Grower Summary

CP 157

Aerial Oomycetes: Assessing Management and Control Options Needed in UK Edible & Ornamental Crops

Final 2016

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Further information

If you would like a copy of the full report, please email the AHDB Horticulture office (hort.info.@ahdb.org.uk), quoting your AHDB Horticulture number, alternatively contact AHDB Horticulture at the address below.

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GROWER SUMMARY

Headline

Developments in spore detection, disease forecasting and biological treatments are aiding progress towards development of effective IPM strategies for aerial oomycete pathogens, but more work is needed.

Key knowledge gaps remain in our understanding of these pathogens, with implications for their control.

Background

Downy mildews, white blisters and certain *Phytophthora* species are examples of oomycete pathogens which can be transmitted aerially and infect above ground plant tissue. The oomycetes are a group of fungus-like organisms that can cause economically significant losses on a wide range of plant species. They can exist as a range of structures throughout their lifecycle, enabling them to persist aerially, in water and in soil.

Economically significant losses due to oomycetes occur across the majority of horticultural production systems. They are often considered to be fairly ubiquitous in the environment, with most aerial oomycetes also able to persist in soil and growing media as either mycelium or oospores. Temperatures between 5-25°C (varying for individual pathogens) favour diseases caused by oomycete pathogens, with white blister pathogens in general favouring slightly higher temperatures than Phytophthoras and downy mildews. The correct temperature coupled with high humidity and/or foliage wetness can lead to the rapid spread of oomycete diseases throughout a crop once present. There has been recent industry concern over downy mildews new to, or not previously a problem in the UK, including on basil, impatiens and aquilegia and also aerial *Phytophthora* species including *P. ramorum*.

Summary

Information on the main aerial oomycete diseases of horticultural crops, determined by a survey to be currently important to UK growers, was obtained from recent UK and overseas research. In addition to published journals, the outcomes of relevant AHDB projects were evaluated. This review highlights research that has provided new understanding of the pathogens and measures for their control, and the gaps in knowledge remaining. Future threats including pesticide resistance and emerging disease problems were reported. Areas for further investigation related to host range, biology and disease management are itemised below. Thirteen crop-specific reviews of edibles and 11 of ornamentals were carried out and key areas of knowledge for the principal pathogens are tabulated below.

Host range

- Previous understanding of pathogen host interactions has been, in general, simplistic
- Downy mildew species once thought to have a wide host range are showing evidence of increased host preference, with numerous species either being reclassified or split into distinct races.
- Evidence suggests that distinct races which occur within pathogen species do not cause symptoms to the same extent on different cultivars of the same host plant.
- Weed relatives may play a role in acting as reservoirs for inoculum in some systems, but this is an area requiring further investigation.

Biology

- Fundamental gaps need to be filled in the understanding of the biology of some oomycete pathogens of UK importance to further aid integrated crop management.
- The role of oospores in infection is poorly understood. Information is lacking on their durability and viability under field conditions, germination, and role in infection.
- Survival of sporangia in the UK is also not well documented. The extent of aerial travel of viable spores is generally unknown, accepting that it will vary between pathogens and depend on environmental conditions.
- The possibility of spread of predominantly-airborne oomycetes *via* contaminated irrigation water requires further investigation.
- Certain downy mildew and white blister infections can remain without symptoms whilst still having a negative effect on a crop.

Integrated Crop Management

- Advances in spore detection and forecasting are paving the way for the more precise timings of fungicide spray applications.
- Across UK horticulture, limited crop resistance is available against oomycete pathogens. Molecular techniques may identify genes for resistance in wild relatives.
- Currently there is not a definitive system for growers to report suspect cases of fungicide resistance; and no monitoring of sensitivity/resistance levels is undertaken.
- There is increasing potential for the successful incorporation of microbial treatments and elicitors together with chemical fungicides within integrated crop management programmes (see Figure below).

