

Advice on Replanting Sites Affected by *Phytophthora ramorum*

The most significant plant species in the life cycle of *Phytophthora ramorum* are those that support spore production; these spores are mainly if not exclusively produced on infected leaves or green shoots. In Britain, the key plant species which act as these 'sporulating hosts' and produce abundant spores from infected foliage are: rhododendron and larch, especially Japanese larch. A few other tree species, most notably holm oak, ash and sweet chestnut, also have foliage that is moderately or very susceptible to infection by *P. ramorum* and can generate significant numbers of spores once infected. Even so, the spore quantities produced from these species tend to be lower than from Japanese larch and rhododendron.

Once these major sporulating hosts are removed from an infected site, residual spores of *P. ramorum* are likely to remain in the leaf litter and soil, but the quantity will gradually diminish over time. Available scientific evidence (based on monitoring sites after the removal of infected rhododendron) suggests this residual inoculum is unlikely to pose an infection risk to species planted on cleared sites, unless they have susceptible foliage, which may be readily infected by whatever spores remain. Also, if the infected foliage then generates high numbers of spores, it creates the potential for a new epidemic of *P. ramorum* to build up on a site and start to affect other trees with susceptible bark, thus becoming the more damaging and lethal form of the disease. There may be an additional risk when replanting some tree species with very susceptible bark if they are planted on sites where infected larch has been cleared but considerable amounts of brash remain, potentially bringing infected larch material into close contact with the bark on stems of young trees. Field observations suggest that bark on stems and branches of young trees of Douglas fir and western hemlock may be especially susceptible to infection by *P. ramorum*.

Species choice

Consideration of what and when to plant on affected but cleared sites is a critical issue. Generally, replanting with a *P. ramorum* susceptible host species is not recommended for 3 years after infected plants have been cleared from an affected area such as a garden or park, but this may not be realistic when restocking with tree species in woodlands and forests. *P. ramorum* also has a wide host range, and many tree species have at least some susceptibility to the pathogen, although species of low or moderate susceptibility are only likely to succumb to infection when close (within 100m) to the heaviest 'sporulator' hosts.

Replanting recommendations

Therefore, advice on what tree species to replant with needs to take account of their bark and foliar susceptibility, the potential to act as a sporulating host should the foliage become infected, as well as the levels of residual contamination remaining on sites after removal of sporulating plants. This information for both conifer and broadleaf species along with advice on whether to replant or not is presented in Tables 1 and 2 below. The data on susceptibility comes from various sources, but primarily from:

- Field assessments and laboratory tests undertaken by pathologists at Forest Research.
- The EU FP6 project Risk Assessment of *Phytophthora ramorum*, which via its website has North American and European records of naturally infected hosts as well as host susceptibility testing on 100s of plant species (see <http://rapra.csl.gov.uk/>).

Replanting recommendations

Table 1: Planting recommendations for conifers on *Phytophthora ramorum* affected sites

| Tree species | Known to be a natural host of <i>Phytophthora ramorum</i> | | Laboratory host of <i>Phytophthora ramorum</i> | | Sporulation on foliage | Planting recommendation |
|---------------------------------|---|------------------|--|---------------|------------------------|-------------------------|
| | Bark | Leaves/shoots | Bark | Leaves/shoots | | |
| <i>Abies grandis</i> | Yes (+) | Yes (+) | Yes (+) | Yes (++) | Low, none | Plant with caution |
| <i>Chamaecyparis lawsoniana</i> | Yes ¹ | No | Yes | No data | No data | Can be planted |
| <i>Larix europea</i> | Yes (+) | No | Under investigation | Yes (+) | Moderate | Avoid planting |
| <i>Larix kaempferi</i> | Yes (+++) | Yes (++) | Under investigation | Yes (++) | Very high | Avoid planting |
| <i>Larix hybrid</i> | Yes (+) | No | Under investigation | Yes (+) | Moderate | Avoid planting |
| <i>Picea abies</i> | No | No | Yes (++) | Yes (+) | No data | Can be planted |
| <i>Picea sitchensis</i> | Under study | Yes ¹ | Yes (++) | Yes (+) | No data | Can be planted |
| <i>Pinus sylvestris</i> | No | No | Resistant | Resistant | No data | Can be planted |
| <i>Pinus contorta</i> | No | No | Yes (+) | Resistant | No data | Can be planted |
| <i>Pinus nigra var larici</i> | No | No | Resistant | Resistant | No data | Can be planted |
| <i>Pseudotsuga mensiezii</i> | Yes (++) | Yes | Yes (++) | Yes (+++) | Low, none | Plant with caution |
| <i>Taxus baccata</i> | No | Yes (+) | Yes (+) | Yes (+) | Low | Can be planted |
| <i>Thuja plicata</i> | No | No | Yes (+) | Resistant | No data | Can be planted |
| <i>Tsuga heterophylla</i> | Yes | Yes | Yes (++) | Yes (+) | No data | Plant with caution |

