Summary Pest Risk Analysis for PHSI interceptions

Name of organism and disease: *Alternaria panax*
Date of PRA production, or revision and revision number: September 11th 2006 (first revision of 9th August version).
Reason for Pest Risk Analysis: Second interception of the pathogen (on plants imported from the Netherlands). Revised in September 2006 to reflect new information on ginseng (*Panax* spp.) production in the EU.

Pest Risk Analysis:	
Question	**Answer**
1. Name of pest:	
1. (a) Fungi	
Anamorph: Genus, species, var., f.sp.	*Alternaria panax*
Common name for disease	Alternaria blight
Special notes on taxonomy or nomenclature	*Alternaria panax* is noted to have a wide range of conidial morphology (Simmons, 1982). The teleomorph or sexual stage of *A.* panax is not known. Known synonyms, of which none are still in common use include: *Alternaria* spp. (associated with ginseng) *Alternaria panacis* *Macrosporium araliae* *Alternaria araliae* *Alternaria actinophylla*
Primary pathogen (Y/N)	Yes
Weak pathogen (Y/N)	No
Saprophyte (Y/N)	No
2. (ai) Does it occur in the UK? No. There is no previous record of *A. panax* in the UK in either the British Mycological Society (BMS, 2006) or CSL fungal checklists (CSL, 2006), or the CABI Crop Protection Compendium (CABI, 2006a).	
(aii) Has it been intercepted before on this host in the UK (check "pathdiary")? Yes. The pathogen was found in 20 plants of a *Fatsia* sp. of unknown origin, at a nursery in April 2004. The outbreak was considered successfully eradicated	
(aiii) Has it been recorded before on this host in the UK? ? Only as above.	

2 (b). Is there any other reason to suspect that the pest is already established in the UK?

The 1988 CMI description (David, 1988) and CMI distribution map (CABI, 1988) both report the fungus as present in Britain on *Fatsia*. This is based on a single undated record from the IMI herbarium. However, neither BMS (2006), CSL (2006) or CABI (2006a) have any UK records for *A. panax*. The single IMI herbarium record could be considered erroneous, since these more recent sources indicate the pathogen's absence from the UK (BMS, 2006; CSL, 2006; CABI, 2006a). Garibaldi *et al*. (2004) states that their record in Italy on *Aralia japonica* is the first record in Europe but previously Simmons (1982) reported *A. panax* on *Schefflera* in Spain.

3. EC Directive Status? Not listed

4. EPPO Status? Not listed

5. What are its host plants?

Alternaria panax is only known to infect members of the Araliaceae. Recorded host genera include: *Acanthopanax, Aralia, Brassaia*, *Dizygotheca, Echinopanax, Fatsia, Kalopanax, Mertya, Panax, Polyscias, Pseudopanax, Schefflera* and *Tupidanthus* (compiled from Simmons, 1982; David, 1988; Farr *et al*., undated). Not all members of the Araliaceae are experimentally susceptible; Quayyum *et al*. (2003) reported that some Araliaceae species showed no symptoms after inoculation, along with plant species from other families including the *Cruciferae, Leguminosae, Solanaceae* and *Gramineae*.

There could be some uncertainty over the taxonomy of the Araliaceae. Mabberley (1997) gives *Eleutherococcus* as a synonym for the genera *Acanthopanax and Kalopanax.* It also states *Brassaia* and *Dizgotheca* as synonyms of *Schefflera*. CABI (2006a) and Garibaldi *et al*. (2004) give *Fatsia japonica* as a synonym of *Aralia japonica*. However, Mabberley (1997) lists *Aralia* and *Fatsia* as different genera.

5 (a). Highlight crop plants grown commercially, including those of environmental or amenity value, in the UK (and EU/EPPO) (include figures for potential yield/quality losses)

Many species of the Araliaceae are used for outdoor ornamental purposes in the UK. None are listed in the New Atlas of British and Irish Flora (Preston *et al*., 2002) indicating very little or no presence in the wild. Many of the Araliaceae host genera that are listed in the Royal Horticultural Society Plant Finder (RHS, 2006), are listed as having several suppliers. *F. japonica* could be considered the most important host of *Alternaria panax* with regards to the UK ornamental industry with over 50 suppliers listed (RHS, 2006). Others of importance with between 10 to 20 suppliers listed are *Eleutherococcus, Schefflera and Pseudopanax* (RHS, 2006).

5 (a). Continued.

