Grower Summary

a) Control of downy mildew (Plasmopara obducens) an economically important foliar disease on impatiens

b) Source of downy mildew (Plasmopara obducens) infection on impatiens

PC 230a 230b

Final report 2012

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Project Title:	a) Control of downy mildew (Plasmopara obducens) an economically important foliar disease on impatiens b) Source of downy mildew (Plasmopara obducens) infection on impatiens
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DISCLAIMER

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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GROWER SUMMARY

Headline

Protectant spray programmes were the most effective in controlling downy mildew infections in impatiens. For curative activity, drenches (where available) were more effective than foliar sprays. Several effective and crop safe products have been identified but the introduction of metalaxyl-M resistant isolates in 2011 highlights the need to review and target programmes according to current infections. Oospores of *P. obducens* have been shown to overwinter under UK conditions and, as a result, could pose a threat to impatiens planted in soils contaminated by oospores.

Background and expected deliverables

Downy mildew of impatiens caused by *Plasmopara obducens* was first reported in the UK in June 2003 and caused considerable economic damage to commercial crops and municipal plantings, especially, though not exclusively, in the South of England. Initially emergency statutory action was taken by the Plant Health & Seeds Inspectorate (PHSI) and the downy mildew pathogen on impatiens was declared notifiable. This was revoked in 2005 on the proviso that the industry took on responsibility for management of the disease through implementation of an industry code of practice (Good Horticultural Practice (GHP). Between 2004 and 2006, the disease was not reported in commercial crops but reappeared at low-moderate levels in 2007, however, in 2008 and 2011 the disease was once again widespread and damaging. In 2008, the disease was principally found late-season in municipal and other outdoor plantings, whereas in 2011 the disease was first noticed in the early spring on nursery premises and was associated with imported vegetative material.

In the original UK 2003 outbreak, it was suspected that impatiens raised from seed or imported vegetative transplants (unrooted or rooted cuttings) may have provided the initial infection source of the disease, though this was not confirmed at the time. Over-wintering or resting spores (oospores) of the pathogen had been previously reported on/in seed in India but were not reported in the early UK outbreaks, suggesting that the pathogen's potential to over-winter under UK conditions was low. However during 2008, oospores were found in stem tissues of *I. walleriana* grown in the UK (Turner *et al*, 2009). Given this, the risk of disease carry-over between seasons on plant debris incorporated into soil has increased significantly; although the reality of this occurring has not been demonstrated under UK conditions. The potential for seed-borne transmission via this route is also potentially increased, though it must be emphasised that, as yet, oospores have not been found within seed-lots of *I. walleriana* or other species and cultivars in the UK.

Work carried out in a previous HDC project (PC 230) and the current projects (PC 230a and PC 230b) addressed a number of the key issues that will allow the industry to take responsibility for the overall management of downy mildew on impatiens; namely the development of techniques for the detection of the pathogen on both seed and young propagation material, identification of effective crop protection products to control downy mildew of impatiens and investigating the potential of seed-borne infections and overwintering of oospores as inoculum sources for disease development under UK conditions.

There are 2 main aims to projects PC230a and 230b:

1. To evaluate the efficacy of a range of fungicides for control of infection by *P. obducens* on impatiens (PC230a).
2. To gain a better understanding of the epidemiology and biology of impatiens downy mildew, especially in relation to the risk posed by potential sources of infection, in particular from seed-borne inoculum and oospore survival (PC230b).

Summary of the project and main conclusions

Fungicide efficacy testing

Fungicide efficacy: Results from the initial laboratory-scale efficacy tests, using the isolate collected in 2009, indicated that a range of different products were effective against impatiens downy mildew, particularly when applied in advance of infection i.e. as a protectant application. Where available, soil drench applications appeared to have better curative activity than the foliar sprays. The wide range of active ingredients showing effective protectant control of the disease is encouraging, as this means that spray programmes could be identified which do not rely on a single mode of action or active ingredient, thus reducing the risk of resistant populations developing and persisting.

Spray timing: Products identified with potential for the control of downy mildew symptoms caused by *P. obducens* were further examined to determine the appropriate time period between applications. The results highlighted a number of products (including some experimental) which provided good protective activity when applied up to seven days prior to infection (as a protectant application) and as a result have the potential to be used as part of a weekly fungicide programme for the prevention of downy mildew infection of impatiens. These included Fubol Gold, Subdue, Paraat, Karamate Dry Flo, Rose Tonic (potassium phosphate) and Valbon. The two experimental products that showed promise were HDC F32 (fenamidone and fosetyl-al) and Percos. However, a lack of products that showed good curative activity has also been highlighted. This potentially could lead to control problems should infected material arrive on a nursery.

