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TOLERANCE OF TREES AND SHRUBS TO DE-ICING SALT

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Summary
Trees can be injured by de-icing in the soil or by exposure of above ground parts to salt-spray. Indications are that exclusion of chloride from plant tissues and physiological tolerance of high chloride levels are the principal mechanisms determining salt tolerance. Some progress has been made in identifying salt-tolerant, species, but much work remains to be done. Provisional lists of species are provided based in their tolerance to salt in the soil and salt spray.

Introduction

1. The damage to trees and shrubs resulting from the use of de-icing salt (NaC1) is well documented. Symptoms include bud failure, leaf scorch, branch and crown dieback, and sometimes tree death (Dobson 1991a). Taking appropriate preventative and ameliorative measures can help minimise injury resulting from the use of salt (Dobson 1991b). These measures should be combined with the use of salt-tolerant species for planting in areas that are liable to experience heavy salt pollution.

Mechanisms of salt tolerance

2. There are two principal mechanisms of salt tolerance; avoidance and physiological tolerance. Avoidance involves the ability of a plant to exclude high concentrations of salt, and this may occur at the whole plant level or at the cellular level. Oak *(Quercus robur*), for example, appears to avoid injury by preventing salt uptake by roots. It is thus able to maintain a low internal concentration of chloride even when the concentration in the external medium is high. Corsican pine (*Pinus nigra* var *maritima*), has a high tolerance to salt spray because it has a relatively thick and impermeable epicuticular wax layer which prevents salt penetrating the needles.

3. Physiological tolerance involves the ability of a plant to withstand high concentrations of salt in its tissues. Thus, for example, at the same tissue concentration of chloride, Corsican pine in considerably less damaged that the more sensitive Weymouth pine (*Pinus strobus*).

4. Overall tolerance is determined by the balance between avoidance and physiological tolerance. Thus, the high sensitivity of beech (*Fagus sylvatica*) results from the fact that despite its relative effectiveness in excluding chloride from the roots, it is extremely sensitive to the small number of ions that do enter the tissues.

Factors affecting salt tolerance rankings

5. Tables in which species have been ranked for salt tolerance have in the past shown marked inconsistencies, even to the extent that a particular species may be classed as highly tolerant by one author and as highly sensitive by another. Much of this confusion can, however, be resolved when it is recognised that tolerance to salt spray and tolerance to soil salt are not necessarily related. For example, Horse chestnut (*Aesculus hippocastanum)* is consistently reported as being tolerant to sale spray but sensitive to soil salt.

6. It is more difficult to resolve the effects on tolerance rankings of factors such as tree age, soil type, waterlogging, drought and frost. Mature or well established trees are generally more tolerant than juvenile or recently planted trees, and dormant trees are more tolerant that those in active growth. Although it is

know that waterlogging, drought and frost may increase injury from salt, little is known about the ways in which these factors interact with intrinsic salt tolerance.

7. The emphasis placed on the different criteria for assessing salt tolerance may also influence tolerance rankings. For example, one observer my place greater emphasis on the initial amount of crown damage after heavy salt application, while another may concentrate on the speed with which recovery growth occurs. Future work needs to recognise factors such as these so that consistent and reliable salt tolerance classifications can be produced.

Species selection

8. Tables- 1-4 have been compiled from over 50 literature sources (see Dobson, 1991c) and have taken into account the factors affecting tolerance described above. Thus, Tables 1 and 3 indicate the tolerance of broadleaved-deciduous and coniferous species to salt in the soil, while Tables 2 and 4 provide information on tolerance to salt spray. The confidence in the classification for each species has been ranked on a scale of 1-4 with 4 indicating species for which there are plentiful data and a high degree of agreement between authors and 1 indicating the converse.

9. Selection of tree species will be largely dependent on location. In towns, the worst salt pollution usually occurs within about 5m of a road and principally involves accumulation of salt in the soil. Thus, for plating in pavements, species should be selected primarily for tolerance to soil salt, although some consideration should be given to tolerance of salt spray, if during the early stages of growth small plants are likely to be exposed to splashed or sprayed salt. On trunk roads and motorways, where average traffic speed is much greater, soil contamination may extend 10-25m from the road. Salt spray damage is worst within 30m of the road although damage has been seen at a distance of up to 200m. Trees planted within 15m of a major road should therefore have good tolerance to both soil salt and salt spray, but at greater distances can be selected on the basis of tolerance to salt spray alone.

