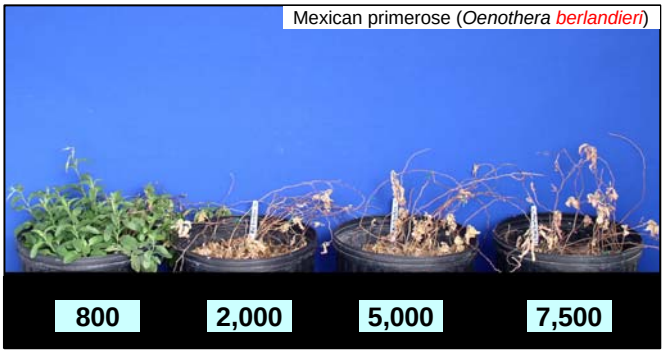
S: sensitive, MS: moderately sensitive, MT: moderately tolerant, T: Tolerant

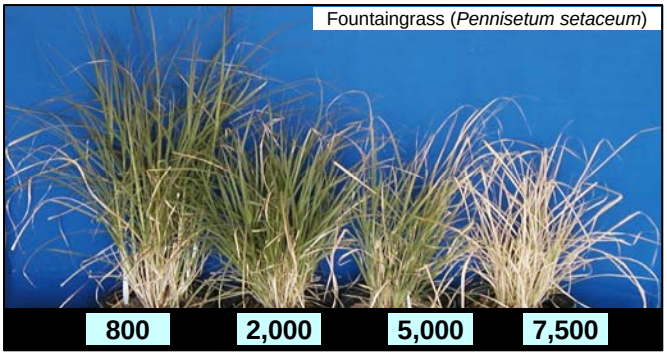












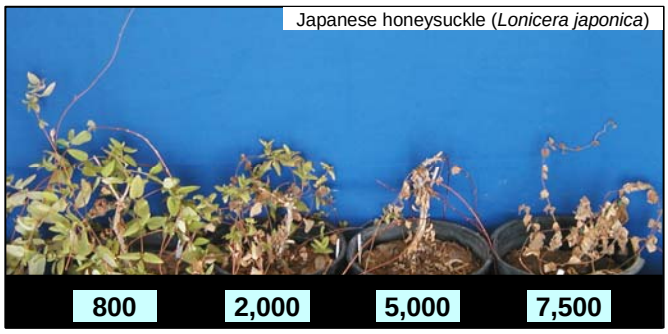
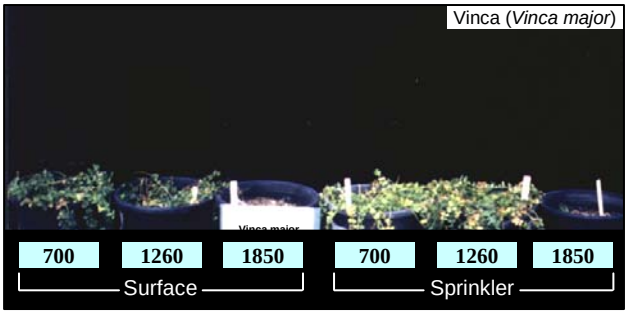
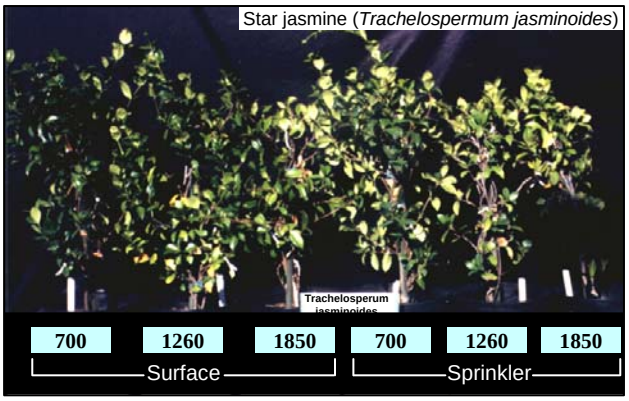


