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Poplar Rust and its Recent Impact in Great Britain

INFORMATION NOTE

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SUMMARY

- Vigorous poplar hybrids represent a valuable resource in lowland Britain, for timber production and potentially also for short rotation coppice (SRC) as a source of renewable energy. Young poplar plantations, including close-spaced single stem plantations and some short rotation coppice, have been seriously affected by leaf-rust (*Melampsora larici-populina*) at some sites, mainly in south-west Britain, between 1996 and 1998. In the worst cases this has resulted in die-back and even death of coppice stools.
- Most of the poplars on the approved list (Forest Reproductive Material Regulations, 1977) are clonal, so that individuals of a given variety (e.g. 'Beaupré') all have the same susceptibility to rust. Previously resistant clones are now affected by new pathotypes ('races') of the rust which appeared in the 1990s.
- Of the varieties approved in 1989 for wood production, 'Boelare' and 'Beaupré' have proved the most susceptible to rust. 'Boelare' has now been removed from the approved list altogether and 'Beaupré' is no longer recommended for use in SRC, where the close packed foliage produces a microclimate favourable to the rust fungus. The risk to widely spaced stands is much lower.
- The formerly resistant varieties 'Hoogvorst' and 'Hazendans' were added to the approved list in 1999 but they have proved to be too susceptible to rust to be recommended for SRC use. So far, they have suffered little damage when grown at wide spacing.
- There is no pesticide approved for use against poplar rust in UK woodlands (including short rotation coppice plantations).
- The main strategy for control is to plant the greatest possible variety of genetic material. This can be achieved by planting mosaics of small varietal blocks, or by mixing the varieties intimately. At close spacing, there is a danger of adverse competition among varieties with different growth rates, but suppression of one variety by another can be avoided through thinning and pruning.
- In the medium term, the variety of genetic material available for planting needs to be widened. A number of varieties are already available for testing, and further material will come forward from continental breeding programmes.

INTRODUCTION

1. Poplar rust is easily recognised by the masses of yellow or orange fungal spores that cover the leaf surface in summer, mainly on the underside. After a few weeks, the leaves blacken, curl up and fall prematurely. The fungus passes through subsequent stages of its life cycle on an alternate host. In the case of *Melampsora larici-populina*, which is the rust fungus of principal concern in Britain, the alternate host is larch (*Larix* spp.) but it is believed by some biologists that Douglas fir (*Pseudotsuga menziesii*) is another alternate host. Larch needles become infected during the following spring by spores which are released from overwintering structures on the fallen poplar leaves. Fresh infection of poplar occurs during the summer.

2. Apart from a reduction in growth due to foliage loss, there is sometimes a failure of the current year's shoot to mature properly. Delayed or imperfect maturation can lead to a dieback of the shoot some time before the following season's growth. If infected shoots are used as sets or cuttings, they may die back or fail after planting out.

3. Occasionally, older wood may also die back, even to the extent that the entire plant may die. Dieback is often aggravated by cold or by opportunistic shoot-killing

fungi such as *Cryptodiaporthe* and *Cytospora*. These can also induce cankers on the surviving portions of the shoot.

4. For most of the 20th century, the worst manifestations of rust damage; i.e. severe loss of yield or the dieback of trees were experienced rarely in Britain, compared to continental Europe. The reason for this is thought to have been a tendency for epidemics in Britain to start later in the summer.

5. Disease resistance in poplar was one of the most important considerations in the breeding of the 'UNAL' varieties in Belgium. Resistance to rust was considered to be of particular importance, as it had been known to cause severe losses in yield and even the death of trees. The six Belgian varieties that were registered for commercial use in the UK in 1989 were at that time totally resistant to attack by all known 'pathotypes' of *M. larici-populina*. (A pathotype, sometimes known as a 'race', is a genetic variant which can attack a particular range of genetic variants in the host species).