For plants grown as ornamentals, disease severity would vary between host species and be dependant upon environmental conditions. The pathogen has rarely been associated with plant death but severe defoliation and loss of market value is not uncommon. For example, Garibaldi *et al*. (2004) reported that 70% of *A. japonica* plants in a nursery in Italy were infected in one outbreak resulting in considerable leaf drop, a reduction in aesthetic quality and loss of market value. With infections of *Schefflera arboricola* death is rarely reported. However, in the USA the pathogen rarely infects more than 10% of the susceptible plants on a nursery, but severe

outbreaks of over 2000 plants have been recorded (Atilano, 1983). On seedlings of susceptible plants, *A. panax* can behave as a damping off organism (Leahy, 1986).

No official statistics are available for Araliaceae grown in the EU or EPPO region. Only *Hedera* species, most notably *Hedera helix* (ivy) is listed as a member of the Araliaceae present in Europe in the Flora Europea plant database (Flora Europea, 2006). However, there are no records of *A. panax* occurring on any *Hedera* species. It is likely that several members of the Araliaceae are grown as ornamental plants in the EU and the EPPO region. For example, Garibaldi *et al*. (2004) reported that *A. japonica* is a foliage plant highly valued in Italy for landscape and interior decoration.

Ginseng (*Panax* spp.) is also a host. This plant has a number of uses other than as an ornamental plant, including in food and beverages as a source of gums and resins (it is used in cosmetics). It is also used in the pharmaceutical industry as well as traditional herbal medicine (CABI, 2006a). It is not native to Europe but to East Asia and North America. Several species exist and most notably cultivated are *Panax ginseng* (Chinese/Korean Ginseng) (sometimes referred to commercially as *Panax ginseng* C.A. Meyer following its renaming from *Panax schinseng* Nees in 1843; Yun, 2001) and *Panax quinquefolius* (American ginseng). Almost all ginseng production takes place in East Asia and North America (Proctor, 1996) but a small amount is grown in Europe, although only unofficial area of production figures are available.

Although CABI (2006a) does not list ginseng as being grown in the EU or EPPO region, Anon (2004) reports that one farmer grows ginseng commercially in the UK, with 2.5 acres (1.01 ha) of the crop in Bedfordshire.

Correspondence with companies growing and marketing ginseng in the Netherlands and Germany has elicited further information. The area produced in Europe varies considerably from year to year with the largest area in recent years being produced in 2000 (50 to 70 ha). Estimates of production in 2006 for *P. quinquefolius* are 0.2 ha in Switzerland, 0.5ha each in Belgium, Denmark and England, 1ha in France, 4 ha in the Netherlands and 1 ha listed as ‘various’. For *P. ginseng*, 2006 production has been estimated as 0.5 ha each in Denmark and Switzerland, 10 ha in Germany and 1 ha again under ‘various’. (B. Schepens, Benseng International, *personal communication*, 2006).

5 (a). Continued.

Specific information from Germany (M. Mueller, FloraFarm Ginseng, *personal communication*) shows there are only two producers there, one producing ca. 7.5 ha per annum.

It is thought that nearly all European-grown *P. ginseng* is consumed within Europe. A high percentage (70 to 80%) of *P. quinquefolius* is exported (mainly to the USA and Taiwan) in the form of dried roots or capsules. (B. Schepens, Benseng International and M. Mueller, FloraFarm, *personal communications*, 2006).

Ginseng takes at least four years to reach maturity so it represents considerable investment from the grower. It is also labour intensive and consequently an expensive crop to grow, for example the crop requires hand weeding (Anon, 2004). An outbreak of the disease could produce significant financial losses, particularly as

third or fourth year crops are at greater risk from infection due to the higher humidity and poorer air circulation resulting from their dense foliage (Anon, 2003).

Yield losses arising from infection of ginseng by *A. panax* would be considerable. Putman and du Toit (2003) reported that over half of a 0.25 ha commercial garden of *P. quinquefolius* was infected with *A. panax* in Italy and Quayyum *et al*. (2003) reported typical *P. quinquefolius* yield losses of 10-20% through *A. panax* infection.

5 (b). Are any of the host plants of forestry importance?

Some species of Araliaceae could be considered to be trees but none are considered important for forestry in the UK, EU or EPPO region (CABI, 2006b). CABI (2006b) lists the following Araliaceae species with forestry use in the Americas and/or Asia: *Dendropanax arboreus* (white gumbolimbo), *Kalopanax septemlobus* (tree-aralia), *Polyscias fulva* (parasol tree), *Schefflera morototoni*.