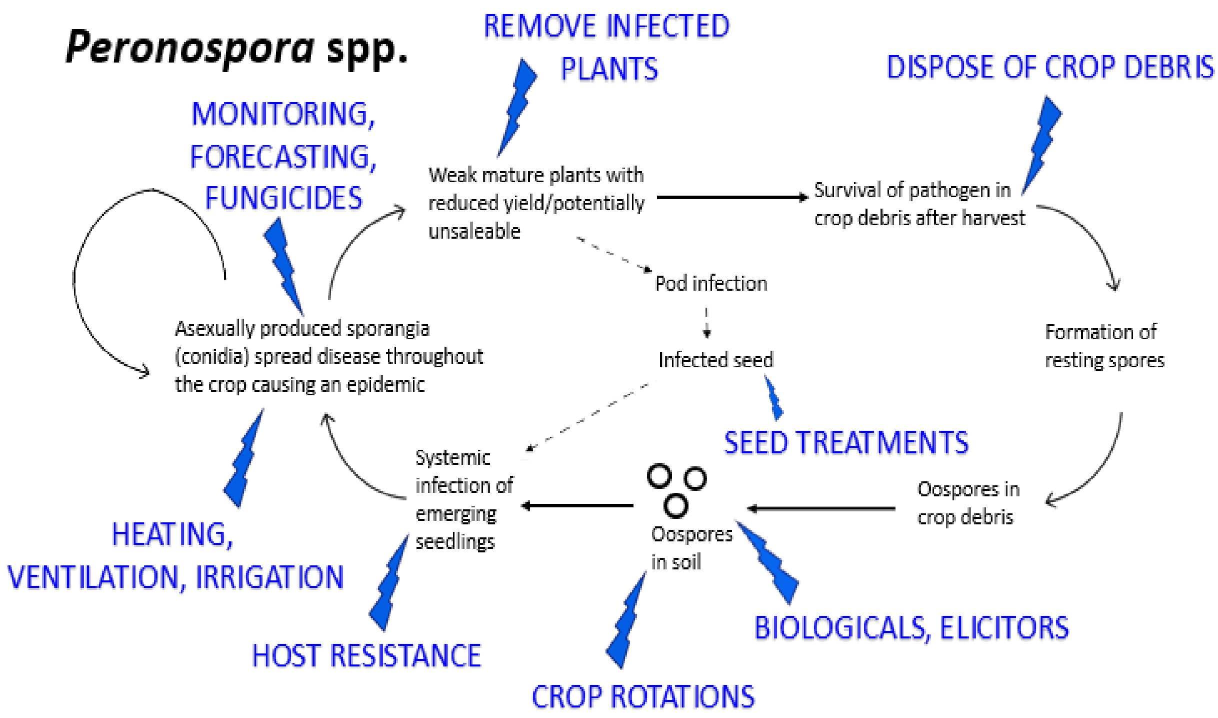

Figure above. General life cycle of a typical *Peronospora* sp. (downy mildew) and integrated crop management. The arrow-flashes shown in blue indicate where control could potentially be achieved by the measures indicated

Financial Benefits

Losses caused by aerial oomycetes can be high, and in many systems, such as salads and herbs, the whole crop can potentially be lost. Preventing disease establishment is the most cost efficient way of combating aerially transmitted oomycete pathogens and this review includes information on recent work on epidemiology and cultural control measures that could help preventative fungicide programmes to be used less frequently (See Summary Table below). The use of resistant cultivars has, for example, the potential to reduce disease incidence by 99% and in broccoli crops was able to increase farm profit by 12%.

Future research towards some of the key knowledge gaps identified in this review, in particular better understanding of the biology of pathogens and their interactions with host and environment, will enable the most effective control methods to be determined.

Action Points

The action points for growers set out how existing information and new understanding gained from the review on the diseases can be applied in integrated crop management programmes.

Effective cultural practices for downy mildew prevention will likely provide wider disease control as a consequence.

- Dispose of crop debris, destroy waste heaps and use other crop hygiene measures
- Remove and destroy volunteer plants as they can be sources of disease inoculum
- Where possible, avoid close proximity of spring plantings to overwintered crops
- Crop rotations of at least five years will minimise infection via oospores
- Where possible avoid making successive plantings across a single field (or in general close proximity) in order to prevent pathogens from moving between them
- Select resistant varieties, if available and acceptable
- Utilise seed treated for the control of oomycete pathogens
- Do not plant too densely, as high humidity within the crop canopy will favour infection and sporulation of many aerial oomycete pathogens
- In protected environments, maintain heating and ventilation to reduce humidity
- Avoid overhead irrigation, or time irrigation for the mornings to reduce leaf wetness
- Utilise disease forecasting systems where available, and monitor crops carefully
- Devise protectant fungicide programmes, consider including biological treatments
- Select fungicides with different modes of action to reduce chemical resistance risk
- Target sprays for at-risk growth stages, if known
- Be alert to any disease symptoms not seen before, or more severe infections, in case of the arrival of invasive pathogens or oomycetes with changed pathogenicity.

