Arboriculture Research Note 96

Issued by the Arboricultural Advisory & Information Service

DIAGNOSIS OF DE-ICING SALT DAMAGE TO TREES

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Summary

Rock salt used for de-icing roads, paths and driveways can cause significant damage to adjacent trees and shrubs. Typical symptoms include the failure of buds to flush, browning of foliage, twig and limb dieback, and in certain cases the death of entire trees. Foliar concentrations of chloride exceeding about 0.5 per cent of the dry weight are symptomatic of salt damage.

Introduction

1. Trees may be damaged near to coasts by salt-laden winds and through inundation by the sea. However, damage of most concern to arboriculturists is that caused by de-icing salt (sodium chloride) used on roads and pavements in winter. Once salt is dissolved it may percolate into the soil around the roots of roadside trees and shrubs, and can be sprayed by traffic onto stems and branches, and the foliage of evergreens. The resulting damage ranges from the death of buds and small twigs to the death of whole trees. That salt is the cause of such damage is not always immediately obvious since many of the symptoms do not appear until early summer. However, by careful examination of the nature and distribution of symptoms and ultimately by foliar analysis, an accurate diagnosis can be made.

Symptoms

2. The symptoms described in this note are summarised from a fuller, illustrated, account of the effects of de-icing salt on trees by Dobson (1991). Symptoms are shown to differ for evergreen and broadleaved-deciduous species and to depend on whether damage is caused by salt spray or salt contaminated soil.

   (i) **Evergreens**. The damage caused by salt spray is often easily identifiable because of its clearly directional nature. Generally only the side of the trees facing the road are affected. Moreover, where prevailing winds occur, trees on the downwind side of the road show the worst damage.

   (a) **Salt spray**. The main symptoms on needle bearing conifers (e.g. pine, yew) are the *yellowing*, followed by the *browning* and *necrosis of the tips of one-year-old needles*. There is usually a clear demarcation between the *basal green* and the *terminal brown* tissue of the needles. Just before browning, *yellow bands* sometimes appear across the needles and this, associated with the appearance of *tiny bleached spots*, helps to distinguish salt damage from other causes of needle browning. On older needles, browned by salt in previous years, necrosis spreads towards the base of the needle, and those more than half browned tent to drop off. It seems that buds are rarely affected by spray and therefore give rise to new needles in the spring which remain green and healthy throughout their first year. Symptoms for thujas and cypresses are broadly similar with the principal symptoms being the *yellowing followed by the necrosis of shoot tips*.

Damage to broadleaved evergreens is characterised by *bronzing* and/ or *necrosis of leaf tips and margins* of one year old leaves. Older leaves, browned by salt in previous years, become progressively more necrotic until they fall off. From the limited data available it appears that some species may develop severe leaf symptoms whilst others, e.g. *Pittosporum,* may show very slight marginal scorch and drop their leaves before stronger symptoms develop.

(b) **Soil Salt**. Leaf symptoms are the same as those described above but are usually *non-directional*. In contrast to damage caused by salt spray, however, buds may fail to flush, and/or foliage may become necrotic shortly after emergence. Soil salt may also result in the death of small branches, large limbs and even whole trees.

(ii) Deciduous species

(a) **Salt spray**. The principal symptoms of damage to deciduous trees from salt spray are the *death of dormant buds and young twigs*. The death of apical buds often leads to '*brooming*' due to the consequent growth of unaffected dormant buds on older wood. Flower buds are usually more sensitive that leaf buds and so flowers may only come out on the side of the tree facing away from the road. Salt spray rarely causes outright tree death but annually recurring damage stunts growth and often gives plants a *one-sided appearance*.

(b) **Soil salt**. Early symptoms include the *failure of buds to flush* in the spring and/or the *death of leaves shortly after flushing*. From June onwards *marginal and interveinal browning* and sometimes *leaf wrinkling or curling* can be observed on fully expanded leaves, including some on trees which showed no early-season symptoms. Affected leaves drop prematurely and *extensive defoliation* may be observed as early as August. Whole trees may be affected or *symptoms may be present only on certain branches* whilst others are normally foliated. It is not unusual for badly affected branches to bear a few *scattered normal leaves*. Some trees showing crown dieback may also have *dead strips of bark* on the trunk, beginning at ground level and extending several meters up the stem.

