



Minnesota Forestry Research Notes

RELATIVE TOLERANCES OF WOODY PLANTS
GROWN IN MINNESOTA TO FIVE AIR POLLUTANTS
- A COMPILATION OF RATINGS -

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Damage to trees and shrubs from air pollutants in urban areas or near certain industrial activity has led to studies which rate the relative sensitivity of plants to particular air pollutants. A summary of results from 14 papers for woody species native to Minnesota or introduced into Minnesota is presented in the Tables. The Tables rate tolerances to damage relative to other species within the same study. Where authors presented continuous lists, the species were arbitrarily divided into groups.

Fortunately, air pollution damage appears to be uncommon in Minnesota. This species rating, therefore, should be used to evaluate alternative planting choices only for locations where pollution problems are known to exist or appear imminent.

The sources of the five air pollutants covered here have been recently summarized by Wood (1975). Hydrochloric acid (HCl) and chlorine (Cl₂) originate from refineries, glass making, and incineration of materials containing chlorine such as polyvinyl chloride. Hydrofluoric acid (HF) and fluorine (F₂) originate from aluminum plants, the manufacture of phosphate fertilizer, brick plants, pottery and ferro-enamel works, and refineries. Ozone, a primary component of urban smog, is a secondary product of nitrogen oxides and hydrocarbons emitted by burning fuels for transportation, industrial processes, generation of electricity and space heating. Ozone also originates from lightning and from air movements bringing tropospheric gases downward. PAN (peroxyacetal nitrate) and homologous compounds are secondary products from exhaust gases similar to those which give rise to ozone. Sulfur dioxide originates from combustion of coal, refining and utilization of petroleum and natural gas, manufacture and industrial use of sulfur and sulfuric acid, and from the smelting and refining of copper, lead, zinc, or nickel ores.

The ratings given in the Tables should be used with caution for a number of reasons. Many of the cited studies exposed greenhouse-grown seedlings for short periods to high concentrations of a pollutant. The results may not be transferable to older plants, grown in forest or lawn, and exposed for longer periods to lower concentrations of a pollutant. Genetic variation to damage within a species can be great, and Minnesota genetic stock was tested infrequently. Where authors listed only genera, even the species may not be grown in Minnesota. Damage also varies with the stage of growth, the age of the leaves (e.g., HF damage to ponderosa pine), the amount of insect and disease attack, the nutrition and water status, and the general vigor of the tree. Differences in methods of evaluation, in pre-conditioning of trees, and in genetic stock may explain disagreements in ratings among studies, e.g., sulfur dioxide for pear and apple. Until more definitive information is published, however, the Tables as a summary of current ratings should be useful in making decisions.

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Table 1

RELATIVE TOLERANCE OF BROAD-LEAVED TREES
GROWN IN MINNESOTA TO FIVE AIR POLLUTANTS

Species	Atmospheric Pollutant				
	HCl or Cl ₂	HF or F ₂	Ozone	PAN	Sulfur Dioxide
Apple		S ₇ I _{3,10}			S ₄ R ₁₀ I _{3,7}
Apple, crab	S ₄		S ₄		
Apple, delicious		I ₃			
Apple, red Jonathan		R ₃			
Ash, green		I ₄	S ₁₃	R ₂	
Ash, mountain		R ₄ I ₃			
Ash, white			S _{5,13}	R ₂	
Aspen, quaking		I ₄	S ₄		R ₈ S _{11,14}
Aspen, large-toothed					S ₁₄
Basswood, American		R ₄			I ₃
Basswood, littleleaf		I _{4,16} S ₉	R _{5,13}	R ₂	I ₁₀
Birch		I ₃			S ₄ I ₃
Birch, paper					I ₁₁ S ₁₄
Birch, cut leaf		R ₄			
Birch, European white		I _{10,16}	R _{5,13}	R ₂	
Boxelder	S ₄	S ₄	S ₄		R ₃
Catalpa			S ₄		S ₄ I ₃
Cherry, black	I ₄				
Cherry, choke		I ₄			I ₈
Cherry, pin					R ₁₁
Elm					I ₃
Elm, American		R ₄			S ₄
Locust, honey		R ₃	S ₄		
Locust, black		R ₁₀ I _{9,16}			
Maple					R _{3,14}
Maple, Norway			R ₁₃	R ₂	
Maple, silver		I _{3,4}	S ₄		
Maple, sugar	S ₄		R _{5,13}	R ₂	
Mulberry, red		I ₄			
Oak, pin	S ₄		I ₁₃	R ₂	
Oak, red	R ₄		R ₁₃	R ₂	R ₁₀
Oak, scarlet			I ₁₃		
Oak, white			S _{5,13}	R ₂	
Olive, Russian	R ₄				
Pear		R ₄ I _{10,9}			S ₄ R ₁₀ I ₁₁
Plum		S ₉			I _{3,10}
Poplar					I _{3,10}
Poplar, balsam					I ₁₄
Poplar, Carolina		I ₄			
Poplar, Lombardy		I _{4,9,16}			S ₄
Walnut, black		I ₄			
Willow		R ₄			S ₁₄
Willow, weeping			S ₄		

