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Phytophthora Disease of Alder

INFORMATION NOTE

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SUMMARY

Phytophthora disease of alder can be found in young woodland plantations and orchard shelterbelts but its greatest impact is on the riparian alders of southern Britain. An annual survey of alders in fixed plots alongside rivers over 8 m wide has been carried out since 1994. This has shown that the incidence of the disease has increased steadily over the years; by 2003 more than 15% of the surveyed trees had been affected or killed by the disease. This Note presents information on the pathogen, on the nature of the disease and on approaches to management and control.

INTRODUCTION

There are four alder species native to Europe: the common alder (*Alnus glutinosa*), the grey alder (*A. incana*), the Italian alder (*A. cordata*) and the green alder (*A. viridis*). In general, members of the genus *Alnus* are pioneer species, able to colonise bare, open ground rapidly and with a great ability to tolerate wet sites. The roots have specialised nodules which fix atmospheric nitrogen as a result of a symbiotic association with the actinomycete *Frankia*. This nitrogen, fixed at rates of 60–400 kg h^{-1} yr^{-1}, is available to both the host tree and to the environment. Common alder in particular has considerable landscape value along waterways; it plays a vital role in riparian ecosystems and the root system helps to stabilise riverbanks.

In 1993 a previously unknown and lethal disease of alder was described in southern Britain (Gibbs, 1995). Initially it was thought to be caused by *Phytophthora cambivora* – a fungus well-known as a pathogen of broadleaved trees but not previously reported from alder. However, it quickly became clear that the pathogen was an entirely new species. Further investigation revealed that the disease was widespread in southern England. Following this discovery, considerable efforts were directed towards characterising the new pathogen, determining the distribution and severity of the disease within the UK, and exploring methods for managing the disease. This Note provides a current assessment of the situation, updating the information presented by Gibbs and Lonsdale (2000). A more detailed record can be found in Forestry Commission Bulletin 126 (Gibbs *et al.*, 2003).

CHARACTERISTICS OF THE DISEASE

From a distance, diseased alders attract attention in mid to late summer because the leaves are frequently abnormally small, yellow and sparse (Figure 1). They often fall prematurely, leaving the branches bare. In a tree with severe crown symptoms, the lower part of the stem is often marked with a black or rusty coloured exudate known as ‘tarry spots’ which can sometimes occur up to 2–3 m from ground level (Figure 2). These spots indicate that the underlying bark is necrotic or dead. Over the next

Figure 1

Affected alder stem showing foliage symptoms typical of Phytophthora disease.

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Figure 2

Base of alder stem showing the tarry spots commonly found with Phytophthora disease.

Figure 3

Italian alder in the remnant of a woodland planting subject to occasional flooding. One tree has recently died from Phytophthora disease.

few years the fine twig structure, the bark and eventually the trunk will break up. However, it is quite common for narrow strips of bark to remain alive and to support a limited growth of new shoots from the trunk and major branches.

The microscopic spores of the alder *Phytophthora* (known as zoospores) are free-swimming in water and therefore probably disperse via river systems as well as in soil. Despite this, it is rare to isolate the pathogen from river water or even from soils around infected alder trees (Brasier, 2003). Experiments have shown that the zoospores are attracted to the fine roots of young alders but these are probably not the main infection sites in nature. Studies of diseased trees have shown that bark killing often begins at the collar (the base of the stem) rather than in the root system (Lonsdale, 2003). Foliar and crown symptoms do not occur until the root collar has been largely girdled. Thus, many years may elapse between infection and the appearance of visible disease in the crowns of affected trees.

Occasionally, trees with severe crown symptoms may recover in subsequent years. This is due to the arrested development of the lesions at the stem base, followed by the development of sufficient live tissues to provide an effective link between root system and crown. Such trees may show basal cankers in the absence of any tarry spots.