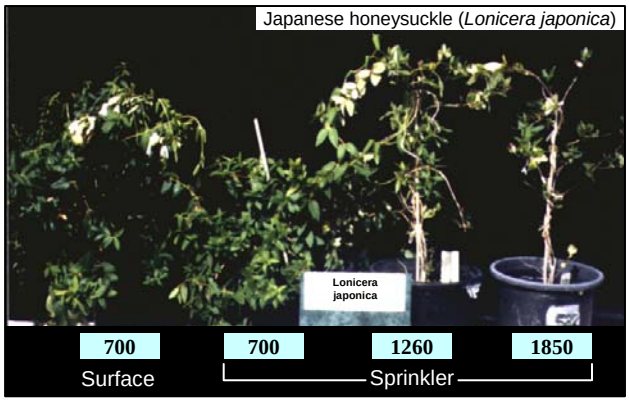
Photo Set B-1. Vines and Ground Covers Under Sprinklers.

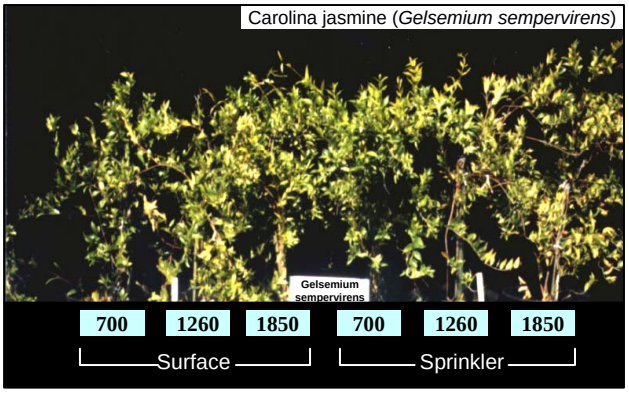
Common Name	Scientific Name	Classification	Common Name	Scientific Name	Classification
Vinca	(*Vinca major*)	S			
Star jasmine	(*Trachelospermum jasminoides*)	MS	Japanese honeysuckle	(*Lonicera japonica*)	MS
Carolina jasmine	(*Gelsemium sempervirens*)	MS	Asian jasmine	(*Trachelospermum asiaticum*)	MS
Lirope	(*Liriope muscari*)	MS	English ivy	(*Hedera helix*)	MT

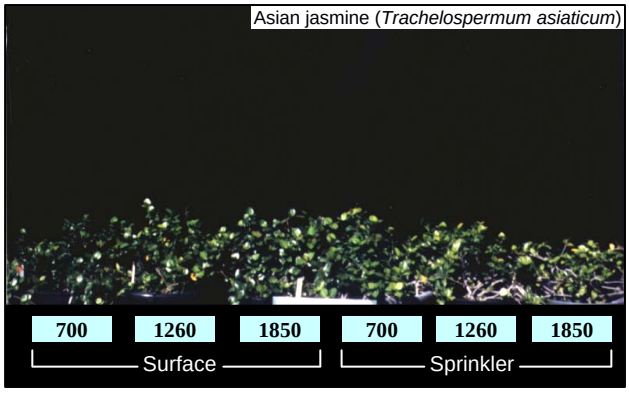
S: sensitive, MS: moderately sensitive, MT: moderately tolerant

