Arboriculture Research Note

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Treatment of tree wounds

By D Lonsdale
Tree Pathologist, DoE Arboriculture Contract, Forestry Authority

Summary

Numerous studies have shown that wound treatments cannot prevent microbial growth beneath wounds on trees, but there are some that can reduce the rate of microbial invasion. The potential for improving such treatments is examined in the light of recent findings. In some circumstances, which are defined here, existing treatments may be of value in protecting trees against 'fresh wound parasites', reducing cambial dieback and enhancing 'callus' formation.

Introduction

1. Many materials have been marketed for the control of decay associated with wounds in trees. Over the last twenty years, some of these haven been evaluated in European and North American research projects, from which it has been generally concluded that fungicides and sealants do not prevent decay. Meanwhile, other studies have shown that the incidence of serious decay can be reduced by avoiding the infliction of certain types of injury which render large volumes of sapwood open to attack by micro-organisms (Lonsdale 1983, Boddy & Rayner 1986). Thus, there is now far less reliance on wound treatments than formerly and their use is no longer standard practice in British arboriculture.

2. There are several practices that can help considerably to reduce the incidence of serious decay beneath wounds. These include formative pruning (the removal of unwanted branches and weak forks while they are still small), and 'target pruning', in which natural structures at the branch base are used for defining the least harmful position of cut (Lonsdale 1983). However, even a 'properly' made wound is not immune from attack by micro-organisms that can cause disease or decay, and ther are some circumstances where an effective wound treatment remains desirable. This Note discusses those circumstances and reviews the scientific *raison d'etre* of wound treatment.

Existing information on the efficacy of wound treatments

Enhancement of wound occlusion

3. Complete occlusion is believed to arrest decay processes (see para.12b), and there might therefore be some value in treatments that could hasten it. However, the benefits would be significant only on wounds of a certain size-range; neither those that are so small that occlusion is soon completed even without treatment, nor those that are so large that the process is long delayed regardless of treatment. A variety of commercial wound paints have been shown to enhance 'callus' growth around pruning wounds (e.g. Mercer 1983) and this effect can probably be obtained with any paint that is not toxic to the cambium, at least during the first year or two after wounding. Especially strong enhancement of 'callusing' has been achieved with wound paints containing thiophante methyl, an ingredient primarily intended as an anticanker fungicide. It should be noted that

'callus' growth can sometimes curl in upon itself if it is formed very rapidly, a formation that tends to promote cracking of the new wood. Flush cuts with 'callusing' mainly confined to their sides are prone to this problem.

4. It is not clear whether the occlusion of bark wounds, as distinct from running wounds, can be enhanced by treatment; work on poplars (*populus* spp) suggests that little or no benefit (J. Kopinga,pers.comm.[1]).

Control of discoloration and decay

5. Research in this area has been done on three kinds of wound: (a) bark wounds, where bark and cambium only are damaged, (b) drill holes or axe wounds in stems and (c) pruning wounds.

6. Information on stem surface wounds is limited, being based mainly on studies of Norway spruce (*Picea abies*) in Germany (Rohmeder 1953, Bonnemann 1979). None of the wound protectants tested in these studies prevented the development of stain or decay fungi, but some materials considerably reduced the extent of fungal development, at least for a few years.

7. There have been many studies involving drill or axe wounds, especially on broadleaved trees in North America (e.g. Houston 1971, Shigo and Wilson 1977, Shigo & Shortle 1983). As with stem surface wounds, total protection against microbial invasion has never been obtained, but the rate of attack has in some instances been slowed down, although perhaps only temporarily.

8. Pruning wound treatments were initially studied in North America on an observational basis (Shigo & Wilson 1971) and later in Britain by experimental evaluation (Mercer *et al* 1983). In these studies, all the tested treatments failed in that none of then prevented the growth of fungi and bacteria beneath the treated wounds.

9. Biological control agents have been tested in drill wounds in stems, and promising results have been obtained, mainly with antagonistic fungi of the genus *trichoderma* (Pottle & Shigo 1975, Pottle *et al* 1977, Mercer 1984).

Control of fresh wound parasites

10. Both chemical and biological control have been tried with some success on pruning wounds against specific parasites that usually confine their attack to freshly exposed tissue. These include the Silver Leaf fungus *Chondrostertum purpureum* (Corke 1980, Dye & Wheeler 1968, Gendle *et al* 1981) and the canker fungus*, Nectria galligena* (Seaby and Swinburne 1976).

