

**Contingency plan for  
Pitch Canker of Pine  
(*Fusarium circinatum*)**

## **INTRODUCTION**

1. Serious or significant pests require strategic-level plans developed at a national level, describing the overall aim and high-level objectives to be achieved, and setting out the response strategy to either eradicate or contain the outbreaks.
2. Following identification by the UK Plant Health Risk Register, the Plant Health Risk Group (PHRG) has commissioned pest-specific contingency plans for those pests which pose the greatest risk and require stakeholder consultation, including *Fusarium circinatum*.
3. The purpose of pest-specific contingency plans is to ensure rapid and effective responses to outbreaks of the pests or diseases described.
4. Contingency planning starts with the anticipation and assessment of potential threats, includes preparation and response, and finishes with recovery.

### **Anticipation**

5. Researching sources of information and intelligence about the pest, including surveillance and horizon scanning.

### **Assessment**

6. Identifying concerns and the preparation of plans.
7. Setting outbreak objectives.

### **Preparation**

8. Ensuring staff and stakeholders are familiar with the pest.

### **Response**

9. Implementing the requirements to either contain or eradicate, including work to determine success.

### **Recovery**

10. Identifying when the response strategy has been effective, or when the response is not considered feasible, cost effective or beneficial.
11. The Defra Contingency Plan for Plant Health in England (in draft 2016) gives details of the teams and organisations involved in pest and disease response

in England, and their responsibilities and governance. It also describes how these teams and organisations will work together in the event of an outbreak of a plant health pest.

## **INTRODUCTION**

The purpose of pest-specific contingency plans is to ensure rapid and effective response to outbreaks of the pests or diseases described, in this case *Fusarium circinatum*, which causes the disease pitch canker of pine. It is designed to help government agencies anticipate, assess, prepare for, prevent, respond to and recover from pest outbreaks.

### **Scope**

This contingency plan was prepared by the Forestry Commission's cross-border Plant Health Service to be used at country and national levels. It should be used in England in conjunction with the Defra Plant Health Contingency Plan, which was developed by Defra/Fera Science Ltd/APHA, and which provides details as to the level of response required and by whom, depending on the scenario. Forestry Commission England's Forest Services will use OGB17b 'Managing Incidents in the Forestry Commission' for relevant incidents. The Scottish Government (with Forestry Commission Scotland) and the Welsh Government will develop similar documents detailing their management of outbreaks. When an outbreak becomes of UK or Great Britain-wide concern, the UK Chief Plant Health Officer will form an outbreak management team to co-ordinate the activities in the different countries.

This contingency plan falls into three main parts:

- official action following a presumptive diagnosis;
- official action following the confirmation of an outbreak; and
- background information about the pest.

This plan will be updated following new information, lessons identified from outbreaks of other pests, or changes in policy or contact details. (It was last updated in October 2016).

## Objectives of this plan

- To raise awareness of the potential threats posed by *F. circinatum*, and therefore ensure that stakeholders are aware of the symptoms it causes.
- To provide guidance on steps to be taken whenever symptoms of *F. circinatum* are observed.
- To ensure that disease outbreaks caused by *F. circinatum* are managed promptly, with the aim of eradicating pioneer populations of this pathogen.
- To ensure that all relevant staff of the Forestry Commission, other government agencies, and local authorities are conversant with the contents of this contingency plan so that effective and immediate action is implemented.
- To ensure that good communications are put in place so that all stakeholders (including the media) are kept fully informed of the scale of infestation, at regional and national levels.

## Anticipation and Assessment

- 1.1. *Fusarium circinatum* Nirenberg & O'Donnell (Ascomycota: Hypocreales) is a fungal pathogen which causes a disease commonly known as pitch canker of pine and mainly affects *Pinus* (pine) species, but also Douglas fir.
- 1.2. It is considered native to North America, where it occupies a wide range of ecological and climatic situations. It is an introduced pathogen in many other parts of the world, including France and Italy (where it is now considered to have been eradicated), Portugal and Spain.
- 1.3. Pitch canker of pine is a significant disease of pine trees, and has been described by the European Food Safety Authority (EFSA) as 'one of the most devastating diseases in the world to affect pine'.
- 1.4. In 2002 it was added to the EPPO [A2](#) list of quarantine pests with potential to cause extensive damage if introduced. In 2007 it became subject to European Union (EU) Emergency Measures (EC Decision 2007/433/EC) to

prevent the introduction into, and the spread within, the European Union, and is considered an EU quarantine pest (2014/78/EU).

1.5. It is officially absent from the UK. In terms of climatic suitability the UK is seen mainly as unsuitable for the establishment of *F. circinatum*, apart from parts of the south-east of England, which have marginal suitability (EFSA PRA).

## Preparation

2.1. The EFSA has conducted a Pest Risk Analysis (PRA). Outbreaks of the organism have been reported in the EU (in Spain, Italy, France and Portugal).

2.2 According to the CLIMEX analysis (EFSA PRA), and considering all the areas where host plants are grown in the European Union, the endangered areas include:

- wide areas of central and northern Portugal;
- northern and eastern Spain;
- southern and coastal areas of France;
- coastal areas of Italy; and
- parts of the coastal areas of Greece.

2.2. *F. circinatum* is listed on the UK Plant Health Risk Register with an unmitigated risk rating high of 75/125, and a mitigated risk rating low of 50/125. Current mitigations listed on the register are regulation, preparation of a contingency plan, and surveillance. Plants for planting have been identified as the major risk pathway.