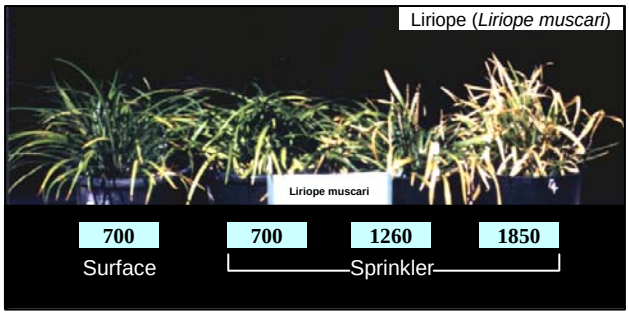












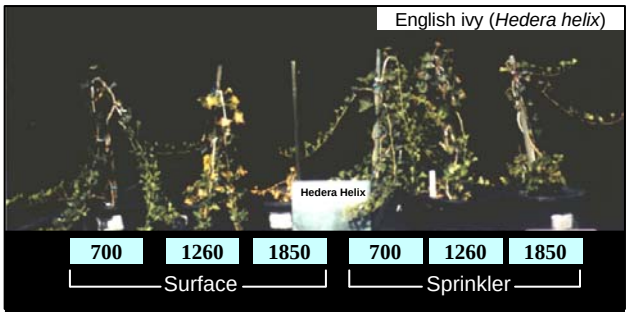
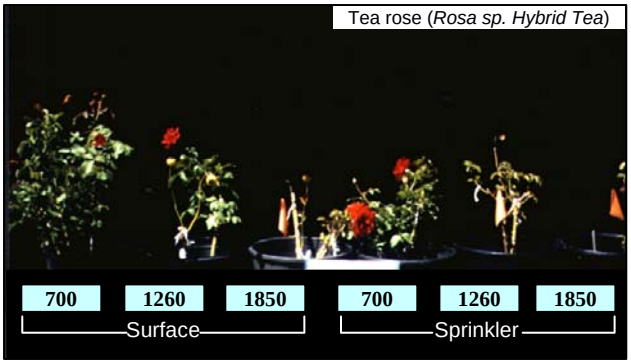
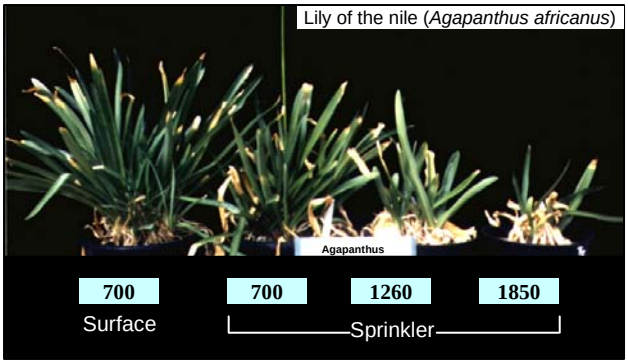


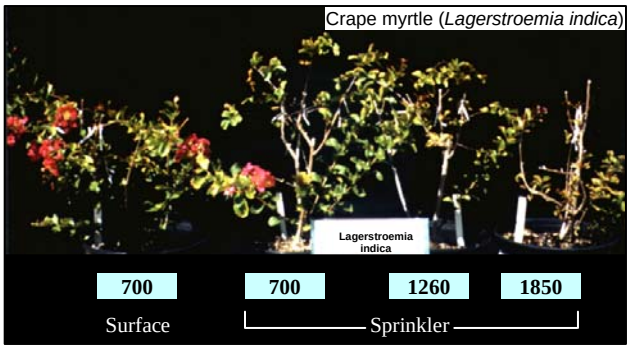
Photo Set B-2. Flowering Perennials and Shrubs Under Sprinklers.

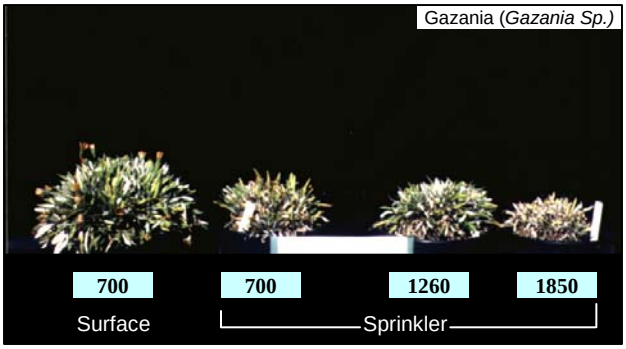
Common Name	Scientific Name	Classification	Common Name	Scientific Name	Classification
Tea rose	(*Rosa sp. Hybrid Tea*)	S	Lily of the nile	(*Agapanthus africanus*)	S
Crape myrtle	(*Lagerstroemia indica*)	S	Gazania	(*Gazania (Gazania sp.*)	MS
Texas sage	(*Leucophyllum frutescens*)	MS	"Lady Banks" rose	(*Rosa banksiae*)	MT
Trailing lantana	(*Lantana montevidensis*)	MS	Verbena	(*Verbena sp*.)	MT