Most records of the alder *Phytophthora* have come from the common alder (*A. glutinosa*), but the fungus has also been detected in grey alder (*A. incana*), and Italian alder, (*A. cordata;* Figure 3). Recent work which has compared the relative susceptibility of the three species indicates that *A. glutinosa* is most susceptible to the disease, while *A. incana* is the most resistant. The disease has not been recorded on any other tree genera and experiments on a number of species of common riparian trees have not shown any of them to be susceptible (Brasier and Kirk, 2001).

DISEASE DISTRIBUTION IN THE UK AND EUROPE

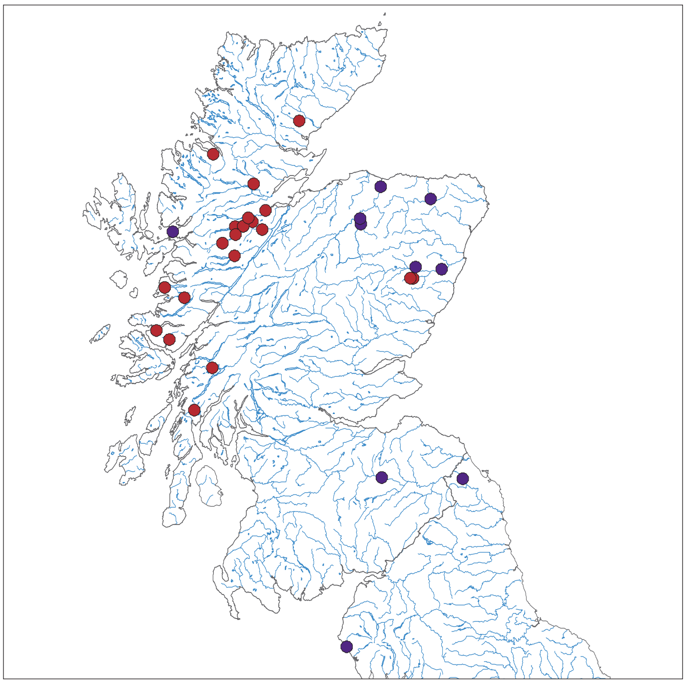
Phytophthora disease is now widespread in Europe and in addition to the UK has been reported from 10 countries: Austria, Belgium, France, Germany, Hungary, Ireland, Italy, Lithuania, The Netherlands and Sweden. Very high losses have occurred in some localities (such as parts of France and Germany) while in others the disease impact has been relatively small.

In the UK it has been known for some years that the disease is present through much of southern England and in parts of Wales (Gibbs *et al.*, 1999). However, until recently it was considered to be present at much lower levels in northern England but reports of the disease from this region are now increasing. For example, it has been recorded on the River Till, a tributary of the River Tweed in the extreme northeast of England (Figure 4).

The disease has also been found at several locations in Scotland, particularly in river catchments in the east of Scotland (Hendry, 2002) on the Rivers Avon, Dee, Deveron, Duirinish and Spey (Figure 4). Phytophthora

Figure 4

Locations in mainland Scotland where Phytophthora disease of alder (blue dots) and alder dieback (red dots) have been found.



disease should not be confused with another disease of native alders that is frequently seen in some parts of Scotland. Alder dieback, which was first observed as long ago as the beginning of the past century, is characterised by the death of aerial parts of the tree alone and not by the root collar and root mortality which occurs in trees affected by the Phytophthora disease. Instead bark lesions occur on branches and commonly coalesce in the parent stem, resulting in girdling and branch and stem death (Gregory *et al.*, 1996). Underlying these lesions the wood is typically stained a dark brown and, on isolation, often yields the Ascomycete fungus *Valsa oxystroma*. This fungus is not a strong pathogen and may only be capable of causing damage to trees subjected to environmental stress. In this respect, the incidence of alder dieback tends to be confined to catchments in the north and west of Scotland, the majority of which can be described as 'spate' systems in which water flow and water levels are inherently volatile. The riparian alders in these areas are likely to encounter greater fluctuations in their environment, and thus be subject to greater environmental stresses than alders growing elsewhere. Such stresses, in addition to local site factors, may contribute to the occurrence of dieback.