2.3. Although *F. circinatum* is not a UK Protected Zone species, the UK has Protected Zone status for imports of conifers in relation to conifer bark beetles.

2.4. In addition, as part of measures required by EC decision 2007/433/EC, an annual survey of *P. radiata* (considered to be the most susceptible pine species) is carried out in what is considered to be the most climatically

suitable areas for *F. circinatum* England and Wales for presence of *F. circinatum*. (The survey is not conducted in Scotland because there are no *P. radiata* stands there, and the climate is not as suitable.)

## Legislation

2.5. A list of the legislation which might be relevant in a *F. circinatum* outbreak is given in Appendix 3.

## Response

### Trigger

3.1. The key indicators which would trigger a response are findings or reports of:

- the presence of an infected tree in a nursery;
- the presence of an infected tree in the wider environment; or
- the presence of the disease in a consignment of imported plants, plant material for decorative purposes (such as Christmas trees and foliage), or seeds.

This can be reported by nursery growers, woodland owners or managers, or members of the public.

## OFFICIAL ACTION FOLLOWING A PRESUMPTIVE DIAGNOSIS

### Communication

3.2. In England, a duty officer from Forestry Commission England or the Animal & Plant Health Agency (APHA) will act as a point of contact for incidents, and it is their job to assign a response officer to incidents when they occur. Similar arrangements are expected to be in place in Scotland and Wales. The response officer investigates and reports back to the Defra Contingency Core Group, which is an 'ad hoc' group put together in response to a notification, and which is usually chaired by the Chief Plant Health Officer. Country teams in Scotland and Wales will fully manage the outbreak in accordance with their own generic contingency plans, but will provide updates to the Defra Contingency Core Group for information purposes and for Defra to report to the European Commission (EC).

- 3.3. The response officer will gather information including the outbreak's location, likely origin, host or commodity, level of damage, extent of outbreak, and risk of spread. The composition of the Contingency Core Group will depend upon the pest or disease in question, and will comprise plant health officials and specialists from the risk group.
- 3.4. Based on the information fed back to it, the Contingency Core Group in England will decide upon the alert status to be given (black, amber or red) to the outbreak, which will determine the level of response (see Appendix 2 for Alert Status Table). In Scotland and Wales, the Core Contingency Group can advise on the alert status and the appropriate response. If required, the Contingency Core Group will request the relevant organisation/s to set up an Incident Management Team to resolve the incident.

### **Holding consignments and movement / planting restrictions**

- 3.5. Until further investigation, and under a containment notice, no material shall leave the site, and local operations associated with tree management will be suspended pending the results of the investigation. The extent of the site will be determined by the incident management team Controller.

### **Preliminary trace forward / trace backward**

- 3.6. The most likely source of entry is the import of seeds, live trees or planting stock, and plant material for decorative purposes from continental Europe, particularly Spain, Italy, France and Portugal.
- 3.7. Depending upon the pathway of entry, tracing forwards and backwards to identify suspect material will be conducted (see para 3.23 below), to identify other potentially contaminated stock or sites. This will include suppliers, propagators and wholesalers, including any clonally related or potentially contaminated stocks, where appropriate.

### **How to survey to determine whether there is an outbreak**

- 3.8. An outbreak of *F. circinatum* is most likely to be detected through specific surveys carried out as part of the annual Protected Zone survey, or during nursery inspections, or following a report from forestry or arboricultural

practitioners, general surveillance by woodland owners or agents, or by members of the public. Detection might also be made during inspections of imported host material.

3.9. If there is evidence of the presence of *F. circinatum*, follow-up inspections or surveys in England by APHA for non-woodland situations, and Forestry Commission England for woodlands, should gather information on:

- likely origin of the disease and, if a consignment of plants or plant products is suspected to be at the origin of the outbreak, details such as other points of destination;
- geographical location and ownership of the affected site, including any abiotic factors which might influence the outbreak, such as public access and/or proximity of similar forest planting. Include maps if possible;
- hosts infested at the site (species, variety, age, proportion of the host in wooded area etc);
- when and how the disease was detected and identified (including photographs of symptoms);
- level of disease incidence;
- extent and impact of damage;
- recent import or movement of host plants or host plant products into and out of the affected site;
- movement of people, products, equipment and vehicles, where appropriate;
- ease of access for machinery on to site;
- relevant treatments applied to host plants which could affect development of symptoms or detection and diagnosis of the pest;
- history of the disease on the site, place of production or in the area; and
- likely biodiversity impacts of any control, including any duty of care obligations under the [Natural Environment and Rural Communities \(NERC\) \(2006\) Act](#).



3.10. Suspect material from infected trees in the wider environment should be either:

- (a) triple wrapped in robust sealed plastic bags; or
- (b) double wrapped in robust sealed plastic bags and the bags placed inside a secure box or vial and sent immediately to the Tree Health Diagnostic & Advisory Service at Forest Research for diagnosis, with an advanced warning . Suspect vectors should be preserved in alcohol and sent in a similar manner. The samples should be accompanied by information about the date when the samples were collected, the location (address, postcode, GPS) and contact details of the person collecting the samples. The address is: Tree Health Diagnostic & Advisory Service, Forest Research, Alice Holt Lodge, Gravel Hill Road, Wrecclesham, Farnham, Surrey, GU10 4LH.

