Rapid assessment of the need for a detailed Pest Risk Analysis for *Peronospora belbahrii*

Disclaimer: This document provides a rapid assessment of the risks posed by the pest to the UK in order to assist Risk Managers decide on a response to a new or revised pest threat. It does not constitute a detailed Pest Risk Analysis (PRA) but includes advice on whether it would be helpful to develop such a PRA and, if so, whether the PRA area should be the UK or the EU and whether to use the UK or the EPPO PRA scheme.

STAGE 1: INITIATION

1. What is the name of the pest?
Peronospora belbahrii (Thines *et al*., 2009).
P. belbahrii was first described as a new species of *Peronospora* in 2009.

Synonyms: None.

Common name: Downy mildew

Note: Previous findings of *Peronospora* sp. infecting sweet basil (*Ocimum basilicum*) and coleus (*Solenostemon scutellarioides*) may be *P. belbahrii* before it was first described as a new species. *P. belbahrii* may also have been misidentified as *Peronospora lamii* (another *Peronospora* species affecting lamiaceous hosts, of worldwide distribution and common in the UK) before sequence identification was carried out. Confusion between species is likely to occur without sequence data, therefore samples must be submitted to a competent testing laboratory for identification.

2. What is the pest's status in the EC Plant Health Directive (Council Directive 2000/29/EC[1]) and in the lists of EPPO[2]?
Peronospora belbahrii is not listed in the EC Plant Health Directive, or any EPPO lists, i.e. the A1 and A2 Lists of pests recommended for regulation as quarantine pests; the EPPO Alert List or the EPPO Action List.

3. What is the reason for the rapid assessment?
Following a PRA for a *Peronospora* sp. on sweet basil (Jones, 2005 Fera internal unpublished), a new species of *Peronospora* infecting sweet basil plants was described as *P. belbahrii* (Thines *et al*., 2009). The 2005 PRA included records that may have been *P. lamii* or may have been *P. belbahrii*. This Rapid Assessment is for *P. belbahrii* and is being done in response to the first finding of *P. belbarhii* in the UK as well as the first finding on a new host, *Agastache* spp. (Henricot *et al*., 2009).

To date there have been seven UK findings of *P. belbahrii* on *Agastache* (5) and sweet basil (2) plants in commercial nurseries (UK and European origin), on which statutory action was taken, and two interceptions of *P. belbahrii* on sweet basil leaves imported from Kenya (Fera, unpublished data). Further detail on outbreaks and interceptions is provided in Table 2 and section 5.

[1] http://europa.eu.int/eur-lex/en/consleg/pdf/2000/en_2000L0029_do_001.pdf
[2] http://www.eppo.org/QUARANTINE/quarantine.htm

STAGE 2: RISK ASSESSMENT

4. What is the pest's present geographical distribution?

Table 1. Distribution of *Peronospora belbahrii*

Continent	Country	Year first found
North America	USA	2005
Central America	No record	n/a
South America	Argentina	2008
Caribbean	No record	n/a
Europe	Italy Hungary Switzerland UK	2001
Africa	Cameroon South Africa	2005
Asia	Iran Taiwan	2006
Oceania	No record	n/a

Details of findings recorded by host, location and publication date are listed in Annex 1 noting that records within this Annex referring to *Peronospora* sp. are now considered to be *P. belbahrii* following the naming of the species by Thines *et al*., (2009).

Reports of downy mildew on sweet basil began in Europe. McGrath (2011) reports that the disease is considered endemic in Europe, having been observed in glasshouses and open fields in Switzerland in 2001 and in glasshouses in Italy in 2003. It now occurs more widely in Europe (e.g. Hungary, found during field surveys and in a glasshouse; UK, outdoors on *Agastache* - see Table 2 below). As summarised in Table 1, *P. belbahrii* has been recorded in North America, Africa, South America, Asia and Europe. Records of a *Peronospora* sp. affecting sweet basil in Benin, Tanzania, Uganda, Belgium and France are unproven as the species *P. belbahrii* due to lack of molecular sequence data.