Table 2

RELATIVE TOLERANCE OF CONIFEROUS TREES
GROWN IN MINNESOTA TO FIVE AIR POLLUTANTS

Species	Atmospheric Pollutant				
	HCl or Cl ₂	HF or F ₂	Ozone	PAN	Sulfur Dioxide
Arborvitae		I _{3,4} R ₁₀	R _{1,5}	R ₂	R _{3,10}
Cedar					R ₁₄
Fir, balsam			R _{1,5}	R ₂	S ₁₁
Fir, Douglas		R ₃ S _{10,4,6}	R _{1,5}	R ₂	S ₁₀
Fir, white		I ₆	R _{1,5}	R ₂	
Hemlock	R ₄	R ₃			
Hemlock, eastern			S ₅ I ₁	R ₂	
Juniper		R _{4,10}			
Larch, eastern					S ₁₄
Larch, European		S ₁₀ R ₆	S ₁	R ₂	I ₁₀
Larch, Japanese		R ₆	S ₅ I ₁	R ₂	
Pine, Austrian		R ₁₀	S _{1,5}	R ₂	I ₁₄ R ₁₀
Pine, eastern white	S ₄	S ₄	I ₁ S _{4,5}	R ₂	S _{4,14}
Pine, jack	I ₄		S _{1,5}		S ₁₄
Pine, Mugho		S ₄		S ₁₂	
Pine, Ponderosa		S ₃ R ₃	S _{4,12}		S ₄
Pine, red (Norway)			R _{1,5}	R ₂	I ₁₄
Pine, Scotch		(S _{4,9} I ₁)	I ₁	R ₂	I ₁₀
Spruce		(I ₁₀)			R ₁₄
Spruce, black					S ₁₁
Spruce, Black Hills			R _{1,5}	R ₂	
Spruce, Colorado blue		S ₄	R _{1,5}	R ₂	
Spruce, Norway		S _{6,10}	R _{1,5}	R ₂	S ₁₀
Spruce, white		I ₄	R _{1,5}	R ₂	S ₁₁

R--The species was more resistant to damage from a specific pollutant than those listed as I or S.

S--The species was more susceptible to damage from a specific pollutant than those listed as I or R.

I--The species was more resistant to damage from a specific pollutant than those listed as S and more susceptible to damage from a specific pollutant than those listed as R.

Blank--No information was found.

Subscript--This refers to a reference of the same number found on the last page.

Table 3

RELATIVE TOLERANCE OF SHRUBS
GROWN IN MINNESOTA TO FIVE AIR POLLUTANTS

Species	Atmospheric Pollutant				
	HCl or Cl ₂	HF or F ₂	Ozone	PAN	Sulfur Dioxide
Alder			S ₄		S ₁₄
Barberry		I ₃ S ₉			
Blackberry	S ₄				
Blueberry		S _{3,4,7}			S ₇ I ₁₁
Bridal Wreath		I ₃ R ₄	S ₄		
Buckthorn		R ₉			
Bush honeysuckle					S ₁₁
Currant		R _{4,9}			I ₃
Dogwood		R ₃			R ₈
Dogwood (<i>C. racemosa</i>)				R ₂	
Dogwood, grey			R ₁₃		
Elderberry		R ₄			
Elderberry (<i>S. canadensis</i>)					R ₁₀
Elderberry (<i>S. pubens</i>)					R ₁₁
Grape	I ₄	S _{3,4,7,9}	S ₄		I ₃
Hawthorne		I ₃			
Hazel					I ₁₄
Hazel, beaked					I ₁₁
Honeysuckle		I ₃			R ₃ I ₁₁
Lilac		I _{3,4}	S ₄		R ₃
Maple, mountain					I ₁₁
Mock orange		I ₃			R ₃
Mooseberry					I ₁₁
Privet	S ₄		S ₄		R ₃
Raspberry		I _{3,4}			I ₁₁
Serviceberry (<i>A. sanguinea</i>)					S ₁₁
Serviceberry (<i>A. alnifolia</i>)		I ₄			
Snowberry			S ₄		
Sumac					R ₃
Sumac, smooth		I ₄			R ₈
Yew	R ₄	I ₄ R ₁₀			R ₁₀
Willow (<i>S. humilis</i>)					I ₁₁

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