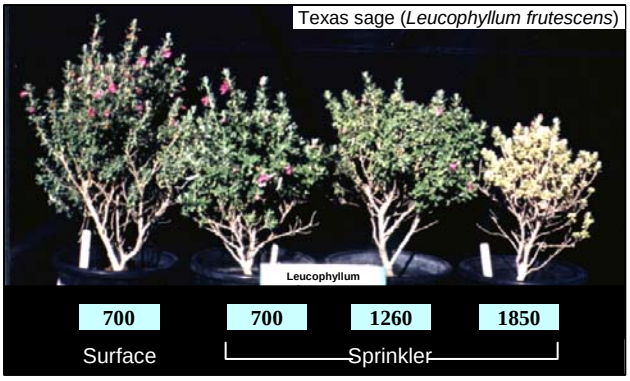
S: sensitive, MS: moderately sensitive, MT: moderately tolerant

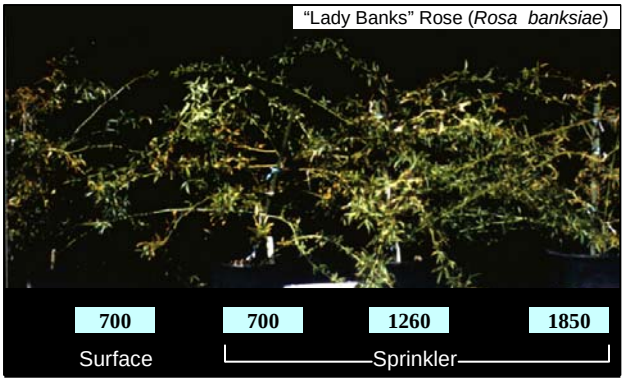


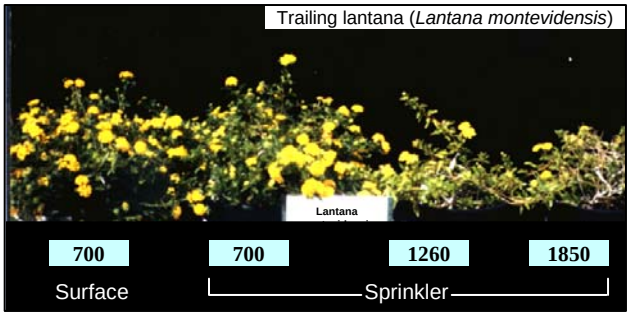












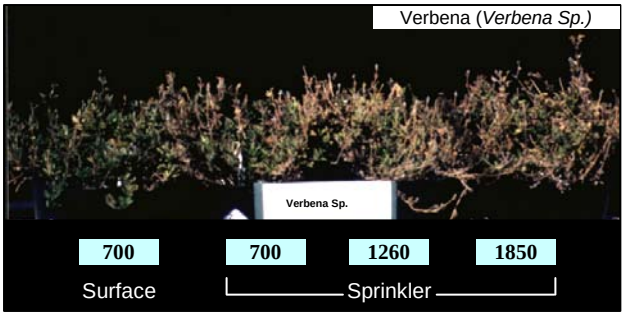
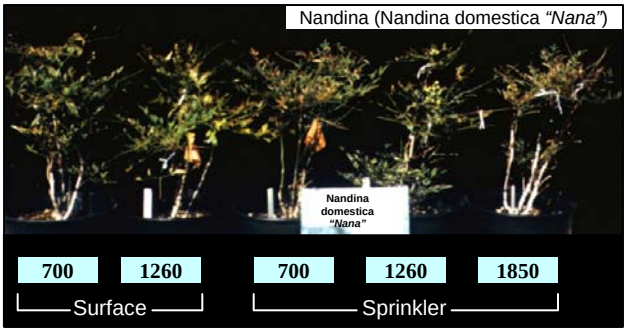
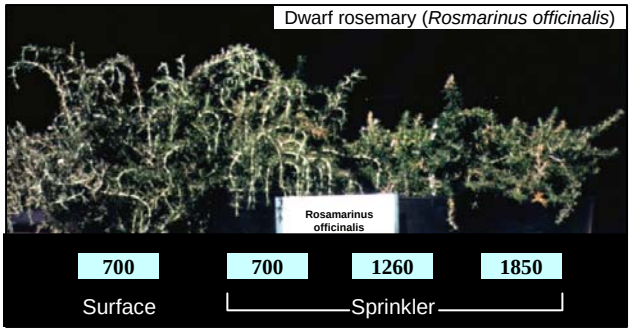