6. Total resistance to rust in poplars, as in most other plants, is usually based on single genes (major genes). This form of resistance tends to be unstable, as it can be overcome by new or previously rare pathotypes of the fungus. Partial resistance and tolerance are more stable attributes, but are more difficult to incorporate through breeding programmes.

7. Each time that a new rust pathotype emerges, a number of previously resistant varieties become susceptible, but it is usual for some of them to retain enough partial resistance or tolerance to produce acceptable crops, despite repeated infection. It was this kind of 'horizontal resistance' that prompted the addition of a further two UNAL varieties to the approved list in Britain, these being the two *Populus trichocarpa* varieties, 'Columbia River' and 'Trichobel'.

RECENT CHANGES IN THE IMPACT OF POPLAR RUST

8. A previously unknown pathotype of *M. larici-populina* ('E4') was detected on the European continent and in the UK in 1994 and proved able to infect all commercially available varieties that had previously been totally resistant. Research workers in France and Belgium found that another pathotype with a slightly narrower range of varietal hosts was often present together with E4. It was at first tentatively called 'E5', but the two together are now regarded as the 'E4 complex'. The build-up of these new pathotypes led to the occurrence of heavy rust infection on the widely grown varieties 'Boelare' and 'Beaupré' in several crops across England and Wales in 1996. In 1997, infection was widespread across much of Britain. A further pathotype, now referred to as E5, emerged in the late 1990s and proved able to infect some varieties, then still under test, which had remained resistant until then.

9. The varieties worst affected in 1996 and 1997 were 'Boelare' and 'Beaupré', with 'Boelare' being the less tolerant of the two. It is now clear that these varieties are less tolerant than 'Ghoy', 'Gaver', 'Gibecq', 'Fritzi Pauley' and 'Trichobel'. The complete or single-gene resistance exhibited by the previously resistant varieties prevented any assessment of underlying partial resistance or tolerance.

10. Poplar rust in Britain has rarely if ever killed trees in the past, but severe attack by pathotype E4, followed by cold-induced dieback, led to the deaths of stools of the varieties 'Beaupré' and 'Boelare' in some short rotation coppice crops in south-west England from 1996 onwards. Isolated instances of mortality in single-stem plantations at close spacing have also been observed in the west of England and in Perthshire. In these instances, the environment of the close-spaced crop probably contributed to the severity of the rust attack, due to the rapid epidemic build-up that can occur in the micro-climate produced by dense low-level foliage. For the most part, this involved the dieback of the current year's growth, but there were some instances in which whole coppice stools, including two-year-old wood, died. Single-stem tree crops of the same varieties are usually less affected. The severity of damage to 'Boelare' in the worst cases was, however, considered sufficient for the removal of this variety from the approved list (Tabbush and Lonsdale, 1999; Tabbush and Parfitt, 1999).

11. From 1996 onwards, infection in some parts of Britain may have begun earlier than previously observed. If the photosynthetic area is depleted as early as the beginning of August, infection is much more likely to lead to loss of winter hardiness and to the development of secondary pathogens. In the worst cases, this can lead to total crop failure.

12. Earlier infection could be the result of an increase in the number of foci of infection as more land is planted with poplar, especially within the vicinity of larch and perhaps Douglas fir. Poplar spores blown from larch trees infect poplar early in the growing season, so that fungus has the entire summer in which build up very heavily. If infection does not occur via larch, it can begin only when spores are blown from other poplar stands. This tends to happen in late summer, when there is less time for disease build-up and when the poplars have already produced considerable growth and carbohydrate reserves. Indeed it seems likely that the late onset of outbreaks in the UK until recent years was due to the rarity of 'first generation' sources of infection via alternate hosts.