New Developments

Methods for evaluating wound paints

11. Before 1983, it was thought that the presence of microbial development beneath a treated pruning wound was proof that the treatment had failed to prevent infection. It then became increasingly apparent that among the micro-organisms that can be found beneath wounds, some are already latently present in healthy wood and can develop following injuries that break xylem water columns. Thus, their presence does not necessarily mean that they have penetrated the wound surface. Also, a literature review revealed that treatments had never been critically evaluated on pruning wounds made in a way now widely recommended; i.e. the 'target' method (Lonsdale 1983). For these reasons, the following rules for pruning wound studies were adopted in the present research programme.

i) Experimental wounds should not be created by removing suppressed branches, except when such branches are being investigated, since these may already contain a partly developed microflora which could interfere with assessments.

ii) Wounds should not be of the ‘stub’ type (Lonsdale 1983), since a stub tends to die back to its natural base or at least to become occupied by a developing microflora.

[1]De Dorschkamp, Wageningen, The Netherlands

iii) The ‘branch bark ridge’ (Lonsdale 1983) should be left in tact whenever a wound is made, so that cells above the wound are not unduly exposed to drying out and to the consequent development of staining and microbial invasion.
iv) The efficacy of treatments should be assessed by the depth to which micro-organisms (especially basiomycete fungi) develop during a given time within the wounded parent stem.

Prospects for formulating treatments through understanding modes of action

12. There are several modes of action by which wound treatments could work, at least in theory. However, detailed knowledge of the biology of decay in living trees is still very patchy and needs to be improved if theory is to be turned efficiently into practice. The main modes of action that have been considered are:

a) *The exclusion of micro-organisms by physical or chemical barriers*. This has failed in the past partly because the exposed tissues are not sterile and so a wound treatment can ‘seal’ micro-organisms in as well as out. Also, most materials have limited durability; surface applications tend to crack, flake or lift away from the wound surface, while fungicides absorbed into the wood can be excessively diluted or can undergo microbial breakdown. However, as mentioned above (para.10), protection can be achieved in the short term and is of value against ‘fresh wound parasites’.
b) *The restriction of gaseous exchange*. This is theoretically more valid than the idea of keeping a wound ‘sterile’. The principle is that decay cannot occur in near-anaerobic conditions, such as may be produced by microbial activity beneath an hermetic seal (provided that no other avenue of gaseous exchange exists), and will be arrested as a result. This is believed to happen naturally beneath a completely occluded wound. However, a sealant intended to prevent gaseous exchange may fail if it is not extremely durable. In any case, most of the sealants marketed in the past as barriers to infection were gas-permeable.

   A novel, polyurethane-based durable sealant has been found greatly to reduce the extent of microbial growth beneath pruning wounds on beech (*Fagus sylvatica*) over the first year (Lonsdale 1991). However, in a longer term trial, this effect did not persist. Conventional sealants can either increase or reduce the rate of microbial penetration depending on the tree species and on the time of year of wounding (Lonsdale 1991).

   If hermetic sealants applied in liquid form prove to be insufficiently durable or impermeable to give lasting inhibition of microbial invasion, another option might be to apply a covering sheet form (e.g. butyl rubber), cut to size and stuck on to the wounded surface. This would clearly be impracticable for most purposes, but might be acceptable where exceptionally valuable specimens trees are at risk due to the creation of large wounds.

c) *Biological control*. This is a promising approach because it allows for the inevitable development of a wound microflora, which can be manipulated to the detriment of harmful micro-organisms. In the present research programme, initial trials of the biocontrol agent *Trichoderma* sp. in drill wounds in beech stems have been extended using pruning wounds on a wider range of tree species. So far, it has been found that this agent was still viable after five years in 80-100% of pruning wounds on beech, oak (*Quercus*), birch (*Betula*), cherry (*Prunus*) and ash (*Fraxinus*) to which it was applied (Lonsdale 1991) In these tree genre, no decay fungi had colonised any of the wounds from which *Trichoderma* was isolated, but the treatment failed to protect wounds on Lombardy poplar (*Populus nigra* ‘Italica’) from infection by the fresh wound parasite *Chondrostereum purpureum.* The value of *Trichoderma* as a wound protectant may need to be judged for individual types of trees rather than for trees in general. Also, there remains a need to evaluate this biocontrol agent under a variety of conditions, especially different seasons of pruning.