Note

There does not appear to have been any further work on species tolerance to salt since this review.

Acknowledgement

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References

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Table1. Tolerance to de-icing **salt contaminated soil**, of selected **broadleaved-deciduous tree species**. Date compiled from the literature.

Tolerant	Moderately tolerant	Intermediate	Moderately susceptible	Susceptible
Elaeagnus angustifolia[4] *Gleditsia triacanthos*[4] *Populus alba*[4] *Populus canescens*[3] *Pyrus communis*[2] *Pyrus'Chanticleer'*[1] *Quercus* spp[3] *Robinia pseudoacacia*[4] *Sophora japonica*[4]	*Betula pendula*[1] *Populus* x *euramericana*[1] *Salix* spp[1]	*Acer saccharinum*[3] *Alnus glutinosa** *Crataegus monogyna*[1] *Fraxinus excelsior*[4] *Malus sylvestris*[1] *Platanus* x *hispanica*[3] *Sorbus aria*[2] *Sorbus intermedia*[1] *Ulmus glabra**	*Acer platanoides*[3] *Acer rubrum*[1] *Acer saccharum*[3] *Alnus incana*[2] *Crataegus oxycantha*[2] *Sorbus aucuparia*[2]	*Acer pseudoplatanus*[4] *Aesculus* x *carnea*[3] *Aesculus hippocastanum*[4] *Betula pubescens*[1] *Carpinus betulus*[4] *Cornus* spp[3] *Corylus* spp[3] *Fagus sylvatica*[4] *Prunus avium*[1] *Tilia cordata*[3] *Tilia platyphyllos*[2]

Table 2. Tolerance to de-icing **salt spray** of selected **broadleaved-deciduous tree species**. Data compiled from the literature.

Tolerant	Moderately Tolerant	Intermediate	Moderately susceptible	Susceptible
Gleditsia triacanthos[3] *Populus alba*[3] *Populus* x *euramericana*[1] *Populus canescens*[2] *Prunus avium*[1] *Robinia pseudoacacia*[4]	*Acer platanoides*[2] *Aesculus hippocastanum*[2] *Alnus glutinosa*[2] *Elaeagnus angustifolia*[3] *Salix* spp[1] *Ulmus glabra*[2]	*Acer campestre*[2] *Acer saccharinum*[3] *Acer saccharum** *Betula pendula*[1] *Crategus monogyna** *Cratageus oxycantha*[1] *Fraxinus exclsior*[4] *Malus* spp[2]	*Acer pseudoplatanus*[3] *Acer rubrum*[1] *Alnus incana*[2] *Carpinus betulus*[1] *Fagus sylvatica*[2] *Quercus* spp[1] *Tilia platyphyllos*[1]	*Betula pubescens*[1] *Cornus* spp[3] *Corylus* spp[2] *Sorbus aucuparia*[2] *Sorbus intermedia*[1]

Table 3. Tolerance to de-icing **salt contaminated soil**, of selected **coniferous tree species**. Data compiled from the literature.

Tolerant	Moderately tolerant	Intermediate	Moderately susceptible	Susceptible
Pinus mugo[3] *Pinus nigra*[1]	*Juniperus chinensis*[1] *Juniperus horizontalis*[1] *Pinus ponderosa*[1]	*Picea pungens*[1] *Pinus strobus*[2] *Pinus sylvestris*[2] *Pinus thunbergii*[1] *Thuja occidentalis*[1] *Thuja orientalis*[1]	*Juniperus virginiana*[1] *Tsuga canadensis*[1]	*Larix decidua*[1] *Picea abies*[4] *Pseudotsuga menziesii*[3]

Table 4. Tolerance to de-icing **salt spray of selected coniferous tree species**. Data compiled from the literature.

Tolerant	Moderately tolerant	Intermediate	Moderately susceptible	Susceptible
Picea pungens[1] *Pinus mugo*[2] *Pinus nigra*[4] *Pinus ponderosa*[1] *Pinus thunbergii*[3]	*Juniperus virginiana*[1] *Larix decidua*[2]	*Thuja occidentalis*[3]	*Pinus strobus*[3] *Pinus sylvestris*[3]	*Picea abies*[4] *Pseudotsuga menziesii*[3] *Tsuga canadensis*[2]

The degrees of certainty with which the above classifications are made are indicated on a scale of 1-4, where 1 = low degree of confidence in classification, and 4 = high degree of confidence in classification. * indicates that the species is reported in literature as being both tolerant and sensitive.