¹ Indicates very uncommon; + very low/low level of susceptibility; ++ moderate susceptibility; +++ high susceptibility

Replanting recommendations

Table 2: Planting recommendations for broadleaf species on *Phytophthora ramorum* affected sites

| Tree species | Natural host of <i>Phytophthora ramorum</i> | | Laboratory host of <i>Phytophthora ramorum</i> | | Sporulation on foliage | Planting recommendation |
|-------------------------------|---|-----------------------|--|---------------|------------------------|-------------------------|
| | Bark | Leaves/shoots | Bark | Leaves/shoots | | |
| <i>Acer campestre</i> | No | No | Yes (+++) | Resistant | No data | Can be planted |
| <i>Acer pseudoplatanus</i> | Yes ¹ | No | Yes (+) | Yes (+) | Moderate | Can be planted |
| <i>Aesculus hippocastanum</i> | Yes ¹ | Yes | Yes (+) | Yes (++) | Low-moderate | Can be planted |
| <i>Alnus glutinosa</i> | No | No | Yes (+) | Yes (+) | No data | Can be planted |
| <i>Betula pendula</i> | Yes (+) | No | Yes (+) | Yes (+) | No data | Can be planted |
| <i>Betula pubescens</i> | No | No | Yes (+) | No data | No data | Can be planted |
| <i>Catanea sativa</i> | Yes (++) | Yes (+++) | Yes (++) | Yes (++) | Moderate | Plant with caution |
| <i>Carpinus betulus</i> | No | No | Resistant | Yes (+) | No data | Can be planted |
| <i>Corylus avellana</i> | No | No | Yes (+) | Resistant | Low | Can be planted |
| <i>Fagus sylvatica</i> | Yes (+++) | Yes (+) | Yes (+++) | Resistant | No | Plant with caution |
| <i>Fraxinus excelsior</i> | No | Yes (++) ¹ | Resistant | Yes (+++) | Moderate | Plant with caution |
| <i>Ilex aquifolium</i> | No | Yes | Yes (+) | Yes (+) | No data | Can be planted |
| <i>Nothofagus obliqua</i> | Yes (+++) | No | Yes (+++) | No data | No data | Plant with caution |
| <i>Nothofagus procera</i> | No | No | Yes | No data | No data | Plant with caution |
| <i>Prunus avium</i> | No | No | Yes (+) | Resistant | No data | Can be planted |

Replanting recommendations

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|------------------------|----------|----------|-----------|-----------|----------|--------------------|
| <i>Quercus cerris</i> | Yes (++) | Yes (+) | Yes (++) | Yes (++) | Moderate | Plant with caution |
| <i>Quercus ilex</i> | No | Yes (++) | Yes (++) | Yes (+++) | High | Plant with caution |
| <i>Quercus petraea</i> | Yes (+) | No | Yes (+) | Yes (++) | Moderate | Can be planted |
| <i>Quercus robur</i> | Yes (+) | No | Yes (+) | Yes (+) | Moderate | Can be planted |
| <i>Salix alba</i> | No | No | Yes (+) | Yes (+++) | No data | Plant with caution |
| <i>Salix caprea</i> | No | Yes (+) | No data | Yes (+) | No data | Can be planted |
| <i>Tilia cordata</i> | No | No | Resistant | Yes (++) | No data | Can be planted |

¹ Indicates very uncommon; + very low/low level of susceptibility; ++ moderate susceptibility; +++ high susceptibility