Arboriculture Research Note

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PREVENTION AND AMELIORATION OF DE-ICING SALT DAMAGE TO TREES

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Summary

Damage to trees from de-icing salt is a recurring problem. The use of soil ameliorants and fertilisers may improve the health and appearance of trees already showing symptoms of salt damage, and can help to minimise injury to previously undamaged trees.

Introduction

1. The symptoms of de-icing salt (sodium chloride) damage to trees are described in Dobson (1991a).

2. Damage from de-icing salt is primarily attributable to the phytotoxicity of the chloride ion. However, damage may also occur because of high concentrations of sodium in the soil. Excess sodium can lead to break down of the crumb structure (deflocculation) of silt and clay soils which may result in compaction and, consequently, inhibition of root growth and decreased moisture availability.

3. A further problem with sodium is that it tends to displace other ions of greater nutritional importance, such as potassium, magnesium and calcium, from cation exchange sites, thus allowing them to be leached out of the soil. The deficiency this creates may be compounded by the action of sodium on plant membranes which results in a preferential uptake of sodium rather than potassium. Although potassium and sodium have similar chemical propertied, only potassium is useful for plant growth. Similarly, high concentrations of chloride in the soil can interfere with the uptake of phosphorus.

4. An extensive literature review (Dobson 1991b) has highlighted methods of minimising the damage caused by each of these factors. However, it must be stressed that the following guidelines are provisional. The findings of the literature review need to be followed up by critical experimental work.

Watering

5. A simple and effective way of removing excessive concentrations of salt from soil is to flush with large volumes of water. 3—mm of water will remove almost all chloride to a depth of more that 0.6m (Rubens,1978). Sodium, on the other hand, is more difficult to remove by this method as it is strongly attracted to soil colloids because of its positive charge. Problems with this method are that excessive watering may lead to waterlogging, especially on clay soils, and the leaching of beneficial nutrients such as magnesium and potassium form the soil. Where possible, watering should therefore be used in conjunction with application of gypsum and fertilisers described below.

6. It has been noted that the amount of rainfall during spring is critical for the development of injury during the summer. If the spring is dry, salt damage symptoms may occur as early as May whilst after a very wet spring damage may be delayed until September/October (van den Burg, 1989).

Gypsum

7. Gypsum (calcium sulphate), has been successfully used to reclaim salt-affected agricultural soils and has potential for ameliorating the effects of salt in roadside soils. For example, Dirr and Biederman (1980) found that *Cotoneaster* plants treated with salt plus gypsum showed only about 40 per cent leaf necrosis whilst plants treated with salt alone shoed 70-80 per cent necrosis. However, there are no firm data for beneficial effects on trees.

8. The high concentration of calcium added to the soil through application of gypsum helps to displace sodium from cation exchange sites and thus reverses the process of soil deflocculation and compaction caused by sodium. This free sodium then combines with sulphate and forms sodium sulphate which is highly soluble and can be readily leached from the soil. Tests in the USA showed that a 76 per cent reduction on soil sodium levels was achieved in just over a year following application of gypsum (Jacobs, 1976). In addition to alleviating soil compaction, a decrease in soil sodium, and an increase in calcium, helps to restore normal functioning of plant membranes.

9. Reduced soil compaction and consequently improved drainage resulting from gypsum application also allows chloride to be leached from soil more easily. Dobson (unpublished data) found that gypsum applied to the soil surface of hawthorn (*Crataegus monogyna*), potted into a 1:1 peat:sand mixture, reduced soil chloride concentrations by up to 21 per cent.

10. It appears from the data available that gypsum is likely to be most effective if applied as a preventative treatment prior to the onset of winter salting, rather than as a curative treatment after injury has occurred. It is therefore suggested that, where de-icing salt could be a problem, gypsum is incorporated into backfill for new trees. However, if this is not possible, benefits may still be obtained by applying gypsum to the soil as soon as damage is observed. At present, with little detailed research available, one cannot improve upon the suggestion that gypsum should be applied at the rates found suitable for agricultural soils i.e. 0.9-3.3kg m^{-2} (Rubens, 1978). As gypsum only dissolves very slowly, one application may continue to have beneficial effects for several years.

Fertilising

11. As salinity can reduce the availability of nutrients to trees by impoverishing the soil, application of fertilisers will generally be beneficial. Specifically, by restoring and ionic balance, fertilisers can allow plant membranes to exclude unwanted ions whilst enabling other nutritionally important ions to be taken up.