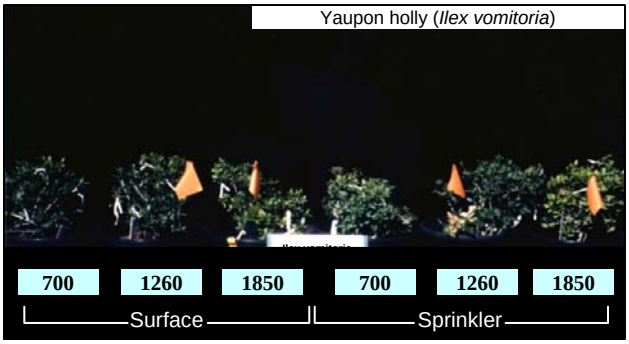
Photo Set B-3. Shrubs Under Sprinklers.

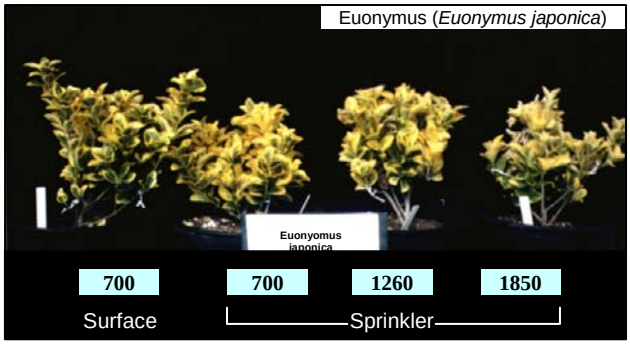
Common Name	Scientific Name	Classification	Common Name	Scientific Name	Classification
Nandina	(*Nandina domestica "Nana"*)	S	Dwarf rosemary	(*Rosmarinus officinalis*)	MS
Yaupon holly	(*Ilex vomitoria*)	MT	Euonymus	(*Euonymus japonica*)	MT
Indian hawthorne	(*Rhaphiolepis indica*)	MT	Buffalo juniper	(*Juniperus sabina "Buffalo"*)	MT
Cotoneaster	(*Cotoneaster buxifolius*)	T	Japanese Boxwood	(*Buxus microphylla*)	T

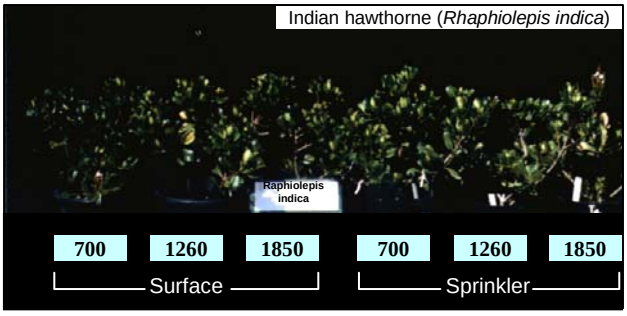
S: sensitive, MS: moderately sensitive, MT: moderately tolerant, T: tolerant