Death may occur as a result of damage during a single winter or through repeated injury over a number of years leading to a terminal decline. Such extreme damage occurs most frequently in urban areas where trees are planted very close to roads, in paved areas such as shopping precincts where salt is often used in very large quantities, and close to poorly positioned or designed roadside salt storage containers.

Foliar analysis

3. The chloride ion is the most damaging part of salt. It is readily taken up by roots and young shoots, and once inside a tree is transported through the xylem until it reaches the end of the transpiration stream. Toxic concentrations of chloride thus accumulated in leaf and shoot tips and tissue death results. The threshold concentration of chloride at which leaf symptoms are expressed varies for different species (Table 1). Species such as *Robinia pseudoacacia* and *Plantus x hispanica* may accumulate large quantities of chloride before symptoms of injury occur whereas species such as *Aesculus hippocastanum* have a lower threshold for injury.

4. In many instances an evaluation of symptoms alone, or in conjunction with circumstantial evidence implicating salt, may be sufficient for a firm diagnosis. However, if confirmation of the diagnosis is required foliar analysis can be carried out. This will involve collecting a sample of damaged leaves from an injured tree, and if possible, undamaged leaves from a nearby healthy tree for comparison. Care should be taken to avoid touching the leaves with bare fingers as this may contaminate them with chloride from human perspiration. Samples should be sealed into plastic bags and dispatched for chloride analysis as soon as possible. Some local authorities may

have analytical laboratories to which the samples may be sent, otherwise, they can be sent to a private analytical chemist.

5. As a general rule, damage can be attributed to salt if the foliar chloride concentration exceeds about 0.5 per cent of the dry weight for conifers, and about 1.0 per cent for broadleaves. As a comparison, leaves from unaffected trees should have a chloride content of less than 0.1 per cent of the leaf dry weight. Table 1 is a rough guide to some of the concentrations of chloride that might cause injury in certain species and genera. Inevitably there is some overlap between concentrations causing injury and those that do not, and so this table should be used with discretion.

Table 1. Summary of reports in the scientific literature of foliar chloride concentrations associated with the appearance of leaf salt-toxicity symptoms for selected tree species and genera (date expressed as a percentage of the leaf dry weight).

Species	No symptoms	Symptoms
Acer spp	<0.20	0.20-2.65
Aesculus hippocastanum	<0.13	0.14-3.20
Betula spp	<0.10	0.40-1.80
Crataegus monogyna	<0.30	0.30-1.00
C.oxycantha	<0.10	0.10-0.60
Fagus sylvatica	<0.50	0.50-3.20
Fraxinus excelsior	<0.40	0.26-3.00
Malus spp	<0.50	0.30-1.31
Picea spp	<0.20	0.10-1.43
Pinus spp	<0.40	0.20-3.67
Platanus x hispanica	<0.80	1.00-2.05
Populus spp	<0.20	0.60-3.90
Prunus spp	<0.20	0.30-2.90
Robinia pseudoacacia	<1.00	1.40-3.50
Sorbus spp	<0.30	0.80-2.70
Thuja spp	<0.30	0.13-1.98
Tilia spp	<0.20	0.60-3.50
Ulmus spp	<0.20	0.38-3.5

Reference

Dobson, M.C. (1991). *De-icing salt damage to trees and shrubs*. Forestry Commission Bulletin 101. HMSO, London.

Acknowledgement

The work on which this note is based was financed by the Department of the Environment.

Published by: April 1991

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Revised with minor amendments February 2013

The Arboricultural Advisory and Information Service provides advice and information about trees based on research results and experience, both national and international, to arboriculturists, landscape architects, the construction industry and other professionals, also to private individuals. The Arboricultural Research Note series is supported by the Forestry Commission.