12. It seems that phosphorus, nitrogen and potassium may be particularly effective in reducing sale related injury. An experiment carried out in W. Germany (Mekdaschi *et al*., 1988) showed that treatment of salt damaged Horse chestnut (*Aesculus hippocastanum)* trees with soil applied NPK fertiliser (ratio not specified) reduced foliar concentrations of sodium and chloride and also reduced visible symptoms compared to control trees. The authors suggested that with gypsum and fertiliser treatment even severely damaged trees could be brought back to health in 5-10 years. Another report showed that the survival rare of Pinus nigra planted in the central reservation of a German autobahn, and thereby exposed to salt spray and soil contamination, was significantly increased by a single treatment with 2 litres of nutrient solution (Ca(NO : MgSO : KH PO 10:5:2:1) prior to winter (Fluckiger abd =Braun, 1981)

13. Fertilisers may be broadcast, placed into holes punched in the ground or injected directly into the ground in liquid form. Details of amenity tree fertilisation are given in Tattar (1978). Because of the danger of further increasing levels of chloride in the soil, formulations using potassium chloride should be avoided. In addition, it is important to use fertilisers with a low nitrogen content, as too much nitrogen can cause an over stimulation of growth with a consequent

Avoidance of injury

14. Salt injury could largely be prevented if trees were planted further away form heavily salted roads. A minimum of 30ft (9m) is recommended by Tattar (2978). Areas close to soakaway drains should especially be avoided. Trees should preferably be protected by a “lip” around the planting area to prevent salty water running into the rooting zone, and / or should be planted on a slightly raised site to encourage salt water to drain away from the tree. Guards made of straw and plastic which prevent salt reaching tree trunks and the area of soil immediately surrounding trees have been tried as a protective measure in Denmark (Hvass, 1986). There is little detailed information about the effectiveness of this type of protection, but it appears that trees thus protected have a greater survival rate.

15. Factors which are not under the control of arboriculturists are the piling of salty snow around the bases of trees, the careless siting of temporary salt piles in the rooting areas of trees, and the poor construction of salt storage depots which allows salty turnoff to affect adjacent vegetation. In these circumstances practical action can be taken by approaching engineers and suggesting appropriate changes to current practices.

Alternatives to salt

16. Calcium magnesium acetate (marketed by BP Chemicals Ltd as Clearway CMA de-icer) is the most promising alternative chemical to salt. It was developed principally because of concern over corrosion of vehicles and the steel reinforcing of bridges. However, besides being non-corosive, CMA is also virtually non-toxic to trees (Dobson, unpublished date). Its main drawback is its price, which at around £500 per tonne is twenty times the cost of salt. Nevertheless, because all the undesirable effects of salt, CMA may be a viable alternative in certain sensitive areas. Another non-corrosive alternative to salt, urea, is currently used to a limited extent on bridges and elevated sections of motorways. Its use is not widespread because it costs about ten times as must as salt, twice as much needs to be applied, it is only effective down to a temperature of -7º C and it degrades to ammonia which can be toxic to aquatic life.

Conclusions.

17. Both the prevention and treatment of salt damage to trees are possible. However, with limited experimental data and little practical experience it is impossible to predict with any confidence the magnitude of any benefits which may result from the use of the measures described above. Thus, much work remains to be done, particularly in assessing the most effective procedures for applying treatments such as gypsum and fertilisers.

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References

Van den Burg, J (1989). Salt damage to trees: physiological mechanisms and their detection. *Groenkontakt* 89, 27-32 (In Dutch)
Dirr, M.A. and Biedermann, J. (1980). Amelioration of salt damage to *Cotoneaster* by gypsum. *Journal of Arboriculture* 6, 108-111.
Dobson, M.C. (1991a). *Diagnosis of de-icing salt damage to trees*. Arboriculture Research Note 96/919PATH. Forestry Commission.
Dobson, M.C. (1991b) *De-icing salt damage to trees and shrubs*. Forestry Commission Bulletin 101. HMSO, London.
Fluckiger, W. and Braun, S. (1981). Perspectives of reducing the deleterious effect of de-icing salt on vegetation. *Plant and Soil* **63,** 527-529.
Hvass, N. (1986). Defending trees against road salt in Denmark. *Arboricultureal Journal* 10 89-94
Jacobs, K. (1976). Dispersal of roadway slats, technical paper 77-4, third interim report. Maine Dept of Transportation, Materials and research Division.
Mekdaschi R., Horlacher, D., Schultz, R. and MArschner, H. (1988). Damage to street trees in Stuttgart by deicing salt and improvement measures to reduce the effects of dicing salt. Angewandte Botanik 62, 355-371.
Rubens, J.M. (1978) Soil desalination to counteract maple decline. *Journal of Arboriculture* 4, 33-43.
Tattar, T.A. (1978). *Diseases of shade trees*. Academic Press Inc., London.

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