Samples collected from nurseries by APHA's PHSI staff should be sent to Fera Science for analysis.

### **Confirmation of a new outbreak**

3.11. Positive identification of *F. circinatum* can only be conducted in the laboratory using defined diagnostic protocols (EPPO, 2009; Ioos et al., 2009). Where on-site diagnostic systems have been developed, these may be used by a pathologist or a suitably trained and competent plant health officer. Samples should only be removed from the site by trained individuals using safe and appropriate equipment, and operating according to [biosecurity guidelines](#).

## **OFFICIAL ACTION FOLLOWING THE CONFIRMATION OF AN OUTBREAK**

### **Strategic actions on confirmation**

3.12. On positive confirmation the following should be initiated:

- notify Westminster Ministers and senior Defra and Forestry Commission officials;

- set up regular (determined by scale of outbreak) Lead Government Department (LGD) meetings to keep partners aware of the current status, actions and possible future requirements, and to agree a communications strategy;
- notify the Devolved Administrations and the EC; and
- inform and discuss with stakeholders.

## **Incident Management and Communication**

- 3.13. In situations where the outbreak is in woodland, Forestry Commission England will appoint an incident controller and an incident management team. For outbreaks in nurseries, APHA would take the lead in England and Wales. In Wales the Welsh Government, with Natural Resource Wales's support, would take the lead in woodland situations. Forestry Commission England's Forest Services will work to the generic Defra contingency plan (in draft 2016), which will be enacted in response to a confirmed outbreak. Forestry Commission Scotland and the Welsh Government will have similar documents detailing their management of outbreaks.
- 3.14. Initial efforts will be directed towards eradicating new outbreaks following the procedures set out below. Failing eradication, efforts will concentrate on containment.
- 3.15. The incident controller will set up a management structure to deliver the functions of incident management. The outbreak will determine the size and nature of the management structure. Identification of and liaison with key stakeholders is a crucial part of this process. An example list of such stakeholders would include, but not exclusively: ICF, Confor, Scottish Government, Welsh Government, Natural Resources Wales, Environment Agency, Natural England and other members of the Defra Group, SEPA, Forest Research, Woodland Trust, National Trust, Country Land & Business Association, Scottish Land & Estates, Royal Horticultural Society, National Farmers' Unions and local councils.

## Surveillance

3.16. To determine the extent of the outbreak a delimiting survey must be carried out as soon as possible after the first finding of *F. circinatum* to determine the geographical limits of the affected area and to demarcate a regulated area. There are two elements to the delimiting survey:

- an immediate intensive survey of all *Pinus* and Douglas fir trees within at least a 1km radius of confirmed infected tree(s), to inspect them for signs of *F. circinatum* presence; and
- a follow-up survey to identify any infected trees which might have been missed, and to determine the outer extent of the outbreak, which might be beyond 1km.

The public will also be encouraged to look for any symptomatic trees, with resources available on the [Observatree](#) website.

## Demarcated areas

3.17. A statutory regulated area should be established as soon as possible after the discovery of an outbreak of *F. circinatum* to help minimise the spread of the pest within the infected area, and to prevent human-assisted transport to areas outside the infected area.

3.18. [EC Decision 2007/433/EC](#) impose the delineation of demarcated areas, including a buffer zone with a boundary of at least 1km beyond the infected zone. Appropriate measures aimed at eradicating *F. circinatum*, and intensive monitoring for the presence of the organism, must be considered within the demarcated areas.

3.19. An initial regulated area around the infected trees will need to be established, within which measures to prevent the movement of all potentially infected host material should be implemented. These measures should include a prohibition on the movement of untreated host material (including firewood, round and sawn wood, wood chips, waste wood, seeds, foliage, bark and arboricultural arisings). Subsequently, the size of the regulated area might need to be increased, depending on the spread of *F. circinatum*.

3.20. Nurseries within the demarcated area will be inspected for the presence of *F. circinatum*, and will have their authorisation to issue plant passports for *Pinus* and Douglas fir plants suspended until the presence or absence of *F. circinatum* within the nursery and within the demarcated area can be determined.

### **Establishment of demarcated areas**

3.21. In cases where several buffer zones overlap or are geographically close, a wider demarcated area shall be defined which includes the relevant demarcated areas between them.

3.22. If *F. circinatum* is confirmed outside the infected zone, the delimitation of the demarcated area shall be reviewed accordingly.

3.23. If, based on annual surveys, *F. circinatum* is not detected in the demarcated area for at least two consecutive years, the pathogen can be considered to be eradicated and the demarcated area removed.

### **Tracing forwards/backwards**

3.24. If the infected trees have been recently planted, i.e. within the previous two years, the source of the plants must be traced back to the supplying nursery, and the nursery visited and inspected by APHA (in England and Wales) for the presence of *F. circinatum*. In addition, any supplies of *Pinus* and Douglas fir planting material from the nursery over the previous two years should be traced to the final planting site or sites, and inspected for the presence of *F. circinatum*.

### **Pest management procedures**

3.25. Depending on the location of the new outbreak, Statutory Plant Health Notices (SPHNs) will be issued by either the Forestry Commission (in woodland situations) or APHA. Timely issue of and response to these and subsequent actions is vital if new outbreaks are to be contained and eradicated. It should be made clear at the outset that the costs of any remedial actions required will be borne by the landowner. The Forestry Commission or APHA will also need to consider whether direct intervention

by government is required to ensure a rapid response to reduce the risk of spread.

