



# Research Information Note 197

Issued by the Forestry Commission Research Division

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## WATERMARK DISEASE OF CRICKET BAT WILLOW: GUIDELINES FOR GROWERS, by K.N. Patrick

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### Summary

Watermark disease can infect species of wild and cultivated willows and thus presents an economic threat to the cricket bat willow industry in east England. This Note is intended to help cricket bat willow growers to identify diseased trees and control the spread of the bacterium in the crop.

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### Introduction

1. Watermark disease caused by the bacterium *Erwinia salicis* has been recognised as a serious disease of cricket bat willow (*Salix alba* var. *caerulea*) in Britain since 1924. The disease can be found widely in the counties of Essex and Suffolk, but also occurs in Bedfordshire, Cambridgeshire, Norfolk, Hertfordshire, Buckinghamshire, Leicestershire and Wiltshire. It has also been found occasionally in various wild and cultivated willows, notably goat willow (*S. caprea*), white willow (*S. alba*) and grey willow (*S. cinerea*). In the Netherlands a different strain of the same bacterium causes serious losses to amenity willows. Symptoms have been reported in Germany and Belgium.

### What to look for

#### **Wilt and 'red leaf'**

2. In a newly infected tree, leaves in the distal parts of one or more branches, usually close to the top of the crown, wilt and turn from green to red-brown. The reddish leaves are visible in May and remain attached to the tree throughout the summer.

#### **Dieback and recovery growth**

3. In successive years the affected branches die back and red leaves develop in other parts of the crown. Bushy side shoots grow from the affected branches but are killed as the disease progresses down the branch towards the main stem of the tree. The extent of killing varies according to a number of factors such as site conditions, tree management and age.

#### **Internal stain and bacterial exudate**

4. When a section is cut from a live branch infected by *E. salicis*, a reddish-brown or brownish-black stain (the 'watermark' symptom), can be seen in the wood, contrasting with the white, healthy tissue. In cross-section, the stain may appear in the form of blotches, or it may occupy complete annual rings. If the bark is peeled away from the branch, the stain can also be seen in the cambium. It may also be found in the wood of the trunk and the stump if a diseased tree is felled. A viscous exudate develops on the stained surface soon after cutting. This bacterial slime is sometimes seen oozing from junctions between branches in affected parts of diseased trees.

#### **Similar symptoms with different causes**

5. The external symptoms of watermark disease can be confused with the presence of broken branches bearing foliage with the 'red leaf' symptom, with dieback associated with overmaturity or, occasionally, with damage caused by certain fungi or insects that may attack shoots and branches. There may be some confusion also with the symptoms of moisture stress or of attack by root-rot fungi such as *Armillaria* spp., but such symptoms differ from those of watermark disease. Root-rot usually causes deterioration of the entire crown, while moisture stress characteristically leads to yellowing and premature shedding of leaves at the base of the current year's shoots. The internal symptoms of the disease may be confused with discoloration due to attack by a variety of wood-inhabiting micro-organisms and insects. Sometimes an irregular, brown, central stain is seen in the trunk. Commonly known as the 'butterfly mark', this stain is thought to be caused by damage due to frost or pruning, and is found in trees that are not affected by watermark disease.

### **Alternative hosts**

6. Watermark disease affects trees and shrubs of the genus *Salix* (family *Salicaceae*). The tree species, in particular the common or white willow and its varieties, are most commonly affected. In Essex between 200 and 500 diseased cricket bat willow trees are reported each year. In contrast fewer than ten diseased trees of other willow species are found in a typical year.
7. Watermark disease has been recorded in the following species:  
  
white willow (*S. alba* L.); golden willow (*S. alba* var. *vitellina*); crack willow (*S. fragilis*); hybrids of *S. fragilis* x *S. alba*; goat willow (*S. caprea* L.); purple willow (*S. purpurea* L.); almond willow (*S. triandra*).
8. Creeping willow (*S. repens* L.), bay willow (*S. pentandra* L.), osier (*S. viminalis* L.) and silver willow (*S. alba* 'Sericea') are susceptible to artificial inoculation, but there is no record of natural infection of these species.
9. In the Netherlands watermark disease seriously affects cultivars of *S. alba* including 'Liempde', 'Drakenburg', 'Belders' and 'Lichtenvoorde'. Watermark disease has not been recorded on Dutch cultivars planted in Britain.

### **How the bacterium spreads**

Three sources of infection are recognised.

#### ***Diseased propagating material***

10. There is strong circumstantial evidence in the case of cricket bat willow that the bacterium can be introduced to new sites on propagating material cut from diseased stool beds.

#### ***Diseased trees***

11. Vast numbers of bacteria can be found on the leaves of healthy trees growing near to diseased trees. Although the process of infection is not understood, it is thought that the bacteria enter healthy trees via wounds and leaf scars.