Findings on plants (outbreaks) in the UK have been on nurseries so it is therefore unclear if there is an import connection (Fera records state origin of plants as Netherlands, Germany (from Italy originally) and the UK; there are no records of the pathogen in the Netherlands or Germany). Interceptions on sweet basil leaves from Kenya have occurred but there is no record of the pathogen there. Details of interceptions and outbreaks in the UK are given in Table 2 below.

5. Is the pest established or transient, or suspected to be established/transient in the UK?

It is not known if *P. belbahrii* is established in the UK, no survey work has been carried out to determine the potential presence and distribution.

There have been 7 separate *P. belbahrii* outbreaks in the UK, 5 on *Agastache* plants (unnamed species) originating from the UK (4) and the Netherlands (1) (*Agastache* cv: 'Apricot Sprite', 'Red Fortune', 'Purple Pygmy', 'Pink Pop', 'Lilac Sprite', 'Astromontana Pop Pink', 'Honey Bee Blue'), and 2 on sweet basil plants originating from the UK (1) and Germany (1); the latter was originally shipped from Italy to Germany . Statutory action was

taken on these outbreaks and all material destroyed. Follow-up inspections by the PHSI one year after the initial outbreaks has confirmed positives at 2 outbreak sites, suggesting the pathogen was not fully eradicated, however no more positives have been detected since further statutory action was taken.

The initial outbreak (at a public garden in Surrey in 2009) was on *Agastache* plants sourced from a nursery in Norfolk, which had distributed potentially infected plants to garden centres across the UK in previous months.

There have also been 2 interceptions of *P. belbahrii* on sweet basil leaves from Kenya, however, as the consignments were of produce destined for retail, no statutory action was taken.

Table 2: UK outbreaks and interceptions of *P. belbahrii*

Host			Material	Country of origin	Date diagnosed	Outbreak site (county)	Interception
Species	Common name	Family					
Agastache		Lamiaceae	Plants	UK	July 2009	Surrey	No
				UK	Aug 2009	Surrey	No
				UK	Aug 2009	Norfolk	No
				UK	July 2010	West Sussex	No
				Netherlands	May 2011	West Sussex	No
Ocimum basilicium	Sweet basil	Lamiaceae	Plants	Germany (Italy)	Oct 2010	West Sussex	No
				UK	Oct 2010	West Sussex	No
Ocimum basilicium	Sweet basil	Lamiaceae	Leaves	Kenya	Oct 2011	Manchester Airport	Yes

6. What are the pest's natural and experimental host plants; of these, which are of economic and/or environmental importance in the UK?

Thines *et al.* (2009) stated that sweet basil (*Ocimum basilicum*) and coleus (*Solenostemon scutellariodes*), which belong to the Lamiaceae family, are natural hosts of *P. belbahrii*. Following the pathogen's description, *Agastache* sp. (also belonging to the Lamiaceae family) was named as a new host (Henricot *et al*. 2009). A *Peronospora* sp. on sage (*Salvia officinalis*) shows similar sequence homology to *P. belbahrii.* However, as no morphological data were available, Thines *et al*. (2009) were unable to conclude that the downy mildew was the same species that infects sweet basil and coleus so sage is not considered to be a host. Thus the only hosts currently recognised are sweet basil (*O. basilicum*), *Agastache* and coleus (*S. scutellariodes*).

The majority of *P. belbahrii* findings have been on sweet basil, which is an economically important commercial crop worldwide, grown for flavouring and fragrances. There are no centrally collected statistics specifically for basil production in the UK although in 2007 the UK market for sales of all fresh herbs was estimated to be worth £38 million (CALU, 2007). A significant proportion of this would have been sales of herbs grown outside the UK. For example, in 2007 sales of organic herbs were estimated to be worth £4 million with 90% of this resulting from imported material (CALU, 2007). In a 2007 pesticide usage survey report of protected crops which included herbs, herbs were aggregated into the category "other vegetables" together with over 30 other crops such as aubergines, Chinese salad leaves,

melons and physalis. In total "other vegetables" were grown in 566ha (Garthwaite *et al.,* 2007).