6. What is its present geographical distribution?

Farr *et al*. (undated) reports the fungus as present in the following countries (with corresponding host records in brackets): Australia (*Fatsia*), Canada (*Panax*), China (*Panax*), Italy (*Aralia*), Korea (*Acanthopanax*, *Aralia, Echinopanax, Kalopanax* and *Panax*), New Zealand (*Fatsia, Mertya* and *Pseudopanax*) and USA (*Acanthopanax, Aralia, Brassaia, Dizygotheca, Panax, Polyscias, Schefflera* and *Tupidanthus*).

Simmons (1982) also noted the fungus as present in Spain (*Schefflera*) and Venezuela (*Polyscias*). David (1988) also reported the fungus present in the then USSR but no host record was given. There has been a recent disease report for the pathogen in Israel on an *Aralia* sp. (Levy *et al*., 2006). The pathogen has been found twice recently in the UK by the PHSI. The first outbreak, which occurred in 2004 on a *Fatsia* species of unknown origin, was subsequently eradicated. For the 2006 outbreak (on *F. japonica* imported from the Netherlands in 2006) statutory measures were imposed and post-outbreak monitoring is currently being carried out.

6 (a). Present in EU?

It is present in Italy (Garibaldi *et al*., 2004) on *A. japonica*, Spain on *Schefflera* (Simmons, 1982) and has been detected in the UK on *F. japonica* imported from the Netherlands in 2006. It was also reported in the UK in 2004 on a *Fatsia* species. It is under eradication in the UK.

6 (b). Present in EPPO region?

As above.

7. Does it appear capable of establishing in the UK/EU/EPPO?

(a) outdoors?

It is feasible for this pathogen to establish outdoors in the UK, and also in the EU and EPPO region. The pathogen has already been reported causing disease in two other European countries (Italy and Spain). A factor that would limit the ability of *A. panax* establishing outdoors is the distribution and abundance of susceptible hosts. Known susceptible hosts of the Araliaceae are not known to be present as wild plants in the UK as indicated by CABI (2006a,b) and Preston *et al*. (2002). CABI (2006 a,b) and Flora Europea (2006) indicate little or no presence of susceptible hosts in the wild within EU and EPPO region countries. There may be scope for the pathogen to establish in cultivated gardens and perhaps ornamental nurseries. RHS (2006) shows that several Araliaceae are sold as ornamental plants in the UK and that there are abundant suppliers of *F. japonica*. This indicates there are at least

some susceptible hosts in UK gardens and nurseries.

The lifecycle of *A. panax* is favourable for establishment in the UK, EU and the EPPO region. On diseased leaves the pathogen produces large numbers of conidia, which are spread by contact, wind or water splash. Moisture is needed for spore germination. Once infection has taken hold within the plant, hundreds to thousands of conidiophores emerge through stomata and conidia are produced within several hours. In moist tropical situations the infection cycle can occur every 5-7 days (Uchida, undated).

The infection cycle will perhaps be less frequent in Europe but nevertheless is likely to be completed as indicated by the outbreaks in Italy (Garibaldi *et al*., 2004) and areas of the USA with mild climates such as Oregon and Washington (Putman and du Toit, 2003).

The pathogen is said by David (1988) to thrive in warm temperatures and moist environments. However, optimum spore production occurs at temperatures of 18-21°C (Uchida *et al*., 1984) and optimum mycelial growth at temperatures of 24-27°C (David, 1988). These temperatures indicate that the pathogen could establish outside in the UK and throughout the rest of the EU and the EPPO region.

One limiting factor would be its ability to survive in the absence of the host. No specific data is available on the survival of *A. panax* but it is likely to survive UK, EU and EPPO region temperature and climate extremes in the absence of a host. Where the pathogen is present in ginseng growing areas in North America, it has been observed to over winter in soil, infested ginseng debris and straw mulches (Quayyum *et al*., 2005), indicating it should survive the relatively mild winters experienced in the UK and other parts of the EU and EPPO region.

7 (b) On protected crops?

Several susceptible plants are grown in protected environments in the UK, EU and the EPPO region. Several susceptible ornamental hosts of *A. panax* belong to the Araliaceae. Ginseng (*Panax* spp.) could also be considered to be a protected crop in the UK. Anon (2004) reports that a Bedfordshire farmer grows ginseng under a canopy that mimics the shade cover of forest trees that are present in the areas where ginseng is traditionally grown in Asia. *A. japonica* was reported to be growing under shade in Italy when infected by *A. panax* (Garibaldi *et al*., 2004). Anon (2003) reports that the extensive areas of shade cloth used in ginseng production restrict air movement and create dead air spaces thereby increasing temperature and humidity. Schepens (B. Schepens, Benseng International *personal communication*, 2006) has suggested that shade coverage is likely to favour fungal disease development in ginseng grown in shade halls.