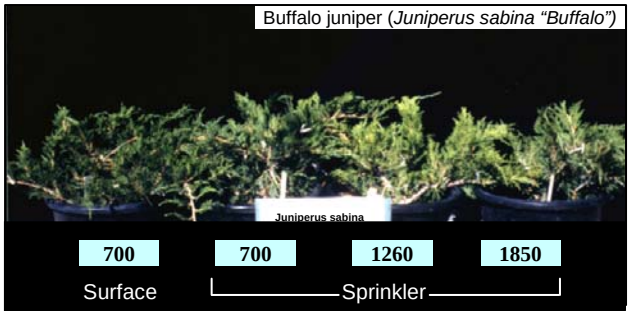


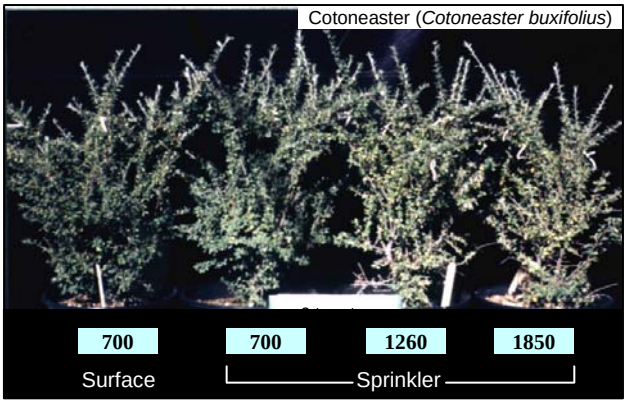












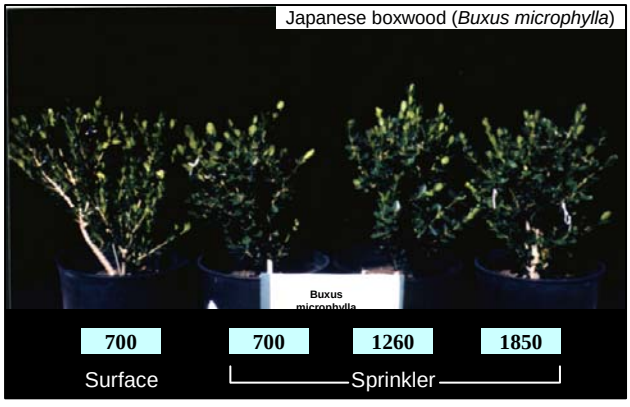
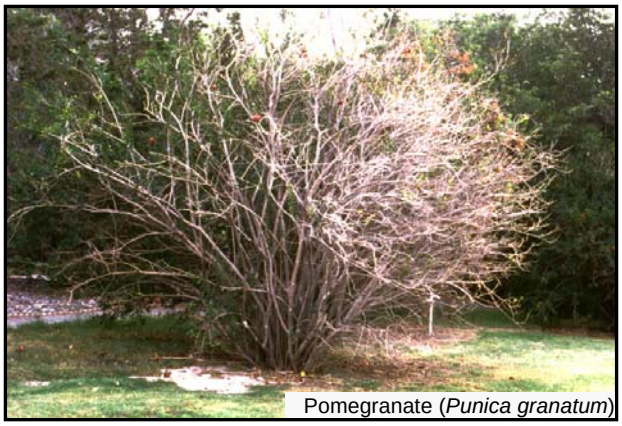


Photo Set B-4. Salt Sensitive Shrub or Trees under Sprinklers.


Silverberry (*Elaeagnus pungens*)


Pomegranate (*Punica granatum*)


Honey locust (*Gleditsia triacanthos*)


Chinese pistache (*Pistacia chinensis*)


Cottonwood (*Populus fremontii*)

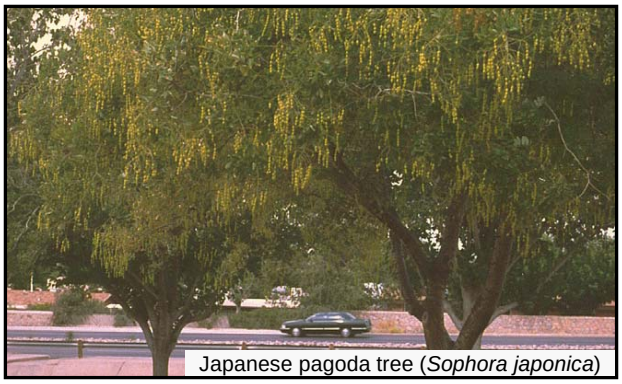

White mulberry (*Morus alba*)


Arizona cypress (*Cupressus arizonica*)

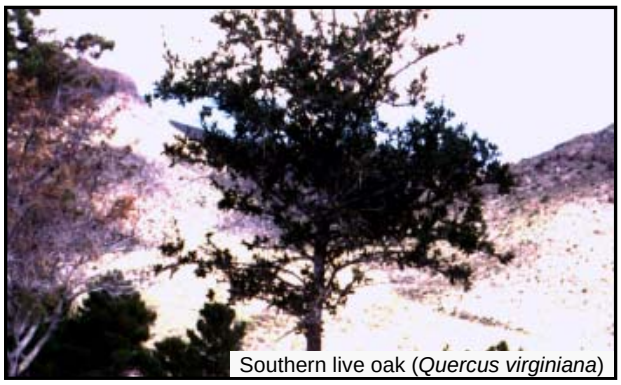

Oriental arborvitae (*Thuja orientalis*)

Photo Set B-5. Moderately Sensitive to Tolerant Trees Under Sprinklers.