Personal communication from T. Davies (British Herb Trade Association - BHTA) to C. Sansford (Fera, April 2012) showed the following: A recent BHTA survey displayed approximately 30ha of sweet basil is grown in the UK with about 25% under protected conditions; all of the crop is grown in the summer months and several crops can be produced from the same area in the same season so the total hectarage would be greater than 30ha. The value of the UK fresh basil industry is gauged in many ways but it is '*in the order of 10s of millions of UK sterling*'. Much of the year the UK imports fresh cut basil, with a high proportion originating in Israel. There is no significant export trade but some would go as frozen product.

Other than Koch's postulates, no data have been found on proving susceptibility of other lamiaceae species to *P. belbahrii*.

7. If the pest needs a vector, is it present in the UK?
P. belbahrii does not require a vector for dispersal.

P. belbahrii is a seed-borne pathogen, with levels of infected sweet basil seeds as low as 0.017% leading to a visible infection of a crop (experimental seed transmission rates; Garibaldi *et al*. 2004). It is unclear from the literature as to whether the pathogen is truly seed-borne (systemic) or a contaminant. Distribution of infested/infected seeds; or infected plants, cuttings and leaves are potential methods for spread of the pathogen over long distances. Once downy mildew has begun to develop, the pathogen can readily spread via wind-dispersed spores (sporangia) that are produced abundantly (McGrath, 2011).

8. What are the pathways on which the pest is likely to move and how likely is the pest to enter the UK? (*By pathway*): (tick box) ✓

The following pathways originate in countries where the pest is present (refer to Annex 1):

Pathway 1 – seed of *O. basilicum* (sweet basil), *Agastache* sp./spp.,coleus (*S. scutellariodes*) and potentially other members of the Lamiaceae from all countries where the pest is present.
This pathogen is present in several European countries and there are no restrictions on imports into the UK from other EU member states. Currently there is no requirement for seed testing prior to entry from 3rd countries. It is thought that transmission by contaminated seed (sweet basil and sage, noting that sage is no longer considered a host) was the most likely route of entry into Switzerland (Belbahri *et al*., 2005). Inspection of seeds at the point of entry will not detect the pathogen as symptoms are not visible.

Very unlikely		Unlikely		Moderately likely		Likely	✓	Very likely	

Pathway 2 – plants for planting (including cuttings) of *O. basilicum* (sweet basil), *Agastache* sp./spp., coleus (*S. scutellariodes*), and potentially other members of the Lamiaceae from all countries where the pest is present with or without soil attached.
This pathogen is present in several European countries and there are no restrictions on imports into the UK from other EU member states. Inspection of symptomatic cuttings at the point of entry reduces the risk of *P. belbahrii* infected material entering the UK from 3rd countries. However, as it is not a quarantine listed organism, hold notices may not be applied and entry may still be possible. Symptoms on leaves may not be visible at the time of entry due to latent infection. The pathogen may move in soil associated with host and non-host plants in the nursery trade. Oospores of pythiacious fungi show a rapid decline in viability within a few months in soil, but are also known to survive for years. Equivalent data on the Peronosporaceae are limited (Van Der Gaag & Frinking, 1997). Oospores of

oomycetes have been known to survive for 5-10 years in soil (pers.comm., P. Jennings, Fera, May 2012).

Very unlikely		Unlikely		Moderately likely		Likely	✓	Very likely	

Pathway 3 – plants of fresh herbs (sweet basil – *O. basilicum*; and possibly other herbs e.g. mints that are members of the Lamiaceae) for consumption from all countries of origin.
If infected produce is grown on or stored in nurseries before going to supermarkets or kept/sold at garden centres, then likelihood of movement within the UK is increased. Transfer to the end of the pathway (growing plants) is also critically dependent on host range, especially if mints and other members of the Lamiaceae family are vulnerable. Consumers sometimes plant-out potted herbs bought for consumption and this increases the risk of entry of the pathogen. Disposal of waste material to compost heaps/green waste bins could also introduce the pathogen to the environment.

