



87	2012	
87	90	EXT

Arboriculture Research Note 87

Issued by the Arboricultural Advisory & Information Service

WATERMARK DISEASE OF WILLOWS

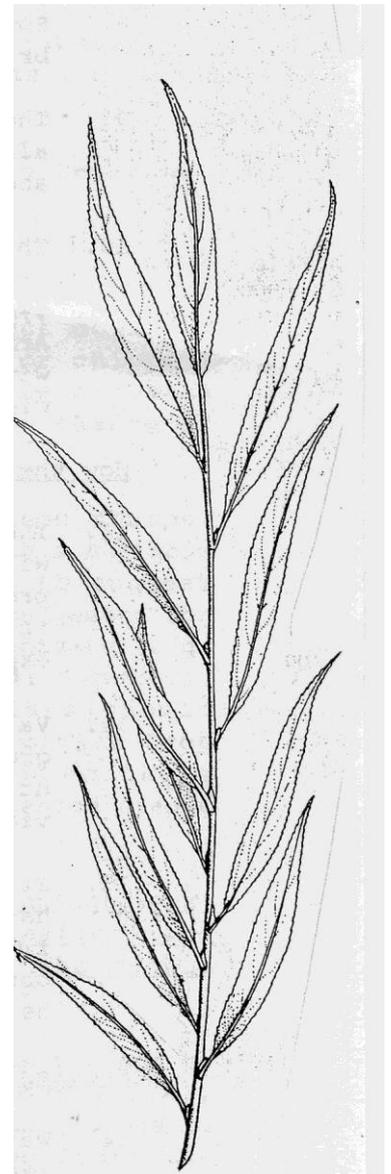
By K.N. Patrick, School of Biological Sciences, University of East Anglia

Summary

Watermark disease is a serious disease of species of amenity, cultivated and wild willows. The distribution, symptoms, species susceptibility, and control of the disease are described.

Introduction

1. The willow in its various species and varieties has an important place in the landscape of Britain, and during the last 20 years has been planted extensively as a quick growing amenity tree. In addition, the Cricket bat willow (*Salix alba* var. *caerulea*), is grown for cricket-bat production in a number of areas, principally within East Anglia.
2. Watermark disease caused by the bacterium *Brenneria* (formally *Erwinia*) *salicis* has been recognised as a serious disease of Cricket bat willow in Britain since 1924. The disease is of wide distribution in the counties of Essex and Suffolk, but also occurs in Bedfordshire, Cambridgeshire, Norfolk, Hertfordshire, Buckinghamshire, Leicestershire and Wiltshire. It has 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 the bacterium causes serious losses to amenity willows. Symptoms have also been reported in Germany.
3. The occurrence of severe and widespread damage amongst amenity plantings in the Netherlands appears to be related to the use of highly susceptible cultivars of *Salix alba* (e.g. 'Liempde') and the absence of effective legislation for disease control. This Note sets out control measures which are necessary to ensure that the disease is kept in check within Great Britain.



Symptoms

4. The first symptoms of Watermark disease often pass without detection. 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 red leaves are visible in May and remain attached to the tree throughout the summer.

5. 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 stem of the tree.
6. The extent of killing varies with site conditions, tree management, host species and age. In some cases, where the disease has been allowed to progress unchecked, entire trees have been killed.
7. When a section is cut from a live branch infected by *B. 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.
8. Sometimes a viscous bacterial slime oozes out from junctions between branches in affected parts of the tree.
9. The symptoms described here are typical of Watermark disease of *S. alba* and its varieties. In other species, differences in growth habit and leaf colour make diagnosis more difficult.
10. The external symptoms of Watermark disease can be confused with the presence of broken branches, which bear foliage with the 'red-leaf' symptom, or dieback due to over maturity, water stress, or infection, by *Armillaria* sp. The internal symptoms of the disease may be confused with discoloration due to attack by a variety of wood-inhabiting micro-organisms.