Warm temperatures would favour disease development. The optimum mycelial growth temperatures of 24-27°C and optimum spore production temperatures of 18-21°C (Uchida *et al*., 1984) would be favourable for disease development in protected crops in the UK. David (1988) states that *A. panax* thrives in warm, moist conditions and that the disease is more severe in plants grown in shade and under sprinkler systems. This would enhance the risk of the disease occurring and establishing in protected environments. The pathogen is able to survive over winter in soil, infested ginseng debris and straw mulches (Quayyum *et al*., 2005). It can also survive as infected seed in ginseng (Anon, 2003). However, ginseng planting material is in the form of seed which has been harvested from berries, sterilised and stratified for more than one year so this may reduce the risk from seed transmission. (B. Schepens, Benseng International and M. Mueller, FloraFarm, *personal communications*, 2006).

8. What is its potential likely to be as a pest in the UK/EU/EPPO?

The fungus is able to cause significant disease on susceptible plants of Araliaceae and has done so on various hosts in countries in North America, Asia and Australasia. The pathogen has been reported in two European countries; on *Schefflera* in Spain (Simmons, 1982) and one outbreak on *A. japonica* in Italy (Garibaldi *et al*., 2004). In the Italian outbreak, 70% of *A. japonica* plants in a nursery were infected resulting in considerable leaf drop, a reduction in aesthetic quality and loss of market value. Thus, *A. panax* has the potential to affect members of the Araliaceae grown as ornamentals under protection and wherever they are planted outdoors.

A. panax is considered to be a major pathogen of ginseng (*Panax* spp.) (Proctor, 1996) and typical yield losses resulting from infection are 10-20% (Quayyum *et al*., 2003). In North America, chemical fungicides are often used to control *A. panax* in ginseng crops (Proctor, 1996).

It would be probable that should *A. panax* become established then the small number of European ginseng growers would need to use chemical means to protect their high value crop.

It is also probable that as ginseng is grown as a foodstuff associated with health benefits, the use of chemicals may not be seen as a preferred option. However, in

the USA, the use of fungicides to save previously organically grown ginseng crops in their third or fourth year is common practice (Adam, 2004).

In conclusion, wherever *A. panax* is present it is an important pathogen of susceptible members of the Araliaceae. It is likely that chemical control options would need to be utilised in some way to control the disease on both ornamental plants and ginseng crops should it become established in Europe and the EPPO region.

9. What are the prospects for continued exclusion?

Exclusion would depend on detection of the pathogen at the port of entry. Symptoms can develop relatively quickly and visual inspection could detect blighted foliage. Early signs of the disease include small, circular water soaked leaf spots (Leahy, 1986). Symptoms would also vary between host plants as in *Panax* species lesions are typically elongate (Anon, 2003). Laboratory diagnosis would be needed to confirm the presence of *A. panax*. Due to the wide variety of conidial shape and size (Uchida *et al*., 1984), accurate diagnosis based on microscopic examination of cultures may prove difficult. Imports of the pathogen on roots would be unlikely since *A. panax* is a pathogen of leaves and stems and does not occur on roots (Anon, 2003). Ginseng is commonly propagated by seed (Davis, 2003). *A. panax* is also known to survive and can be introduced on ginseng seed (Anon, 2003), hence ginseng seed introduced to the UK, EU or the EPPO region could be tested for freedom of *A. panax*. However, most of the ginseng growers in Europe use home-saved seed. It is possible that some Danish farmers import limited amounts of seed from Canada; China and Korea are alternative sources. There has been no anecdotal evidence of the movement of any ginseng disease through imported seed over the past ten years. (B. Schepens, Benseng International and M. Mueller, FloraFarm, *personal communications*, 2006).

10. What are the prospects for eradication?

Good if the pathogen is detected soon after arrival and the initial infected plants are destroyed and others are treated with an effective fungicide. Eradication could be hindered if favourable (warm and moist) conditions are present and numerous disease cycles occur quickly. As this pathogen can be dispersed by wind, eradication may be protracted by a combination of favourable disease conditions and several secondary disease outbreaks. Also, as the pathogen can survive in the absence of the host at least over winter, persistence of the pathogen in soil would be problematic for successful eradication.