Very unlikely		Unlikely		Moderately likely	✓	Likely		Very likely	

Pathway 4 – cut leaves of fresh herbs (sweet basil – *O. basilicum*; and possibly other herbs e.g. mints that are members of the Lamiaceae) for consumption from all countries of origin.
Infected leaf material for consumption has been intercepted from Kenya on cut leaves of sweet basil at point of entry in the UK. No action was taken due to the low risk of spread to the natural environment. Disposal of waste material to compost heaps/green waste bins could introduce the pathogen to the environment.

Very unlikely		Unlikely		Moderately likely	✓	Likely		Very likely	

9. How likely is the pest to establish outdoors or under protection in the UK?

Very likely.

The initial UK outbreak in 2009 was found on *Agastache* in a walled garden outdoors in the south of England (pers. comm., B. Henricot, Royal Horticultural Society (RHS), UK, 2012). *P. belbahrii* is considered endemic in Europe and has been found on sweet basil both under protection and outdoors. Infected samples in Switzerland have been collected from sweet basil plants in glasshouses and open fields in the Lake Geneva region, however, it is unclear if the plants survive all year round or are harvested from the open fields (Belbahri *et al*., 2005). In the USA, *P. belbahrii* was confirmed in 2008 in both field- and glasshouse-grown sweet basil crops, as well as home gardens, in many states (e.g. North Carolina, Pennsylvania, New Jersey, New York, Massachusetts, Kansas and Missouri) (McGrath, 2011).

Whilst the known hosts of the pathogen vary in their ability to overwinter outdoors in the UK, the pathogen has the potential to survive in infected plant debris as oospores in the absence of a host. Sweet basil is very sensitive to cold, with best growth in hot, dry conditions. It behaves as an annual if there is any frost, so would die out over winter in the UK climate. Only 25% of sweet basil production is under protection (pers. comm., T. Davies, British Herb Trade Association, UK, April 2012), but it is unknown how much *Agastache* and coleus is grown outdoors. *Agastache* sp. winter hardiness varies, with the hardiest of species able to survive well below the UK winter temperatures so it is possible that the pathogen could overwinter on this host outdoors (see http://en.wikipedia.org/wiki/Agastache).

Coleus is a tropical plant grown as a house plant, so is likely to be produced under protection. It is often grown as an annual in colder areas, since the plants are not hardy. (see http://en.wikipedia.org/wiki/Coleus).

Production of coleus and sweet basil outdoors where it may not survive the winter, could still allow for establishment in the UK due to the overwintering potential of the oospores in plant debris and soil. Re-planting susceptible host plants in contaminated plant debris and soil would lead to re-infection of the newly-emerging plants both under protection and outdoors.

Outdoors:	Very unlikely		Unlikely		Moderately likely		Likely		Very likely	✓
Under protection:	Very unlikely		Unlikely		Moderately likely		Likely		Very likely	✓

10. How quickly could the pest spread in the UK?

The pathogen appears to spread internationally with seed. Prior to *P. belbahrii* being formally described in 2009, Garibaldi *et al*. (2004b) reported an unspecified *Peronospora* on sweet basil (likely to be *P. belbahrii*) as spreading quickly in Italy and attributed this to seedborne inoculum.

An earlier PRA from 2005 on an unidentified *Peronospora* sp. on sweet basil (Fera (CSL) internal document, Jones, 2005) reported that a major UK glasshouse grower raises its plants from seed. If this grower was to be supplied with a contaminated seed lot, the pathogen could potentially spread throughout UK basil producers very quickly indeed.