## **Disposal**

- 3.26. Trees, including branches and round wood, which are felled to eradicate *F. circinatum* infections should be destroyed, preferably on site, by chipping and composting (EFSA Journal 2010; 8(6):1620) or by burning as close as possible within the demarcated area designated for this purpose. Burning must comply with appropriate waste management regulations, which are administered by the Environment Agency in England, the Scottish Environment Protection Agency (SEPA) and Natural Resources Wales. No more than 10 tonnes may be burned per 24-hour period: burning more than this will require specific approval from the relevant authority. Gadgil et al. (2003) recommended that all infected trees should be felled. Merchantable logs may be sold to a processing plant within the demarcated area for conversion to products such as pulp or fibre board. Their use as saw logs is not allowed. Branches and other debris must be disposed of by chipping and composting or by burning.
- 3.27. Host plant material for decorative purposes, particularly material used for Christmas trees, should be disposed to a local landfill which buries or composts green waste. Alternatively, it can either be burned or chipped and composted, and then used as mulch, but only if the composting method meets the required phytosanitary standard. (EFSA Journal 2010; 8(6):1620)
- 3.28. In nurseries and Christmas tree farms, the use of seed from a verified source and a country that is known to be free of the disease is of paramount importance. When diseased seedlings or trees are found, they should be uprooted and either burned on site or placed in a sealed plastic bag and transferred to a site or incinerator where they can be burned. Chipping and composting is not recommended as a disposal method within a nursery. This is because of the likely proximity to susceptible plants, and because the pathogen might persist long enough for contaminated soil associated with the composting area to act as a pathway for the pathogen to spread to new areas within the nursery. As much of the root system as possible should be removed. Because the fungus can be associated with

soil, care should be taken not to distribute soil from the removal site to other locations on the nursery or farm. The use of equipment which has recently been moved from an infected site should be avoided unless thoroughly cleaned and disinfected. Because the pathogen might be present in areas where it has not yet been detected, using a high-pressure wash, followed by disinfection, to remove soil before allowing any equipment on site is a good precaution.

- 3.29. It is not recommended that logs and firewood cut in infested areas be moved from the demarcated area. If such logs must be moved, debarking is recommended, because it will reduce the habitat of the vector insects which can carry the pathogen and transmit the disease to healthy trees (CABI 2015, *F. circinata* datasheet). It should be transported, with a protective covering ensuring that all material is contained, to a licensed incinerator. Care should be taken to avoid damaging any susceptible trees in close proximity to the operation. It is critical that all material is safely removed from the site by following biosecurity guidelines. Gadgil et al. (2003) recommended that all infected trees should be felled. Merchantable logs may be sold to an authorised processing plant within the demarcated area for conversion to products such as pulp or fibre board. Their use as saw logs is not allowed. Because the spores can survive in soil, there should be a restriction on movements of potentially contaminated soil (EFSA Journal 2010; 8(6):1620). All equipment used in the felling and disposal process should be thoroughly cleaned and disinfected, along with any personal protection equipment used.
- 3.30. The [EFSA PRA](#) provides more detailed advice on the management of infected areas and the disposal of infected material.

### Public outreach

- 3.31. It is crucial to have public support for the management programme and to help with general surveillance. Engaging the public will require the provision of timely, balanced and accurate information about monitoring and control. It can also provide opportunities for the public to participate in monitoring and reporting suspect trees using the reporting tool [Tree Alert](#). The voluntary tree health surveillance network, [Observatree](#), could also be deployed. Information, subject to available budget, can be made available

through newspapers, radio, TV, publicity materials, the internet, social media, and face-to-face contact. It should be targeted locally, especially within the infected and regulated areas and, where appropriate, regionally and nationally.

3.32. It is important to provide information on the location and size of the infected and regulated areas, statutory and voluntary responsibilities, indications of changing or enlarging distribution, management options, pathways by which the pest might have arrived and could be dispersed, the prospects for GB forestry and the host species more generally, and what people can do to help, especially in terms of monitoring. Managing this level of public engagement will require a central administration office capable of handling a large number of enquiries and able to provide general and specific information. Liaison with communications and press teams from other countries will be required for cross-border outbreaks.

#### **Review measures in the case of prolonged official action**

3.33. Where eradication proves ineffective, efforts should shift to containment, with the focus moving from outbreak management for eradication to a plan for containing the outbreak. If continuing action is required within the demarcated area over a prolonged period, a review of the management programme should be undertaken regularly (e.g. annually) to determine the success and cost effectiveness of the measures in the longer term. This review will involve consultation with stakeholders and should include:

- evaluation of the effectiveness of current measures;
- evaluation of the economic impact and cost effectiveness of continuing existing measures;
- consideration of further measures to strengthen containment and eradication actions;
- consideration of statutory obligations and impact on import and export procedures;
- consideration of alternative approaches or the cessation of statutory action; and
- consideration of the impacts on biodiversity from control methods.

## **Criteria for declaring / change of policy and reviewing the contingency plan**

3.34. This and other contingency plans will be reviewed on an annual basis to accommodate any significant changes in pest/pathogen distribution, dispersal, refinement of surveillance techniques, legislation changes or changes in policy. When and if policy makers in the country or countries affected deem that eradication is no longer a viable option, there will be a move towards containment. The criteria for determining such a break point could be based on a proportion of host species lost, a set number of hectares lost, the number of individual outbreaks, resources needed, or a combination of these. However, this will be determined by the policy makers in the country or countries affected. Further details can be found in the Defra generic contingency plan.