The scale of the disease in the UK

The principal information on the scale of the disease comes from a series of riparian plots established in 1994 in the southern half of England and east Wales on rivers over 8 m wide. These plots have now been assessed for 10 successive years and data from them are contained in Table 1. Further analysis of the survey data from 1994 to 1996 can be found in Gibbs *et al.* (1999). The survey is based on alders (maidens or coppice stools) that have at least one stem of 7 cm diameter at breast height. Annual fluctuations in the total number of trees assessed are due to the net effect of recruitment, through growth into the 7 cm size class, and loss, due to activities such as felling or events such as flood. The data show that in 1994 4.3% of the stems that were assessed were diseased or dead, with a small proportion of the dead trees killed by causes other than *Phytophthora*. The percentage of trees affected by *Phytophthora* has increased each year so that by 2003 15.3% of the total was diseased or dead. By extrapolation from the plot data, it is possible to estimate the total number of trees in the survey area. This procedure gives a population of 580 000 trees, of which 63 000 are diseased and 26 000 have died. On average, the disease incidence is highest is southeast England. However, heavy losses are occurring in some of the large alder populations that occur along western rivers – for example, in the Marches.

Scrutiny of the individual plot data reveals considerable variation. For example, in some plots the increase in infected trees has been rapid and all are now diseased, while in others there has been little or no increase in disease levels from 1994 to 2003. The disease tends to be less frequent in trees that are 1–10 m away from the water's edge, indicating a strong negative effect of distance from water. However, in some instances where young seedling alders establish on the exposed soil of the

Table 1 Summary of data from riparian alder plots surveyed each year from 1994–2003.

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Number of trees assessed	1681	1718	1719	1721	1716	1734	1763	1773	1792	1752
Number of diseased trees	51	62	86	101	112	138	164	179	193	189
Number of dead trees	22	28	40	44	54	59	61	66	74	78
% of diseased or dead trees	4.3	5.2	7.3	8.4	9.7	11.4	12.8	13.8	14.9	15.3

river flood plain some distance from the river, many eventually succumb to the disease apparently becoming infected after episodes of flooding.

A few trees have definitely recovered from the disease, i.e. there has been no recent death of bark and the leaves are of a normal size and colour, although they may remain sparse. Such trees show the development of new tissues at the edge of basal stem lesions, as described above. It remains to be seen whether this remission from disease is permanent.

THE PATHOGEN

Soon after the pathogen was first isolated in 1993, it was recognised that it had several unusual properties. This suggested that it was a new species hybrid which had probably originated relatively recently.

Building on a study of the morphological and cultural characteristics of the fungus (see Brasier *et al.*, 1995), molecular analysis has shown that the alder fungus is a hybrid between *P. cambivora* and a fungus close to *P. fragariae* – a pathogen of strawberry (Brasier *et al.*, 1999). It is now spreading across Europe as a hybrid swarm. Some of the hybrid types are locally very damaging, and pose a serious threat to alder and the stability of riparian ecosystems. The standard type of the pathogen has recently been named as *Phytophthora alni* subspecies *alni*, and the different hybrid types or variants are collectively known as *P. alni* subspecies *uniformis* and *P. alni* subspecies *multiformis* (Brasier *et al*., 2004).

Environmental factors may also play a part in the occurrence of the disease and it seems probable that distinct waves of infection can occur, which may be associated with flooding episodes or other disturbance. In 1994 survey data showed a correlation between the level of total oxidised nitrates in a stretch of river and the incidence of *Phytophthora* infection in the adjacent riparian alder (Gibbs *et al.*, 1999), although this has not been repeated since. The reasons for the causal relationship between these two variables is unclear, but sections of river with highest nitrate counts will also be those most exposed to other types of human activity and disturbance. A newly evolved pathogen which is being gradually disseminated around the country, would be likely to appear in much-disturbed rivers before more remote watercourses.