In the UK outbreaks on *Agastache*, where infection was found, plants were destroyed. With respect to these findings it seems likely that infected plants have been moving in trade within the UK as infected plants at one of the outbreak sites were sourced from another UK nursery (pers. comm., J. Walker, PHSI, UK, 2011). Also infection has been confirmed in plants grown from seeds sourced within the EU (pers. comm., A. Gaunt, (PHSI), UK, 2011).

The pathogen can readily spread naturally via the easily wind-dispersed spores that it produces abundantly, but these are short-lived, surviving just a few days. Spread by this method is dependent on susceptible hosts being within the spore dispersal area. There are many members of the lamiaceae family growing wild in the UK, such as wild mints, thyme and marjoram, but it is not yet known if they are susceptible to *P. belbahrii*. Wind dispersal is likely to be the main way it has spread throughout the eastern USA every summer since 2008, similar to its well-known relative, the cucurbit downy mildew fungus (*Pseudoperonospora cubensis)*. If hosts are not abundant then spread by wind-dispersed spores may cause a local spread, whereas spread through trade would be quicker and reach greater distances. Oomycetes can survive approximately 5-10 years as their resting structures (oospores) in crop debris, soil and woody tissue which can be easily transported around the UK thus furthering the spread.

Within growing plots the pathogen can spread rapidly through plants, under conditions of high humidity and cool temperatures (Belbahri *et al*., 2009).

Natural spread:	Very slowly		Slowly		Moderate pace		Quickly		Very quickly	✓
In trade:	Very slowly		Slowly		Moderate pace		Quickly		Very quickly	✓

11. What is the area endangered by the pest?

All areas where sweet basil, *Agastache* and coleus are produced or planted in the UK.

12. What is the pest's economic, environmental or social impact within its existing distribution?

Belbahri *et al*. (2009) reported the pathogen causing complete crop losses (sweet basil) in some glasshouses. This is due to the high quality demanded when marketing leafy herbs; leaves with any injury can be unmarketable thus leading effectively to complete crop loss.

Prior to the formal identification of *P. belbahrii* in 2009, a *Peronospora* sp. (now known to be *P. belbahrii*) was reported as causing a damaging foliar disease on sweet basil in Italy. In the Liguria area of Italy, 50-70% of plants were affected (Garibaldi *et al*., 2004b, Minuto *et al*, 2004). Sweet basil leaves, where air circulation was poor, were severely affected by the pathogen (Garibaldi *et al*., 2004b). During field surveys in Hungary in 2010, significant incidence of downy mildew was observed in two plant stands with 17 to 20% leaf area infected amongst 80 to 90% of two basil cultivars. Leaves suffered large chlorotic lesions, followed by necrotisation from the middle. Chlorosis often involved the entire leaf surface. The pathogen can also cause premature leaf drop (Nagy & Horváth, 2011).

P. belbahrii infection of coleus causes stunting of growth, chlorosis and distortion of the foliage (inward curling and twisting of leaves) usually turning brown and necrotic. Foliage infection results in defoliation and death of young seedlings (Palmateer *et al*. 2007). The fungus is considered to pose a serious threat to the production of coleus and other Lamiacae grown commercially (Henricot *et al*. 2009). However, no figures are published on the current impact of this pathogen on coleus.

P. belbahrii infection of *Agastache* sp. causes chlorotic leaf spots which eventually turn brown. (Henricot *et al*. 2009). As this is a relatively new record on this genus of plants there are no figures available on the current impacts caused by the pathogen. Following the outbreak on this host at a public garden in Surrey, statutory action has been taken which is an indirect impact to date.

For specialist herb growers, severe outbreaks have caused significant crop losses (at least on sweet basil). However, in the UK herb production is relatively small in comparison to major crops.