In circumstances where official action is no longer considered appropriate, stakeholders should be consulted and a timetable and mechanism agreed for the removal of official measures and for the dissemination of information on managing the pest as appropriate.

The plan should only be re-consulted upon if significant new information is presented which affects the approach to the management of an outbreak.

## **Recovery**

4.1. A site can be deemed to be in recovery when annual monitoring indicates no presence of the disease for two consecutive years.



## Appendix 1: Pest Background Information

**Source: EPPO datasheet; CABI 2015, *Gibberella circinata* datasheet; EFSA Journal 2010; 8(6):1620.**

*Fusarium circinatum* is the causal agent of pitch canker disease. It almost exclusively affects *Pinus* spp., but Douglas fir (*Pseudotsuga menziesii*) can also be a host. This disease is a serious threat to pine forests wherever it occurs, especially on plantations of *Pinus radiata*, due to extensive tree mortality, reduced growth and timber quality. Multiple branch infection may cause severe crown dieback and eventually lead to the death of the tree. This aggressive fungus may also cryptically infect *Pinus* seeds, and then cause damping-off in seedlings. Conifer seeds can be colonised by *F. circinatum* externally and internally (where it can remain dormant until seed germination), so seeds and plants are both potential pathways for entry.

### Identity of organism and quarantine status

Species name: *Fusarium circinatum* Nirenberg and O'Donnell

Synonyms: *Fusarium subglutinans* f. sp. *pini* Hepting; *F. moniliforme* Sheldon var. *subglutinans* Wollenweber *F. lateritium* f. sp. *pini* Hepting; *Fusarium subglutinans* (Wollenweber & Reinking) Nelson *et al.* f. sp. *pini* Correll *et al.*

Common name: Pitch canker of pine

UK risk register: Unmitigated 75/125; Mitigated 50/125

EPPO status: A2 list

EU status: Present

UK status: Absent

Emergency Measures ([Decision 2007/433/EC](#)) are in place to prevent the introduction into and the spread within the European Union, and it is considered an EU quarantine pest ([2014/78/EU](#)).

There is also an EU COST action on this pathogen [Action FP1406 Factsheet](#).

## Hosts

*F. circinatum* mainly infects *Pinus* spp. In North America, its main native hosts are *P. elliotii*, *P. palustris*, *P. patula*, *P. radiata*, *P. taeda* and *P. virginiana*. It has also been recorded on more than 30 other *Pinus* spp., including the European and Mediterranean species *P. halepensis*, *P. pinaster* and *P. sylvestris*, various North American species planted in Europe such as *P. contorta* and *P. strobus*, and various Asian species (e.g. *P. densiflora* and *P. thunbergii*). There are occasional records on *Pseudotsuga menziesii*, but only associated with limited damage, although it can act as a pathway for spread.