Summary Table of key knowledge areas either met or lacking for aerial oomycete pathogens present on UK horticultural crops

Pathogen and host	**Active research**	**Molecular diagnostics developed**	**Fungicide resistance observed**	**Optimum growth conditions identified**	**Resistant cultivars**	**Progress with bio-logicals**	**Forecasting**	**Host specificity**	**Cultivar specificity (races)**
Phytophthora spp. (trees & shrubs)	Yes	Yes	No	Yes	Some information	No	No	Some information	No
Peronospora sp. (*Aquilegia*)	Yes	No	No	No	Unknown	No	No	Unknown	Unknown
Peronospora grisea (hebe)	Yes	No	Possibly	Some	Unknown	Yes	No	Unclear	Unknown
Plasmopara obducens (*Impatiens*)	Yes	Partly	Yes	Yes	No	No	No	Yes	Unknown
Peronospora chlorae (*Lisianthus*)	No	No	No	No	Unknown	No	No	Yes	Unknown
Peronospora hyosami f. sp. *tabacina* (*Nicotiana*)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Peronospora violae (pansy & viola)	Yes	Yes	No	Yes	Yes	No	No	Yes	Unknown
Peronospora spp. (poppy)	Yes	Yes	Yes	No	Yes	No	Yes	Multiple pathogen spp.	Unknown
Peronospora sparsa (rose)	Yes	Yes	No	Yes	Yes	Yes	Yes	Rubus & rose	Unknown
Peronospora antirrhini (*Antirrhinum*)	Some	No	Yes	Yes	Some information	Yes	In part	Yes	No
Pustula sp. (*Senecio*) white blister	Yes	No	No	No	No	No	No	Uncertain (multiple spp.?)	Unknown
Peronospora sparsa (*Rubus*)	Yes	Yes	No	Yes	Yes	Yes	Prediction model	Unconfirmed	Unknown
Pseudoperonospora cubensis (cucurbits)	Yes	Yes	Yes	Yes	Yes	Yes	Not for UK GH cucurbits	No evidence	Several races identified

Peronospora destructor (onion)	Yes	Yes	Yes	Yes	Yes	Limited	Yes	Unconfirmed	Unknown
Peronospora viciae f. sp. *pisi* (pea)	Yes	In develop-pment	Yes	Needs re-evaluating	Yes – race specific	Limited	No	Cultivar specific	Yes
Peronospora viciae f. sp. *fabae* (Faba bean)	Unknown	In develop-ment	No - but reliant on **one** EAMU	No	Limited	No	Yes	Yes	Unknown
Hyaloperonospora sp. (salad rocket)	Unknown	Yes	No	No	No	No	No	Unconfirmed	Unknown
Hyaloperonospora brassicae (vegetable Brassicas)	Yes	Yes	Yes	Yes	Limited	Yes	No	Unconfirmed	Yes
Peronospora jaapiana (rhubarb)	Unknown	No	No	No	Unconfirmed	No	No	Unconfirmed	Unknown
Peronospora farinosa f. sp. *betae* (beetroot)	Unknown	Yes	No	Yes	Yes	No	No	Unconfirmed	Unknown
Albugo candida (veg. Brassicas) w. blister	Yes	Yes	Yes, needs checking.	Yes	Yes	Yes	Yes	Isolate dependent	Yes
Phytophthora. syringae (apples & pears) fruit rot	Unknown	No	No	Yes	No	No	No, but risk of post-harvest rot prediction	Unconfirmed	Unknown
Plasmopara petroselini (parsley)	Unknown	No	No	Some work	Limited	No	No	Unconfirmed	Unknown
Peronospora belbahrii (sweet basil)	Yes	In development	No	Yes	Potentially in near future	No	No	Numerous *Ocimum* spp.	Unknown
Peronospora salvia-officinalis (sage)	Unknown	No	No	Some work	Limited	No	No	Species specific	Unknown
Peronospora lamii (mint)	unknown	No	No	No	No	No	No	Unconfirmed	Unknown
Peronospora porri (leek)	Yes	Yes	Yes	Yes	Yes	In progress	No	Alliums, but leek isolates distinct group	Leek isolates evidence of race?