#### ***Diseased stumps***

12. The bacterium may persist at a site even after diseased trees have been cut down and burned. It can survive in diseased stumps for at least 4 years. Laboratory experiments and field observations suggest that the bacteria can spread via root grafts to healthy trees planted within 5 metres of diseased stumps.

### **Control measures**

#### ***Sanitation felling***

13. In the event of an outbreak of watermark disease, the first concern of the grower should be to fell and burn all diseased trees on the site, including wild willows. Burning the diseased material reduces the amount of inoculum and so lessens the chance of further infection.
14. In Essex, Suffolk and Bedfordshire, sanitation felling is controlled by legislation. The Watermark Disease (Local Authorities) Order (1974), as amended, enables the local authority to serve notices on growers to destroy any diseased willows and propagating material. In the rest of Britain the Order is not enforced at the time of writing, but could be extended to cover other counties provided their local authorities conform to the directives as issued by the Forestry Commission.
15. In the absence of a sanitation order, growers are recommended to carry out a thorough, annual inspection of their trees between May and October, when the external symptoms are visible. If the disease is thought to be present in wild or amenity willows, the local authority should be consulted prior to felling. Growers with stool beds should also inspect the cut stool surfaces when sets are harvested. Sets and stools with symptoms should be destroyed by burning.

#### ***Cut stump treatment***

16. Two measures are recommended to prevent root grafts forming between diseased stumps and replacement trees:
  - Never plant replacement sets next to untreated diseased stumps.

- Immediately on felling a diseased tree, treat the stump with a suitable herbicide to kill the stem and roots. Cutting deep channels in the stump with a chainsaw, prior to applications, aids penetration of the herbicide. The following products are recommended for stump treatment: ammonium sulphamate (e.g. Amcide); glyphosate (e.g. Roundup); and triclopyr in diesel oil (e.g. Timbrel). Laboratory tests and field trials show that Amcide and Roundup (laboratory tested only) kill *E. salicis*. Persons requiring up to date information about suppliers should consult *The UK pesticide guide*, published annually by C.A.B International and the British Crop Protection Council. Special care should be taken when these herbicides are used near watercourses and in closely planted stands where translocation via root grafts may occur.

**BEFORE USING A HERBICIDE ALWAYS READ CAREFULLY THE MANUFACTURERS' INSTRUCTIONS ON THE LABEL (INCLUDING ANY ACCOMPANYING LEAFLET) AND APPLY THE CHEMICAL FOR THE USE, AT THE RATE AND BY THE METHOD RECOMMENDED PAYING PARTICULAR ATTENTION TO ASPECTS OF SAFETY.**

#### ***Disease-free propagating material***

17. Inspection for visual symptoms is regularly conducted on the stool beds in Essex and Suffolk, where about 80% of cricket bat willow supplied to British growers is propagated. The disease status of stool beds grown elsewhere is not known. In Britain, work is in progress to register stool beds and the sets produced from them as a means of identifying and eliminating infection sources. In due course, sets certified as disease-free may become available as a result of this work.
18. Enquiries and requests for diagnosis should be directed to the Watermark Disease Research Group at the University of East Anglia, or the Forestry Commission, at the addresses given in paragraph 21.

#### **Effect on the timber**

19. In Essex where over 50% of the total cricket bat willow crop in the United Kingdom is grown, less than 0.2% of the trees are affected by watermark disease. However, where the disease persists locally, losses for individual growers can be considerable.
20. The discoloration of willow wood following infection is associated with changes in phenolic compounds in the tissues. Infected wood fractures easily and is not suitable for the manufacture of cricket bats. Merchants negotiate the purchase of diseased cricket bat willow trees in a variety of ways. Commonly trees are valued prior to felling; but in some cases the value is calculated by the number of clefts produced. Trunks with over 30% cross-sectional area stained contain no marketable wood. Trunks with less than 30% area stained yield some clefts as the diseased wood is cut away during cleft production. Often willow merchants will bear the cost of clearing diseased trees as payment for any marketable timber. If the trees have no market value, merchants will charge growers for felling them.

#### **Further advice**

21. Advice on any aspect of watermark disease can be obtained from:

1. The Watermark Disease Research Group  
School of Biological Sciences  
University of East Anglia  
Norwich  
NR4 7TJ

Tel: 0603 56161

2. The Pathology Branch  
Forest Research Station  
Alice Holt Lodge  
Wrecclesham  
Farnham  
Surrey  
GU10 4LH

Tel: 0420 22255

22. Advice on plant health legislation can be obtained from:

The Plant Health Officer  
Forestry Commission  
231 Corstorphine Road  
Edinburgh  
EH12 7AT

Tel: 031 334 0303

Issued by:  
Technical Publications Officer  
Forest Research Station  
Alice Holt Lodge  
Wrecclesham  
Nr Farnham  
Surrey  
GU10 4LH

January 1991

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ISSN 0267 2375

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