**Disease cycle**

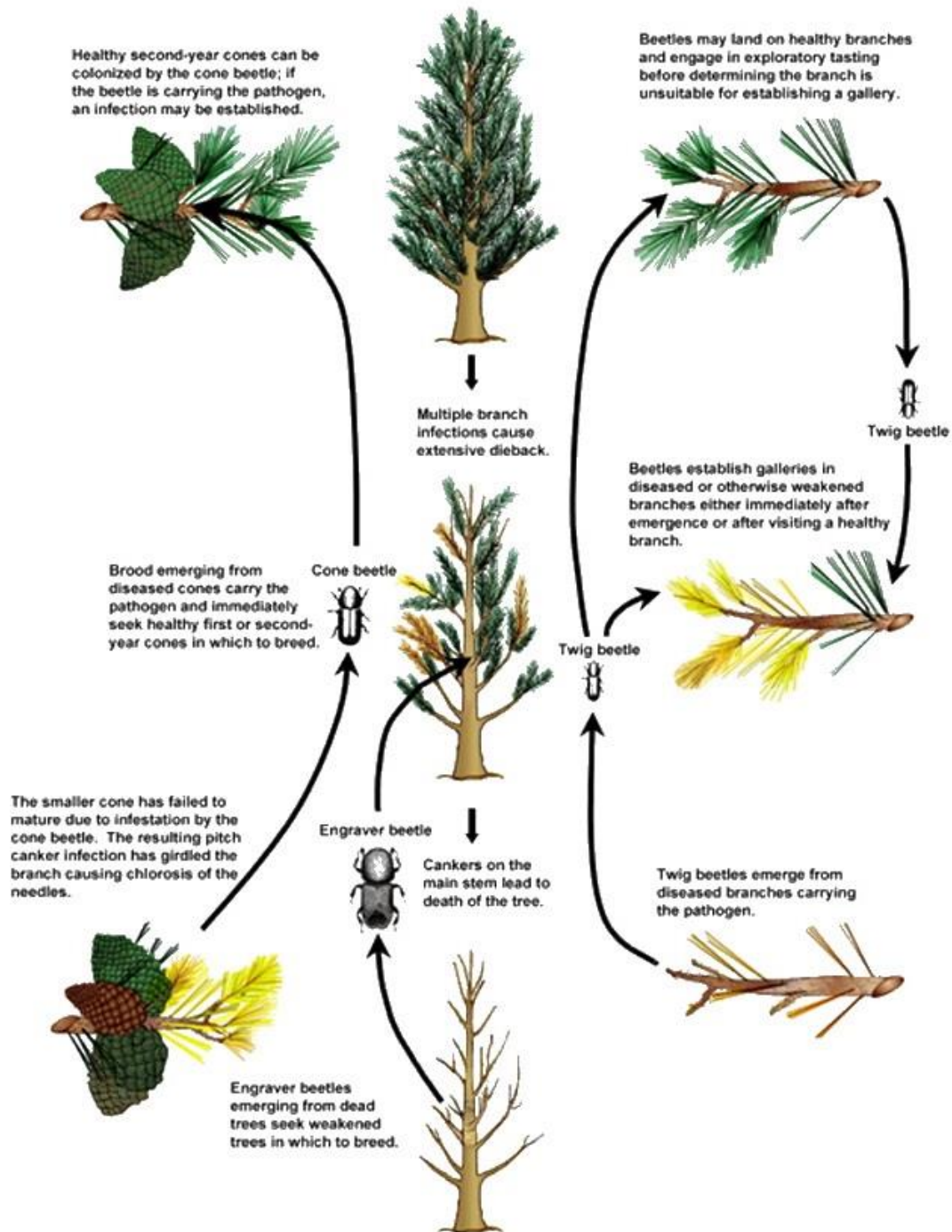


Figure 1 – *Fusarium circinatum* life cycle. Source: Gordon et al (2001), Plant Disease, Vol 85(11): 1128-1139.

Spores produced by *F. circinatum* can be disseminated by the wind or insects. Several pine-associated insects become contaminated by the pathogen whilst breeding in pitch canker-infected branches. Suitable insect vectors include twig beetles (*Pityophthorus* spp.) and engraver beetles (*Ips* spp.). Birds and mammals can also be occasional vectors.

Alternatively, insects and other agents can create wounds which provide entry points for infection if the pathogen spores are already present on host surfaces. The suitability of a wound for infection might depend on how rapidly it dries out, and infections appear to be associated with locations and seasons where atmospheric moisture is readily available and temperatures are relatively warm, such as during summer thunderstorms in the south-eastern United States.

### Identification

The fungus causes cankers which girdle branches, aerial roots and even trunks of *Pinus* species, and these are often associated with conspicuous and sometimes spectacular resin exudates ('pitch') in response to the fungal infection. Symptoms can be observed at any time of the year. *F. circinatum* can also be soil-borne and cause root rot (Coutinho *et al.*, 1997); and it can infect seeds cryptically (Storer *et al.*, 1998).



Figure 2 – Yellowing and reddening of needles on pine affected by *F. circinatum*. Source B. Summerrell, Royal Botanic Gardens NSW, AU.

Infected seedlings show typical damping-off symptoms, but these are not unique to *F. circinatum* infection: needles turn red, brown or chlorotic, and die from the base upwards, or the entire seedling dies.

Root infections are most often observed on seedlings in nurseries, but can also occur on exposed roots of larger trees in landscape plantings. Symptoms on roots include brown discoloration and disintegration of the cortex, but are similar to symptoms caused by other root rot pathogens. Above-ground symptoms do not usually become apparent until the pathogen reaches the crown and girdles the stem, causing yellowing of the foliage. Resin-soaked tissue might be observed after removal of the bark on the lower part of the stem.



Figure 3 – Prolific resin bleeds on mature tree affected by *F. circinatum*. Source R. Cyr, Green tree

Aerial infection symptoms include yellowing of the needles, which turn red in time and finally drop, and dieback of the shoots. Multiple branch tip dieback, due to repeated infections, can lead to significant crown dieback. The female cones on infected branches can also become affected and abort before reaching full size. Thereafter, cankers can appear on the shoots, on the main stems and even on the trunk, associated with resin bleeding. However, symptoms in older trees can be mistaken for those caused by *Sphaeropsis sapinea* (Fr.) Dyco & Sutton (synonym *Diplodia pinea*), so the diagnosis should be based on laboratory testing. Sometimes, the resin bleeding can coat the trunk and lower branches for several metres below the infection level. The stem cankers are flat or slightly sunken, and sometimes affect large surfaces of cortical and subcortical tissue of the trunk. Removal of the bark shows subcortical lesions with brown and resin-impregnated tissues.



Figure 4 – Canker formed by *F. circinatum* on *P. radiata*. Source R. Anderson, USDA Forest Service.