Very small		Small		Medium	✓	Large		Very large	

13. What is the pest's potential to cause economic, environmental or social impacts in the UK?

Medium losses are likely for producers of sweet basil, coleus and *Agastache*. The impact of the pathogen will depend upon how easy it is to control using conventional methods for downy mildews. Without controls, this pathogen could be very damaging to sweet basil and possibly other members of the Lamiaceae. The most likely potential impact of an outbreak of *P. belbahrii* in the UK would be on the fresh basil herb industry which has been estimated to be worth in the order of 10's of millions of UK sterling (see 7.).

Very small		Small		Medium	✓	Large		Very large	

14. What is the pest's potential as a vector of plant pathogens?

P. belbahrii is a plant pathogen with no capacity to act as a vector of other pathogens.

STAGE 3: PEST RISK MANAGEMENT

15. What are the risk management options for the UK? *(Consider exclusion, eradication, containment, and non-statutory controls; under protection and/or outdoors).*

Exclusion

The pathogen has already entered the UK. It is also present in other EU countries and third countries. Currently there are no specific phytosanitary requirements that would prevent further entry into the UK. Future exclusion would depend upon on knowing that the pathogen is not already established in the UK (this would require an official survey) and in there being a requirement for statutory controls on the pathways of entry listed in response to question 8:

> *Pathway 1 – seed of* O. basilicum *(sweet basil),* Agastache *sp./spp., coleus (*S. scutellariodes*) and potentially other members of the Lamiaceae from all countries where the pest is present.*
>
> *Pathway 2 – plants for planting (including cuttings) of* O. basilicum *(sweet basil),* Agastache *sp./spp., coleus (*S. scutellariodes*), and potentially other members of the Lamiaceae from all countries where the pest is present with or without soil attached.*
>
> *Pathway 3 – plants of fresh herbs (sweet basil –* O. basilicum*; and possibly other herbs e.g. mints that are members of the Lamiaceae) for consumption from all countries of origin.*
>
> *Pathway 4 – cut leaves of fresh herbs (sweet basil –* O. basilicum*; and possibly other herbs e.g. mints that are members of the Lamiaceae) for consumption from all countries of origin.*

Controls on each of these pathways would be dependent upon sourcing clean seed and plants from the places of production. This is dependent upon their being a reliable method of testing for the pathogen in seed lots and plant material. Given that it is not known whether the pathogen is systemic in seed or a contaminant (or both), further work would be required before such a method could be developed. Similarly the efficacy of seed treatments would need to be known as this could be used to ensure seed was free from the pathogen. Determining the latent period of the pathogen in plant material (other than seed) would be necessary as a precursor to setting requirements for inspection and testing of such material at places of production.

Eradication

Eradication is unlikely to be feasible outdoors given the potential for the oospores to survive lengthy periods (years) in soil or leaf litter in the absence of a host. Eradication under protection is more feasible but this depends upon complete removal of infected material, it's safe disposal, and a thorough clean-up of the facilities and structures therein before the use of appropriate disinfectant products.

In the UK outbreaks on sweet basil, anecdotal evidence suggests that symptoms have not been seen until close to harvest. Therefore eradication was not attempted, material which was severely infected was destroyed as it was not fit for marketing. Infected leaves were removed from plants infected to a lesser extent and these plants were then marketed as normal (pers. comm., A. Gaunt, Plant Health and Seeds Inspector (PHSI), UK, 2011).

Containment

Due to the symptoms appearing late in the crop production cycle (at least in sweet basil), measures to contain the organism are limited to measures to prevent the spread of the organism to adjacent or subsequent crops.

The principles of control are outlined below:

1 Destruction of the infected plants and associated material by incineration or deep burial.

2 Hygiene measures should be employed to prevent further spread of the pathogen. Any surfaces which have come into contact with these plants should be cleaned thoroughly to remove all debris, any debris should be destroyed by burning or deep burial.

3 Any other Lamiaceae in the surrounding area should be checked for signs of infection.

4 Fungicide spraying of any adjacent plants in the family Lamiaceae could be considered to prevent these becoming infected thus preventing further spread. There are a number of products which have Specific Off-Label Approvals (SOLAs) for protected herbs, however without knowing which species are likely to be treated specific products cannot be recommended.