Despite the need for further evaluation, *Trichoderma* has been shown to protect fruit trees against infection by C*hondrostereum purpureum* (Corke 1980), and at least in this application, there is a case for its use. However, as with other tree wound protectants, legal restrictions have cast some uncertainty over the commercial availability of *Trichoderma* preparations. One product, 'Binab T', has been available in the UK, but its registration is currently under review.

d) *Reduction of cambial dieback* around the wound edge can be achieved using wound sealants given certain combinations of tree species and time of year Lonsdale 1991). This may be of value because it helps to avoid the development of an enlarged zone of damaged wood which takes a relatively long time to become occluded. It is also possible, though not proven, that the enlargement of this zone by dieback is itself an increased risk factor for decay, irrespective of the occlusion rate.

Recommendations

13. Good Arboricultural practices should be adopted, since irrespective of the desirability of wound treatments, it is essential to avoid excessive injury from bad practice. Good practices include:-

- formative pruning of young trees to minimise eventual problems created by the need to remove large, unwanted or unstable limbs.
- Using the 'target pruning' technique for the removal of live or dead wood
- Minimising the size of pruning wounds and, in cases where major branches must be removed, ensuring that large wounds on any one stem are as few in number as possible and not close together; especially if the type of tree involved is known to be particularly susceptible to attack by any fresh wound parasites or decay fungi.
- Being aware that the time of year when pruning wounds are created may affect the incidence of associated disease or decay (Lonsdale 1991)
- Managing sites so as to avoid accidental injuries to roots, stems or branches
- Not pruning trees during periods of moisture stress (e.g. during drought or following serous root injury)

14. It should not be assumed that wounds created by 'correct pruning' are immune from the development of extensive decay. Continuing research could lead to the availability of treatments that would complement the natural defences of the tree (see para.12). The inadequacy of past treatments should not lead to rejection of this possibility.

15. Since the use of appropriate wound dressings can protect against cambial dieback when they are pruned at 'unfavourable' times of year, the use of such materials in these circumstances should be considered, subject to current advice on their efficacy and legal approval.

16. Where available, dressings that control fresh wound parasites should be used on wounds on species known to be highly susceptible to such pathogens (see para.10). Pathogens that could be controlled in this way, given suitable treatments, are listed in the Appendix with their known hosts.

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Arboricultural Advisory and Information Officer
Alice Holt Lodge
Wrecclesham
Farnham
Surrey
GU10 4LH

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Principal Fresh Wound Parasites and Their Hosts

Pathogen	Types of disease	Hosts	Possible wound Treatments
Chondrostereum purpureum	Silver-leaf, Stem dieback, decay	*Prunus* spp *Eucalyptus* spp *Betula* spp *Populus* spp Many others	Triadimefon in Alginate gel* *Trichoderma*** Octhilinone+
Amylostereum Laevigatum	Stem dieback, Canker-rot	*Chamaecyparis Lawsoniana* *Thuja plicata* *Thija occidentalis*	Perhaps as for *Chondrostereum*
Stereum rugosum	Canker-rot	*Quercus rubra*	Perhaps as for *Chondrostereum* *Setereum rugosum*
Stereum Sanguinolentum	Sapwood stain, decay	*Picea* spp *Larix* spp	Perhaps as for *Chondrostereum*
Nectria spp	Stem cankers	Most Rosaceae	Thiphante Methyl paind*** Octhilinone + Cresylic acid ++

* Based on "Bayleton BM", Bayer UK Ltd; this usage has not been submitted for approval under CPR, 1986

** "Binab T"; HDRA Sales Ltd; currently approved for professional use only

*** "Mildothane canker paint"; May & Baker Agrochemicals; not approved

+ "Pancil T"; Rohm & Haas; approved for professional use only

++ "Synchemicals Medo"; Synchemicals Ltd.; not approved

Before using any wound protectant always read carefully the manufacturer's instructions on the label (including any accompanying leaflet) and apply the material for the use, at the rate and by the method recommended, paying particular attention to aspects of safety.

Wound treatment materials that could give at least partial control are included above but it should be noted that, at the time of writing, very few are approved for use as tree wound paints under the UK Control of Pesticides Regulations (CPR), 1986. Both approval and market availability are subject to frequent change, so that the naming of materials here must be for information, rather than practical recommendation.