DISEASE MANAGEMENT

It is not recommended that time and resources should be spent in attempts to eliminate the fungus from a site through the felling or winching out of affected trees. These operations cannot be conducted in a sufficiently comprehensive way to be effective. On riparian sites, the disturbance created by this activity, including bringing machinery on site, may even spread the disease by allowing infective spores and fragments of the fungus from diseased trees or soil to come into contact with healthy trees further downstream.

Coppicing

Coppicing encourages the regeneration of new growth, especially if the tree has a diseased root system that can no longer support the entire crown. It also prevents diseased trees from becoming unstable and causing damage to the anchoring riverbank. Ideally, trees should be cut for coppicing 20–30 cm above ground level, leaving a tall stump to develop new shoots under favourable space and light conditions.

Studies on the potential for Phytophthora disease management through the coppicing of affected trees were initiated in summer 1996 when 50 alders, in various stages of disease, were felled along Hadley Brook in Worcestershire. Some stools were either already dead or soon died. However, vigorous coppice growth occurred from the stumps of a number of severely affected trees. The health and vigour of the regrowth has now been assessed over eight years (see Figure 5). Much of it remains healthy, although it is clear that far fewer shoots regenerate from the stumps of diseased trees compared with healthy trees. In some cases apparently healthy trees were probably diseased but not yet showing symptoms prior to coppicing, as the new growth quickly showed signs of disease. However, even stumps cut from trees with entirely dead crowns sometimes resprouted, although the number and vigour of the sprouts were always less than with healthy stumps (Table 2).

Resistance to disease

Experiments involving 15 European provenances of *A. glutinosa* saplings were established in 1996 on sites subject to flooding alongside rivers where many diseased trees could be found (the Rother in West Sussex and the Clun in Shropshire). After four years the disease was apparent in all of the provenances at one or other of the sites and no consistent evidence of variation in resistance was apparent.

Figure 5

Health of regrowth from coppiced trees at Hadley Brooke in Worcestershire: (a) trees coppiced after the entire crown had died; (b) diseased trees after coppicing; (c) healthy trees after coppicing. Dark purple bars indicate stools with only healthy regrowth; grey bars, stools with disease in some or all of the regrowth; light purple bars, dead stools.