DISEASE MANAGEMENT

13. Where dieback or death has already occurred, management decisions will have to be taken on a case-by-case basis. The severity of further outbreaks can often be reduced by thinning and high pruning; as this makes conditions less sheltered and humid, it should help to create a micro-climate which is less conducive to the rapid build-up of rust. If there are alternate hosts nearby, the removal of prunings and leaf litter from the poplar stand might reduce the overwintering of the fungus and thereby prevent infection of the alternate host and ultimate transmission to the poplar. This measure cannot, however, be unequivocally recommended, as it is unlikely to be practicable on many sites and can also have a detrimental effect on soil fertility and structure. As a general measure, it is better to avoid close proximity between poplar crops and the main alternate host, *Larix* spp. There is no absolutely 'safe' distance from larch, but the risk of early and severe infection is very high within 150 m and much lower beyond 500 m.

14. Since the future prevalence of rust cannot be predicted, the use of the more susceptible varieties for new planting needs to be regarded with caution. 'Boelare' is no longer approved in new plantings for wood production or for SRC use. Additionally, 'Beaupré', 'Hoogvorst' and 'Hazendans' should not be used in SRC plantings.

15. Some of the varieties which are quite susceptible to the older pathotypes of *M. larici-populina* (E1, E2 and E3) seem to have become rather less affected now that E4 is often dominant. 'Raspalje' has been added to the list of approved varieties for this reason (Tabbush and Lonsdale, 1999).

16. Two new varieties, 'Hoogvorst' and 'Hazendans', are resistant to pathotype E4 and are now available in the UK. They are, however, susceptible to E5, which emerged in the late 1990s, and which affected them severely in a short rotation coppice trial in the south-west of England. Nevertheless, they have been only moderately affected when planted for timber production at wide spacing and have thus maintained better growth than 'Beaupré' and 'Boelare' under similar conditions. Good partial resistance or tolerance to rust, rather than total resistance, has been the main criterion in the preliminary selection of new varieties that are currently being evaluated. If successful, some of these could be approved within the next two to three years.

17. There is no pesticide approved for use against poplar rust in UK woodlands (including short rotation coppice plantations). Trials elsewhere in Europe have indicated that partial but economically acceptable control can be achieved by one or two annual applications of a fungicide with curative and persistent properties. However, were these materials to be approved for UK use, chemical control would remain expensive, sometimes physically impracticable and in many cases environmentally undesirable.

18. The main strategy for control is to plant the greatest practicable array of genetic material. The currently approved *P. trichocarpa* x *P. deltoides* varieties, such as 'Beaupré', can be usefully included in single-stem plantings. It is, however, advisable to use them together with *P. deltoides* x *P. nigra* varieties such as 'Ghoy', 'Gaver' and 'Gibecq', which tend to be somewhat more resistant to infection and tolerant to disease. Genetic diversity can be achieved by planting mosaics of small varietal blocks, or by mixing the varieties intimately. At close spacing, however, there is a danger of adverse competition among varieties with different growth rates. Selective thinning and pruning could reduce such a problem but is unlikely to be economically worthwhile, as the produce from small-diameter thinnings is of value only for niche markets.

19. The severe outbreaks of rust that started in 1996 caused understandable concern among growers. However, despite the increased impact of rust on yield, UK plantings of single-stem poplars have generally shown very little dieback, except when near

larch or when grown at close spacing. (The advised spacing is initially not less than 4 x 2 m, increasing through thinnings to a final distance of 8 x 8 m). Even in these isolated cases, dieback or serious loss of growth has been largely confined to highly susceptible varieties, such as 'Beaupré' and 'Boelare'. If a range of varieties is chosen and if close spacing and proximity to larch are avoided, the planting of single-stem stands remains economically worthwhile. The prospects for SRC poplars are less good, owing to the rust-conducive conditions in close spacing. Willows currently offer a wider choice of varieties suitable for SRC (Tabbush, Parfitt & Tubby, in press) but it is worth noting that the *P. trichocarpa* variety 'Trichobel' has out-performed fast-growing willow varieties at several sites across Britain, even when affected by rust.

20. The narrow genetic base of the varieties that were registered in 1989 remains a general cause for concern. The long-term future of poplar can only be secured through a breeding programme which seeks to widen the genetic base of material available, selects for good partial resistance and tolerance rather than total resistance, and produces a sustained flow of new material.

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