Non-statutory controls

The Horticultural Development Council (HDC) has a best practice guide for downy mildews on herbs which is available by registering on their website: http://www.hdc.org.uk/

The principles of control described by the HDC guide are similar to those outlined above under 'containment' with the addition of the following points (N.B. the Guide makes mention of fungicidal active ingredients that could be used for seed treatments and/or foliar application; these are not mentioned here):

Cultural control
Disease-free planting material.
Varietal resistance (none available at present for this pathogen)
Use of disinfectants in cleaning-up after an outbreak (following a thorough clean-up of the facilities and structures therein).
Limiting leaf wetness duration to <4hrs; adequate ventilation and spacing between plants; avoiding overhead irrigation and watering late in the evening; avoiding the use of fleece/mesh over plants (such material increases susceptibility to downy mildew).

Chemical control
With the proviso that there must be approval for use; fungicidal seed treatment might protect against early infection with downy mildew.
Approved foliar fungicide use must be in conjunction with cultural control. There is no evidence of resistance to phenylamide chemicals (often used against downy mildews) to date in this species but care must be taken to try to prevent this by ensuring products are used in a mixture with fungicides with a different mode of action (see the HDC Guide for details).

16. Summary and conclusion of rapid assessment.
(Highlight key uncertainties and topics that will require particular emphasis in a detailed PRA) General / overall summary and conclusion and then specific text on each part of the assessment.

This rapid assessment shows:

Likelihood of entry:
Entry of the pathogen has already occurred.

- Potential for future entry is considered to be *likely* on imports of seed and plants for planting of sweet basil (*O. basilicum*), *Agastache* and coleus (*S. scutellariodes*) and possibly other members of the Lamiaceae from countries where the pathogen occurs (see Table 1).

- Potential for future entry is *moderately likely* on plants and cut leaves of sweet basil (*O. basilicum*) and possibly other herbs that are members of the Lamiaceae from the same countries.

Likelihood of establishment:
The pathogen may already be established in the UK. However, only an official survey would determine whether this was the case. Based on the existing (and seemingly growing) international distribution of this pathogen, it is *very likely* that *P. belbahrii* could establish on sweet basil (*O. basilicum*), and/or *Agastache* grown in the UK both outdoors or under protection. Coleus is grown as a house plant and so is produced under protection. The pathogen could also establish on this host. Other members of the Lamiaceae may also support establishment of the pathogen but their susceptibility is not known.

Economic impact:
The potential economic impact of *P. belbahrii* in the UK is rated as *medium.*
It is possible that without controls the pathogen could cause total crop losses in sweet basil (*O. basilicum*). The value of the fresh basil herb industry in the UK has been estimated to be in the order of 10's of millions of UK sterling. Other plants are at risk including the ornamental hosts *Agastache* and the house plant coleus (*S. scutellariodes)* and possibly other members of the Lamiaceae.

Endangered area: All areas of the UK where sweet basil, *Agastache,* coleus *(S. scutellariodes)* and potentially other members of the Lamiaceae family are grown both outdoors and under protection.

Risk management: This pathogen has the potential to be managed by non-statutory means outlined above in response to question 15. In the first instance this involves sourcing clean planting material (seeds and plants), and good crop management including managing humidity and leaf wetness. Where outbreaks have occurred removal and safe disposal of infected plants/plant debris followed by hygiene measures on the place of production to prevent spread in neighbouring or subsequent crops will be necessary. Chemical (fungicide) treatments of seed with an approved product may be beneficial. Treatment of plants in new or adjacent crops (protectant sprays) should only be undertaken with approved products and in conjunction with cultural control. Ensuring the use of fungicides with different modes of action will help prevent the development of resistance to phenylamides (often used against downy mildews) in this species.