## Distribution of the organism

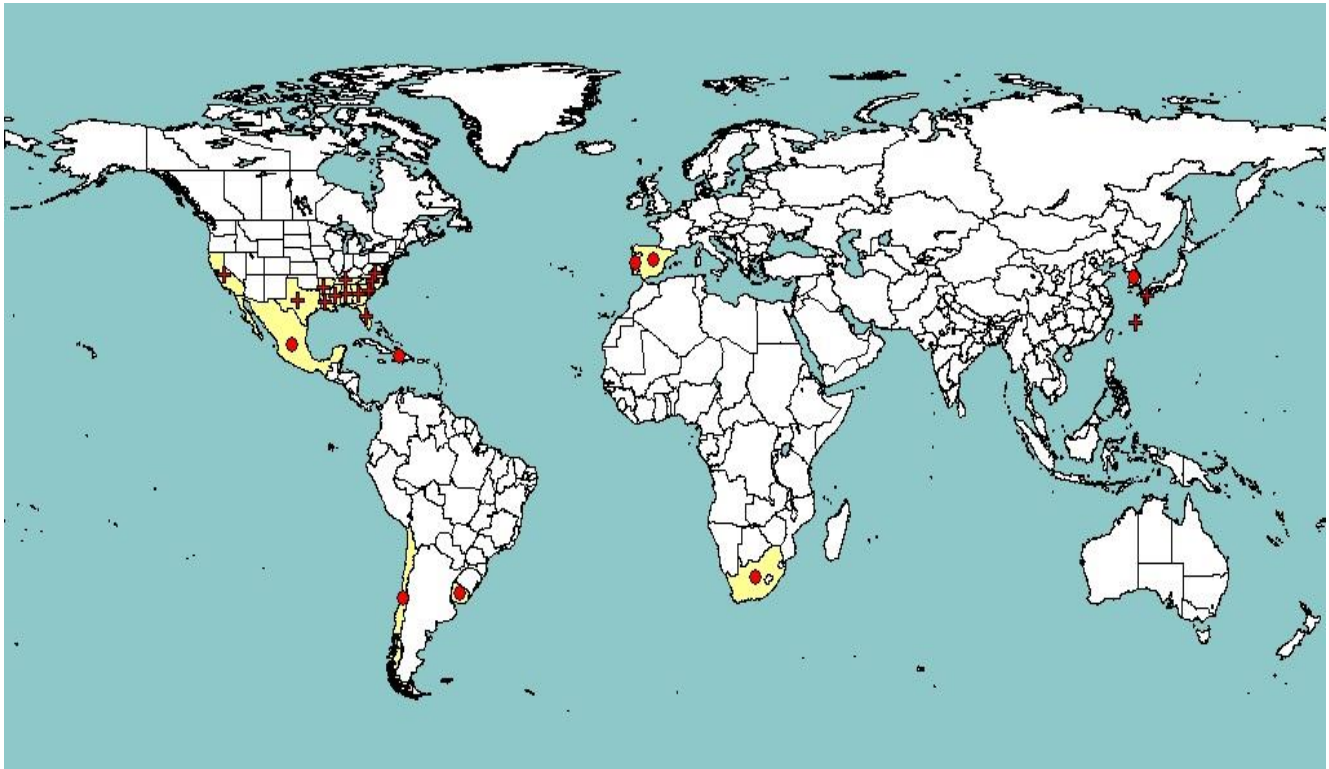


Figure 5: Distribution of *F. circinatum* at April 2014. Circles represent national records and crosses represent sub-national records. (EPPO PQR database)

In the USA, *F. circinatum* causes disease in 12 south-eastern states and in the Monterey Peninsula and coastal areas of California. It is also present in Mexico, Haiti, Chile and South Africa (but only in nurseries), and in parts of Asia (Japan, Korea and possibly Iraq). It is thought most likely that *F. circinatum* originates from the south-eastern USA or Mexico.

In Europe, *F. circinatum* is a relatively recent arrival and has been reported in nurseries and forests in several countries, namely France and Italy (where it is now considered to have been eradicated), and Spain and Portugal (<https://gd.eppo.int/taxon/GIBBCI/distribution>). The occurrence of the pathogen is most common in coastal areas of affected EU countries.

The potential for establishment in Europe, based on a CLIMEX analysis reported in the EFSA PRA, indicates that the endangered areas are central and northern Portugal; northern and eastern Spain; southern and coastal areas of France; coastal areas of Italy; and parts of the coastal areas of Greece. The UK climate is

currently considered unsuitable for *F. circinatum* establishment, except in in south-eastern England, where it is considered marginally suitable.

## Damage impact and controls

Pitch canker is a chronic problem in the south-eastern USA, where it affects production in plantations, nurseries and seed orchards. As such, it frequently adds to the cost of production, but does not result in large financial losses in most years. Most southern pines are affected to some extent, including loblolly pine (*Pinus taeda*), which typically sustains only minor damage, whereas slash pine (*P. elliottii*) can be more severely affected. Major epidemics affected slash pine in Florida in the 1970s, with an estimated loss of between 385 and 869 thousands of cubic metres annually in the period from 1974 to 1979 (Dwinell et al., 1985). The use of less-susceptible genotypes, and changes in silvicultural techniques, has greatly reduced the impact since then. Pitch canker can also cause significant losses in pine seedling nurseries, and reduced cone yields in seed orchards, in south-eastern USA.

Pitch canker is an important cause of damage and mortality of *P. radiata* in urban plantings and native forests in California. Costs of tree removal and replacement might eventually amount to several million dollars in severely affected areas (Templeton et al., 1997). Native or planted *P. muricata* and *P. attenuata* are also affected.

Pitch canker has been a serious problem in seedling nurseries in South Africa. It is also found in nurseries in Chile and Spain, but the extent of the problem is not widely known. Pitch canker is apparently only a minor problem in Japan, but is perhaps more serious in Korea.