How the bacterium spreads

11. There is strong circumstantial evidence in the case of Cricket bat willow that the bacterium can be introduced to new sites on propagation material cut from diseased stools. It can remain latent in the wood for many years before the symptoms of the disease are expressed.
12. 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.
13. *Brenneria salicis* often persists at a site even after diseased trees have been cut down and destroyed. It can survive in diseased stumps for at least four years. Laboratory experiments and field observations suggest that the bacteria can spread via root contact to healthy trees planted within five metres of diseased stumps.

Species susceptibility

14. Watermark disease affects trees and shrubs only 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 recorded each year. In contrast fewer than ten diseased trees of other species are found.
15. Watermark disease has been recorded in the following species:

White willow (*S. alba* L.); Cricket bat willow (*S. alba* var. *caerulea*); Golden willow (*S. alba* var. *vitellina*); Crack willow (*S. fragilis*); hybrids of *S. fragilis* x *S. alba*; Goat willow (*S. caprea* L.); Grey willow (*S. cinerea* L.); Purple willow (*S. purpurea*); Almond willow (*S. triandra*). The disease has not been recorded in any other species, and it is not known whether other commonly grown willows such as the common weeping willow and the *babylonica* hybrids are susceptible.

16. Creeping willow (*Salix 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.
17. In the Netherlands Watermark disease seriously affects cultivars of *S. alba* including 'Liempde' (highly susceptible), 'Drakenburg', 'Belders', and 'Lichtenvoorde'. Watermark disease has not been recorded in Dutch cultivars planted in Britain.
18. Further research is needed to identify Watermark disease-resistant species and varieties.

Control

19. No chemical cure exists. Diseased trees should be cut down and burned. Where practicable the roots should be dug out or chipped. The chipping must not be used as mulch. Burning the diseased material reduces the amount of inoculum and so lessens the chance of further infection.
20. Replacement willows should never be planted close to diseased stumps. Large stumps that cannot be removed should be treated with a suitable herbicide to prevent regrowth. There is some evidence to suggest herbicides kill *B. salicis*. The following products are suggested for stump treatment: ammonium sulphamate (withdrawn 2008); glyphosate (e.g. Roundup); and triclopyr in diesel oil (e.g. Garlon 4; Timbrel). Persons requiring up to date information about suppliers should consult the U.K. Pesticide Guide, published by 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.

21. In Essex, Suffolk, and Bedfordshire Watermark disease is subject to 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. The Order can be extended to cover other countries provided their local authorities conform to the directives as issued by the Forestry Commission.
22. Inspection for visual symptoms is regularly conducted on Willow stools in Essex and Suffolk from which Cricket bat willow is propagated, and those in the Netherlands from which amenity willows are propagated. No tests are yet available to determine if latent bacterial infection is present. In Britain, work is in progress to register stool beds and the sets produced from them as means of identifying and eliminating infection sources.
23. Landscape architects and others specifying willows should avoid devoting large areas to susceptible species, particularly in regions with a history of Watermark disease. If the disease does occur in these plantings, replacements should be with trees other than willow. In due course Watermark resistant varieties may become available as a result of screening work being conducted in Belgium.

Enquiries and requests for diagnosis should be directed to Watermark Disease Research Group, School of Biological Sciences, University of East Anglia, Norwich NR4 7TJ.

Acknowledgement

Research on Watermark disease in Britain was initially undertaken at the University of Leeds, under the direction of Dr T F Preece, and in recent years was funded by the Leverhulme Trust and Thomas Phillips Price Trust. The work is now based at the University of East Anglia and is funded by the Cricket Bat Willow Research Group, and association of Cricket bat willow growers.

Suggested Reading

Preece, T.F. (1978). Watermark disease of the Cricket bat willow. *Forestry Commission Leaflet 20*.

Published by:

July 1990

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

Revised with minor amendments December 2012

NOT TO BE REPRODUCED WITHOUT THE PUBLISHER'S PERMISSION

© Crown Copyright 1990

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.