11. How would eradication be achieved?

Affected plant parts or whole plants would need to be destroyed and nearby plants and unaffected species of *Araliaceae* treated or destroyed within an appropriate *cordon sanitaire*. Follow-up inspections would be required to ensure eradication was successful. Removal of infected plant material including fallen leaves and other associated debris would reduce the numbers of conidia present in an outbreak and help disrupt the disease cycle. Lowering the humidity where possible could also be used to reduce the chance of subsequent infection. Where practical, cleaning and disinfection of the area where infected plants have been standing should be carried out, to reduce the potential for carry over of the pathogen to future crops.

In glasshouse situations, UV filtering film on the glass could possibly be utilised to prevent spore formation and stop the fungus completing its lifecycle (Agrios, 2005).

A. panax is likely to be able to survive in the absence of its host and so any potentially infected soil may need to be removed and disposed of in an appropriate way.

Appropriate fungicides could also be used where the situation allows in both outdoor and protected crops and would be useful as a protective treatment for susceptible plants surrounding the initial area of infection. It should be noted that the Araliaceae are particularly prone to chemical damage (Leahy, 1986).

Mancozeb (Proctor, 1996), chlorothalonil (Anon, 2003) and iprodione (Uchida, undated) have been reported as effective fungicides to control this pathogen and are permitted for use on ornamental plants in the UK under the long-term extension of use arrangement (Anon, 2006). However, there have been reports of resistance to iprodione (Rahimian, 1987). Presently in North America, azoxystrobin and pyraclostrobin are used in alternation with protectant fungicides such as mancozeb and chlorothalonil to prevent resistance (Hausbeck, 2004).

There are currently no fungicides approved for use on ginseng in the UK.

12. Conclusion and CSL action recommendations.

Alternaria panax is not known in the UK and should therefore be considered an exotic pathogen. The pathogen has been reported to be present in two European countries (Spain and Italy). A significant level of disease was observed on *A. japonica* in Italy (Garibaldi *et al*. 2004). The pathogen has the ability to cause disease in European climates, at least to *A. japonica*. However, *A. panax* is an important pathogen of many members of the Araliaceae and is likely to be a threat to other susceptible members of the Araliaceae in the UK/EU/EPPO areas should it become established.

Hosts of *A. panax* are not important plants in the UK except in some cultivated situations, perhaps the most important host in the UK being *F. japonica*, as indicated by RHS (2006) with over 50 suppliers. A recent outbreak occurred on *A. japonica* in Italy (Garibaldi *et al*., 2004). Establishment of the pathogen could have an impact on nurseries growing susceptible hosts particularly as infection can result in defoliation and significant loss in value for what many consider to be foliage plants.

A. panax can also infect ginseng (*Panax* spp.), which is grown as an edible crop. However, although ginseng is a high value crop, production is very limited in the UK, EU and the EPPO region. There is only one commercial grower known in the UK (*ca.* 1 ha) (Anon, 2004) but there are a number of other growers across Europe and the EPPO region. The area produced in Europe varies considerably from year to year with the largest area in recent years being produced in 2000 (50 to 70 ha). (B. Schepens, Benseng International, *personal communication*, 2006).

Continued exclusion would depend on detection soon after arrival and consequent action. As symptoms develop quickly and are noticeable on the foliage of susceptible hosts it is likely that they can be detected by visual inspection.

Prospects for successful eradication are good, as evidenced by the successful eradication of the one of the recent outbreaks in the UK (the second UK outbreak is currently under official control). Nevertheless as the pathogen can be dispersed by wind, should the pathogen remain undetected and favourable disease conditions prevail, further outbreaks could result and eradication would not be straightforward as the pathogen can survive in the absence of the host.

There is a range of chemical options available to control this disease for ornamental plant production. Some of the chemicals used to control *A. panax* in nursery situations are already used in the control of other diseases (e.g. iprodione and mancozeb), although the Araliaceae are prone to chemical damage (Leahy, 1986).
For commercial ginseng production there is currently no chemical control option available. It is probable that as ginseng is grown as a foodstuff associated with health benefits, the use of chemicals may not be seen as a preferred option. Chemicals are frequently used to control several ginseng diseases in North America (Proctor, 1996). A wide range of cultural methods could be implemented which may go some way to managing the disease.

12. Continued.
It is recommended that because this pathogen occurs in other European countries, because its host-range is limited to relatively minor albeit valuable hosts and because it should be possible to control the disease using standard nursery practice and field controls for the small area of ginseng grown in the UK no further statutory action be taken for future findings of *A. panax* in the UK.

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Location: CSL Sand Hutton, UK, YO41 1LZ
Date: September 11th 2006

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