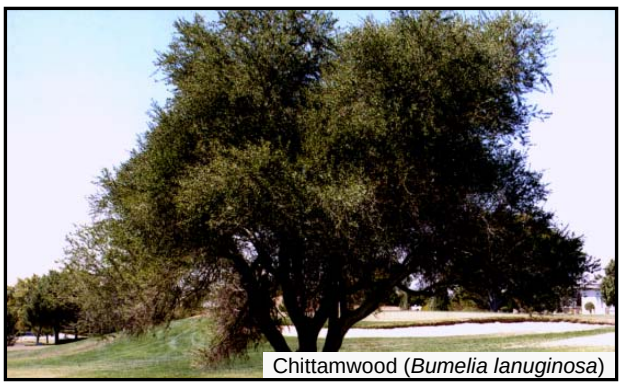

Weeping willow (*Salix babylonica*)

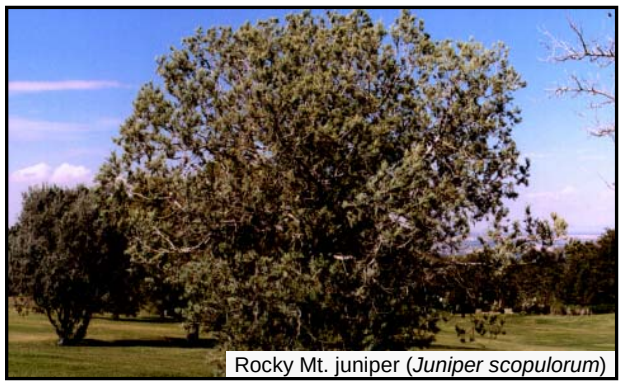

Japanese pagoda tree (*Sophora japonica*)


European olive (*Olea europaea*)


Southern live oak (*Quercus virginiana*)


Juniper (*Juniperus chinensis*)


Chittamwood (*Bumelia lanuginosa*)


Rocky Mt. juniper (*Juniper scopulorum*)

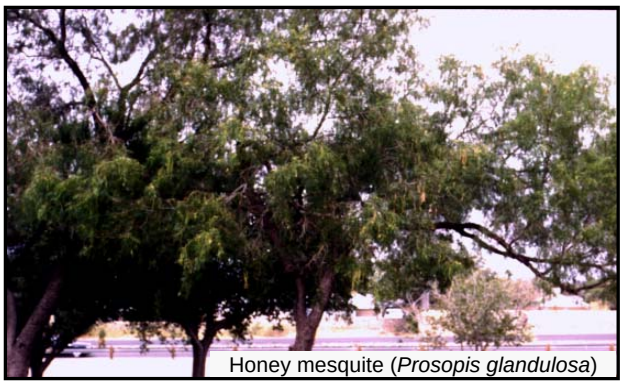

Honey mesquite (*Prosopis glandulosa*)

Photo Set B-6. Leaf Injuries and Salt Accumulation Under Sprinklers.

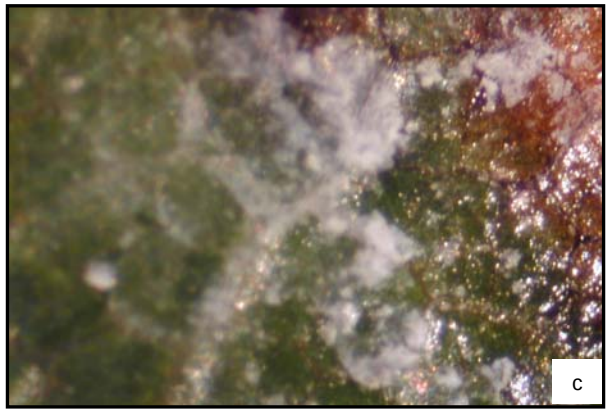
Cottonwood (*Populus fremontii*)

a

Silverberry (*Elaeagnus pungens*)

b

Shumard red oak (*Quercus shumardii*)