Control methods around nurseries include greater attention to sanitation, maintaining a robust microbial community which will inhibit root-infecting pathogens, and avoiding practices which predispose trees to disease, such as excessive fertilization and planting in poorly drained soils. In the wider environment limiting the spread of the disease from existing infections is a critical element of management. To this end, branches and logs removed from infected trees should be disposed of locally. Seeds and seedlings can both carry the pathogen, and so should not be moved from infected to non-infected areas. Infections caused by *F. circinatum* are associated with wounds resulting from



silvicultural practices, such as pruning and seed harvesting, weather-related injuries, and insect activity. The risk of disease in managed plantings can be reduced by limiting pruning operations to cool, dry periods, which are less conducive to infection, and by judicious control of insects which can serve as wounding agents and vectors (Gordon et al 2015).

## **Main pathways**

### a) Natural Dispersal

*Wind:* *F. circinatum* produces spores which are wind dispersed and can be detected through spore trapping in proximity to diseased trees, but not in disease-free areas. However, little is known about the limits of airborne dispersal, and the observations suggest that airborne spread occurs over relatively short distances, with possibly longer-range dispersal at intensities which reduce as distance from the main source increases.

*Vectors:* In California, many insects are known to carry the pitch canker pathogen, including pine-associated bark beetles (Coleoptera: Scolytidae) in the genera *Pityophthorus*, *Ips*, *Conophthorus* and *Ernobius* (Coleoptera: Anobiidae). The pathogen has also been recovered from *Lasconotus* species, beetles which are thought to be predatory, although it is not known whether they are important as agents of dispersal. In south-eastern USA, *Pissodes nemorensis* and *Rhyacionia* species are suspected vectors and/or wounding agents.

### b) Movement in Trade and Transport

Longer-distance spread is likely to occur mostly through human-aided movement of infested or infected plant material, including live plants, parts of plants, and wood and bark.

*Plants:* Because infected seedlings might show no symptoms, it is possible for the pathogen to move cryptically in the plant trade. Seedlings and branches or logs cut from diseased trees can also carry the pathogen.

*Wood:* *F. circinatum* can survive for one year or more in infected wood (maintained at moderate temperatures), so movement of infected wood can spread the pathogen. It might be further disseminated by insects which

are carried within the wood, and later emerge from it, especially if it still has bark attached.

*Seeds:* *F. circinatum* has been shown to be present in seed both externally and internally.

*Soil:* The pathogen does not survive for long in soil (typically less than 12 weeks, although the time depends on soil type and conditions). However, in some circumstances it might persist long enough for contaminated soil to act as a pathway for disease spread to new areas.

### c) Silvicultural Practices

Contaminated pruning implement and infected soil on tools or vehicles also represent risks for transport of the pathogen, and biosecurity procedures should be used, including spraying tools, PPE and machinery with disinfectant. Pine litter (fallen needles) from infested areas (which might be used as mulch) might also harbour the pathogen, and should not be moved into non-infested areas. Small-diameter branches can be chipped to eliminate insects, but the pathogen can survive this process. Debarking logs will eliminate most of the insects likely to carry the pathogen, should they be breeding in this type of material.

### **Import controls**

*F. circinatum* was added in 2002 to the EPPO A2 action list of pests, and endangered EPPO member countries are therefore recommended to regulate it as a quarantine pest. It has since become subject to [European Commission Decision 2007/433/EC](#), which invoked provisional emergency measures to prevent introduction into and spread within the EU. It includes legislation on plant imports and movement within the EU of soil, growing media and wood materials. APHA must be notified of any imports of pine from the EU as per [the requirements of the Plant Health Order 2005](#).

Seeds of *Pinus* spp. imported from countries where *F. circinatum* is present should also be free from the pathogen, and can be subject to specific tests. There is a risk of introduction with soil but, in general, most EPPO countries prohibit the import of soil, and restrict the import from other continents of plants with soil. These measures should be effective against *F. circinatum*.

**Appendix 2 – Alert status categories – (based on alert status levels for draft Defra generic contingency plan)**

<b>ALERT</b>	<b>STATUS</b>	<b>COMMAND LEVEL</b>
White	Plant pest or disease with potential for limited geographical spread	Instigation of incident management plan involving operational command at appropriate level, and implementation of Standard Operating Procedures or scientific advice where applicable
Black	Significant plant pest or disease with potential for limited geographical spread	Instigation of incident management plan, usually involving joint tactical and operational command at appropriate level. Implementation of plant pest/disease-specific response plans where applicable
Amber	Serious plant pest or disease with potential for relatively slow, but extensive, spread leading to host death and/or major economic, food security or environmental impacts	Instigation of incident management plan usually involving joint strategic and tactical command, and plant pest/disease-specific response plans where applicable
Red	Serious or catastrophic plant pest or disease with potential for rapid and extensive geographical spread leading to host death and/or major economic, food security or environmental impacts	Instigation of incident management plan involving strategic, tactical and operational command, and implementation of plant pest/disease-specific response plans where applicable

## Appendix 3: Relevant legislation

### Domestic:

[The Waste Management Licensing \(Scotland\) Regulations 2011](#)

[The Environmental Permitting \(England and Wales\) Regulations 2010](#)

[Natural Environment and Rural Communities Act 2006](#)

[Plant Health \(Forestry\) Order 2005](#)

[Plant Health \(England\) \(Amendment\) Order 2015](#)

[The Plant Health \(Forestry\) \(Amendment\) \(Wales\) Order 2015](#)

[Plant Health Act 1967](#)

[Forestry Act 1967](#)

### European:

[EC Council Directive 2000/29/EC](#)

[Decision 2007/433/EC](#)

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