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Lightning Damage to Trees in Britain
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Summary

Lightning damage to trees is far more common than the incidence of obvious external signs suggests. It is often necessary to examine trees carefully for evidence of internal symptoms to distinguish between lightning damage and progressive root-killing diseases. Lightning strikes affect groups of trees, in plantations or hedges, as well as isolated trees. Oak, poplar and Scots pine appear to be the species most frequently affected. Lightning conductors can be fitted to valuable amenity trees where the risk of a strike is high.

Introduction

1. Each year lightning strikes cause death or serious damage both to isolated trees and groups of trees in plantations, hedgerows and screens; and they are also a rare cause of fires. This Note summarises information on the damage that can occur and the tree species most commonly affected.

What is lightning?

2. Lightning is the sudden, massive discharge of electricity through the atmosphere. There are many theories about the generation of the electrical potential which results in lightning, but from observations and recent research the explanation most widely accepted may be found in the literature of the Meteorological Office (1982), De Rosa (1983) and Williams (1988). When the electrical potential between a cloud and the ground reaches a critical value the insulating quality of the air is overcome and a faint streamer of negative charge (leader stroke) of a few hundred amps descends in a zigzag, often branched, path. As the streamer nears the ground a powerful positive streamer moves upward to meet the leader stroke.

3. This results in a massive upward discharge (main stroke) of around 10 kilo amps creating the vivid flash and rapid heating of air in the discharge channel causing the shockwave heard as thunder. A complex lightning stroke can discharge up to 200 Megawatts in a fraction of a second. Much of this energy is dissipated into the air producing a bright flash and rapid heating, however sufficient energy can be imparted to an object struck to cause damage.

How to recognise lightning damage to trees

4. Lightning damage to trees falls into three distinct categories:

(i) **Catastrophic damage.** There is usually little difficulty in recognising this form of damage as strips or patches of bark are forced from the tree leaving a visible scar on the trunk. In some

cases there may be a jagged furrow in the wood. Such scars are normally fairly narrow (2 to 15cm wide), are often broadest at the base of the tree, and frequently follow a gently spiralling path up the trunk. Occasionally the scars extend below ground level and track along the top of a surface root. Rarely, large irregular patches of bark are forced off and thrown some distance; in extreme cases the strike may be so violent that the tree is split or shattered. Trees suffering catastrophic damage may be killed almost immediately or die within a few months. Though exceptionally some major roots may also be killed immediately, the roots are usually the last part to die. Some trees survive and the scars, which are visible for many years, may be invaded by decay fungi. In known cases of Wellingtonias (*Sequoiadendron giganteum*) struck by lightning 2 to 3 metres of the top were killed outright but the rest of the tree remained healthy. In the absence of any other sustainable explanation it is quite probable that most Wellingtonias showing similar damage have also been struck by lightning.

(ii) **Non-catastrophic damage.** In a large number of cases trees exhibit no distinctive or immediate signs of the strike but die-back gradually. As it may take many months for this to occur the crown symptoms can mimic a root disease. However, the fact that the roots remain alive or, if the tree does not recover, are usually the last part to die helps to rule out such a disease. An even more diagnostic feature which is sometimes present is a strip of dead bark running up the stem. This can be located by cutting into the bark at various points. The strips have been the same dimensions and follow the same path as the visible scars described above though sometimes they may be discontinuous. Branches along the line of the strip often die first, revealing the path of the strike. There are also a few cases where bark death is diffuse and does not produce a well-defined strip. If growth continues after a strike there is often a ring of abnormally large, disorganised or darkened cells in the wood formed immediately after the strike in some parts of the tree. This is sometimes conspicuous enough to appear to the naked eye as a dark circle or arc in a clean-cut cross-section, but usually a low powered microscope is needed.

(iii) **Group killing.** Lightning strikes commonly damage or kill groups of trees in plantations and hedgerows. Though one or two central trees in a group strike may show catastrophic damage or the distinctive bark death described in (ii) above, the majority will merely die slowly. Usually the trees at the edge of the group die more slowly that those at its centre giving the impression that the group is expanding as if from a spreading root infection. Where an examination of the growth pattern of the trees is possible, the deterioration of the trees will be found to have occurred at the same time. There may also be a lightning ring in the wood which will help date the strike in the affected trees. Group size can vary from several hundred trees covering up to 1 ha down to 3 or 4 closely spaced trees. In the latter instance a number of such small groups may be found close to each other. Very rarely, the sudden death of circular patches of seedlings or transplants in a nursery is due to a lightning strike.

Which tree species are affected?

5. During the period 1932-1935, Dark (1936) investigated cases of damage to trees from 1962 to the present date and the Forestry Commission have investigated cases of lightning damage through its Pathology Advisory Service (now Tree Health Diagnostic and Advisory Service). Comparison of the lists shows that oak (*Quercus* sp.), poplar (*Populus* sp.) and Scots pine (*Pinus sylvestris*) are most frequently killed or damaged.

6. The records of 1932-1935 are, by definition, of trees where damage was obviously caused by lightning (i.e. catastrophic damage) whereas most of the Forestry Commission records involve damage which was not immediately attributable to lightning (i.e. non-catastrophic damage). This may explain some differences such as the higher figure for beech (*Fagus sylvatica*) and the wider range of conifers in the later period.

7. However, any attempt at producing a list of tree species most susceptible to lightning strikes must take into account the relative abundance of that species in an area together with the frequency of

cases of damage. Such an analysis is beyond the scope of this note and it is an area which may well merit further investigation.

Prevention of lightning damage

8. Trees can be protected with lightning conductors but the cost of installation is high. The specifications and installation procedures for lightning conductors are in the BS 6651 (British Standards Institution, 1985) and an excellent account of the work involved is given by Dolwin (1985). Any lightning conductor installed must conform to the standards in the Code of Practice and it is advisable that the work is carried out by trained and experienced contractors.

References British Standards Institution 2002. Code of Practice for Protection of Structures against Lightning, PD *6651* British Standards Institution, London.

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