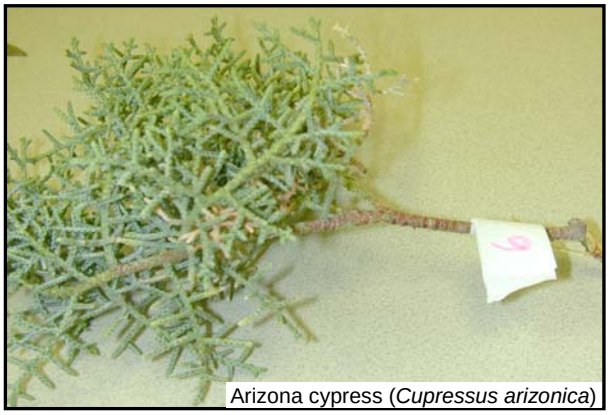


c

White mulberry (*Morus alba*)

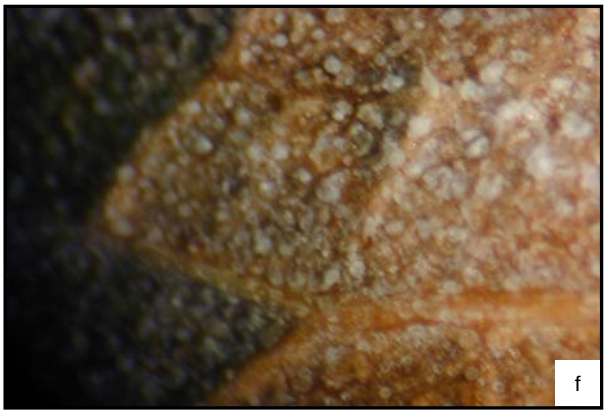
d

Photo Set B-7. Leaf Injuries and Salt Accumulation Under Sprinklers (cont'd).


Arizona cypress (*Cupressus arizonica*)

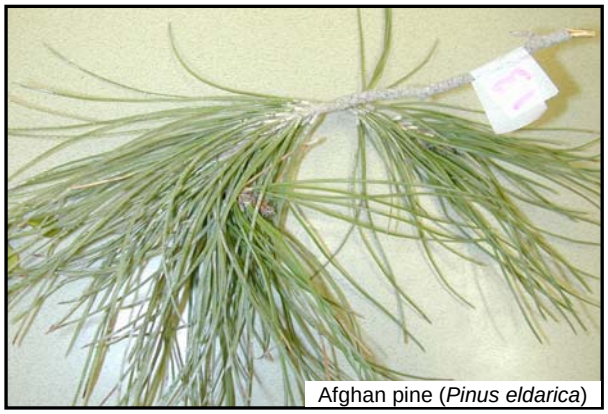

e


Arizona ash (*Fraxinus velutina*)


f


Juniper (*Juniperus chinensis*)


g


Afghan pine (*Pinus eldarica*)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Acknowledgement

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Related Publications

Miyamoto, S., I Martinez, M. Padilla, A. Portillo and D. Ornelas, 2004. Landscape Plant Lists for Salt Tolerance Assessment. 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.

Appendix: Ionic Composition of Irrigation Water Sources

Plant Response to Soil Salinity

Photo Sets: A – 1 through A – 6

Dissolved salts	Conductivity	Na	Cl
ppm	dS m^{-1}	-----ppm-----	
800	1.2	140	180
2000	4.4	760	1230
5000	9.4	1900	3090
7500	13.7	2800	4600
10000	17.0	3800	6190

Plant Response to Sprinkling

Photo Sets: B – 1, B – 2, B – 3

Dissolved salts	Conductivity	Na	Cl
ppm	dS m^{-1}	-----ppm-----	
700	1.1	140	140
1260	2.0	280	360
1850	3.0	425	590
Photo Sets: B – 4 through B – 7			
1120	2.1	350	550