17. Is there a need for a detailed PRA? If yes, select the PRA area (UK or EU) and the PRA scheme (UK or EPPO) to be used. *(for PH Risk Management Work stream to decide)*

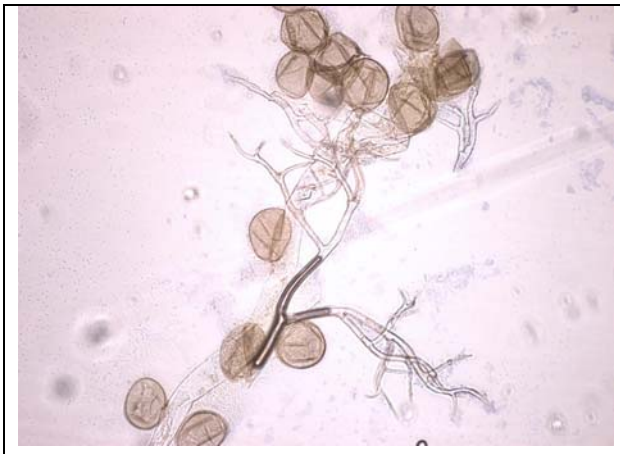
No	✓

Yes		PRA area: UK or EU		PRA scheme: UK or EPPO	

18. Given the information assembled within the time scale required, is statutory action considered appropriate / justified?
Based on presence in the EU and potential for being managed by non-statutory methods by the grower industry, statutory action is not considered appropriate for this pathogen.

Yes Statutory action		No Statutory action	✓

19. IMAGES OF PEST

	 
Fera	Fera (PHOT No. J16899)

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Annex 1: Records of *Peronospora* sp. and *Peronospora belbahrii*.

Peronospora sp. identifications in this table can be assumed also to be *P. belbahrii* due to morphological and sequence similarity to the initial description by Belbahri *et al*., 2005.

Pathogen	Host		Family	Location	Reference
	Scientific name	Common name			
Peronospora sp.	*Ocimum basilicum*	Sweet basil	Lamiaceae	Switzerland Italy	Belbahri *et al*., 2005
Peronospora sp.	*Solenostemon scutellarioides*	Coleus	Lamiaceae	USA (Louisiana ad New York)	Daughtrey *et al*., 2006
Peronospora sp.	*Ocimum basilicum*	Sweet basil	Lamiaceae	South Africa	McLeod *et al*., 2006
Peronospora sp.	*Ocimum basilicum*	Sweet basil	Lamiaceae	Iran	Khateri *et al*., 2007
Peronospora sp.	*Solenostemon scutellarioides*	Coleus	Lamiaceae	USA (Florida)	Palmateer *et al.,* 2007
Peronospora sp.	*Ocimum basilicum*	Sweet basil	Lamiaceae	Argentina	Ronco *et al*., 2008
Peronospora sp.	*Ocimum basilicum*	Sweet basil	Lamiaceae	Cameroon	Voglmayr and Piatek, 2008
Peronospora sp.	*Ocimum basilicum*	Sweet basil	Lamiaceae	USA (Florida)	Roberts *et al*., 2009
Peronospora sp.	*Ocimum basilicum*	Sweet basil	Lamiaceae	USA (Massachusetts)	Wick and Brazee, 2009
Peronospora sp.	*Ocimum basilicum*	Sweet basil	Lamiaceae	USA (California)	Blomquist *et al*., 2009
Peronospora belbahrii	*Agastache* sp.	Mexican Giant Hyssop, Orange hummingbird mint, Texas hummingbird mint	Lamiaceae	UK (England)	Henricot *et al*., 2009 and see Table 2
Peronospora belbahrii	*Ocimum basilicum*	Sweet basil	Lamiaceae	UK (England)	See Table 2.
Peronospora belbahrii	*Ocimum basilicum*	Sweet basil	Lamiaceae	Taiwan	Chen *et al*., 2010
Peronospora belbahrii	*Ocimum basilicum*	Sweet basil	Lamiaceae	Hungary	Nagy and Horvath, 2011