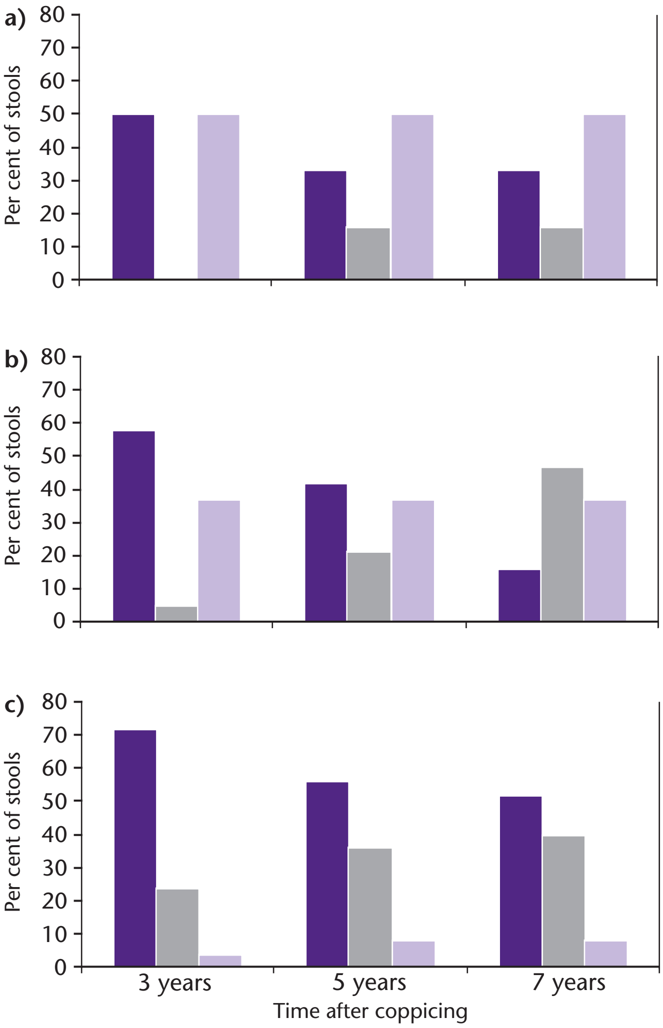


Table 2

Amount of resprouting after coppicing stems of *Alnus glutinosa.*

Condition prior to coppice	Time after coppicing		
	3 years	5 years	7 years
Dead trees (*n*=6)			
Mean number of shoots	3 (1–3)*	1.7 (1–3)	1.7 (1–3)
Mean height of shoots	3.5 m	3.5 m	4.3 m
Diseased trees (*n*=19)			
Mean number of shoots	6.3 (1–9)	6.1 (1–26)	11.5 (1–54)
Mean height of shoots	2.5 m	3.5 m	4.0 m
Healthy trees (*n*=25)			
Mean number of shoots	14.7 (3–40)	14.9 (3–40)	24.6 (3–63)
Mean height of shoots	3.6 m	4.3 m	6.0 m

* Range in the number of shoots on the coppiced stems.

At the Rother site the incidence of disease in each of the 15 provenances ranged from 29% in the Welsh provenance to 59% in an English provenance; at the Clun the disease incidence ranged from 0% (Austrian and Hungarian provenances) to 31% (English). However, the Hungarian and Austrian provenances were only moderately resistant when directly inoculated with *P. alni* (Gibbs, 2003).

PLANTING POLICIES

There is evidence that the pathogen can be disseminated on alder plants which have become infected in the nursery, a common occurrence with other species of *Phytophthora* that affect ornamental nursery stock. Alders could become infected in the nursery either by watering with contaminated river water or through contact with already infected material. In Germany, the alder pathogen has been found in rootstocks of alders from three out of four commercial nurseries that were screened (Jung *et al.*, 2003). In the UK the evidence of nursery involvement is indirect. In one instance, disease in two young woodland plantations had the common feature that both had been planted up with alders supplied by the same nursery: the plants had been imported from Belgium. In addition, the disease has also been found in sites remote from watercourses: in young woodland plantations for example and in orchard shelterbelts. The most likely origin of the disease in those instances is that the trees were already infected in the nursery prior to planting out.

Those who are concerned about the risk of buying infected plants, should evaluate potential suppliers carefully and, if possible, see the growing stock in the nursery prior to purchase to determine that there are no apparent health problems. Partners in a European Union Concerted Action project (FAIR5 CT97 3615) working on disease of alder have suggested that good practice in nurseries should include:

- No irrigation with river water in the nursery.
- At least one growing season inspection of plants to look for symptoms of *Phytophthora* infection.
- Routine disinfection of the nursery before new alder plants are introduced into an area where alder plants have been previously.
- Replanting of alders in ground where diseased alder plants have been growing should not be attempted for three years.

In addition, it is important to know if Phytophthora-controlling fungicides have been applied to plants prior to sale, as these may suppress symptom development in infected plants.

The planting of alder on sites liable to flooding by rivers, on the banks of rivers where diseased alders are known to occur, presents a high risk. While alder is often the most suitable genus for a variety of reasons, owners should take account of the threat of disease and consider other flood-tolerant species, such as willow, as replacements or in mixture.

Special care should be taken not to introduce the fungus to remote riparian sites. Instead, natural regeneration of alder from seed should be encouraged as it occurs readily although the young plants may need to be protected with a stock-proof enclosure.

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