Baseline sensitivity data: Concentrations of active ingredient which reduced infection by *P. obducens* isolates by an average of 50% compared to the control (EC_{50}) were determined for the products Fubol Gold and Subdue. These products carry the greatest risk of development of resistance due to containing metalaxyl-M. EC_{50} values of 108 and 0.34 ppm for total active ingredient in Fubol Gold (metalaxyl-M + mancozeb) and Subdue (metalaxyl-M) respectively were established for the *P. obducens* isolate collected in 2009. EC_{50} values could not be established for the *P. obducens* isolates collected in 2011 as no control was achieved even following the application of full rate Fubol Gold (EC50>645ppm) and Subdue (EC50>56 ppm). These tests indicated that all the isolates collected from UK nurseries during 2011 were resistant to metalaxyl-M, and potentially suggested they had a common source.

Glasshouse-scale programme trials (on both impatiens and pansy downy mildew): To validate the small-scale laboratory experiments carried out in this and a previous project two large scale replicated trials were established, one on impatiens and the other on pansy/viola. In each trial 19 spray programmes (as both preventative and curative) were trialled alongside an untreated control. Both trials identified a number of spray programmes with good preventative activity; generally based around products containing metalaxyl-M. In both trials, curative spray programmes (where the programme was started after the onset of disease) were generally less effective than preventative programmes (where the programme was started in advance of introduction of the disease).

Detection of latent impatiens downy mildew infection

The downy mildew primers and probes first used in HDC project PC230, and which proved capable of detecting latent infections of downy mildew in pansy leaf tissues, have also been shown to detect latent infection of impatiens caused by *P. obducens*. Levels of downy mildew DNA were shown to increase in the leaf material until the point when symptoms were expressed. This approach could therefore potentially be used in the future to 'screen' vegetative cutting material for the presence of the pathogen, though further validation would be required to develop it as a commercial service.

Testing for seed-borne transmission of impatiens downy mildew

As a result of the tests carried out in this project no evidence was found to suggest that downy mildew of impatiens caused by *P. obducens* is seed-borne.

Over winter survival of Plasmopara obducens oospores

Experiments were set up to examine the survival of *P. obducens* oospores over the 2010 winter period. The use of the LIVE/DEAD® BacLightTM bacterial viability stain indicated that oospores were able to survive what was a particularly harsh winter period, with only a 5% drop in viability (100% down to 95%) between September 2010 and June 2011. Oospore viability could not be confirmed by either of the direct germination tests used in this study.

As a difference in metalaxyl-M resistance had been shown between isolates of *P. obducens* collected pre-2011 (metalaxyl-M sensitive) and those collected in 2011 (metalaxyl-M resistant) it seemed that, through resistance testing of isolates collected infections in the wider environment, it might be possible to determine whether oospores had overwintered and then gone on to cause infections during 2011. As a result a number of requests were made during September and October 2011 for infected plant material to be sent to Fera for testing.

Four downy mildew infected plants were received, three from 'back gardens' in Leeds, York and Coventry, and the fourth from a growers hanging basket located in Cambridge. There was no previous history of impatiens downy mildew at any of the four locations and all four were late season infections. All four infections were shown to be caused by the metalaxyl-M resistant strain introduced in 2011 suggesting that they were caused by airborne sporangial inoculum.

Financial benefits

It is still not possible to predict the full financial benefits from this project. However, the impatiens downy mildew pathogen is aggressive and, under favourable environmental conditions, can cause significant economic losses. Therefore, if the project is successful in helping the industry to reduce the risk from the disease it will be of considerable economic benefit. If we assume a conservative retail cost per plant of 25p with approximately 94.5 million plants produced by the industry annually (97% from seed raised and 3% from vegetative material) then we have an industry value of £23.5M/annum for the production of *I. walleriana* alone (Davis, pers. comm.). If we estimate 10% plant losses of impatiens may be incurred due to the disease, then the financial benefit in impatiens alone could be as high as £2.4M/annum (in years where disease severity is high). Assuming losses also occur due to downy mildew infections in other crops e.g. pansy and viola, then the gross economic benefit of this R&D could be much higher.

Action Points for Growers

- Ensure any starting plant material (vegetative cuttings or seed) is disease free. If possible avoid importation of vegetative cutting material.
- If unrooted or rooted cutting material is imported, check it immediately on receipt, ideally prior to transfer to the glasshouse. If there are signs of downy mildew infection reject the cuttings immediately and seek confirmatory diagnosis using available Plant Clinic services.
- Isolate and clearly label vegetative cutting and seed crops, including those from different suppliers to allow containment of outbreaks and also traceability should future problems arise. This is particularly important with the identification of metalaxyl-M resistant isolates in 2011.
- For seed crops ensure adequate air circulation around plants to minimise prolonged periods of leaf wetness by better spacing and by increasing the ventilation in the glasshouse. Avoid overhead watering, especially late in the day, as this is likely to encourage infection. If it is necessary to water from overhead systems then do this early, on days when solar radiation levels will ensure the leaves have a chance to dry out quickly.

- Be aware of criteria for sporulation and infection and check susceptible crops regularly, making arrangements for any suspicious plant material to be sent for diagnosis. Where infected plants are found remove them immediately by carefully placing them in a plastic bag *in situ* to avoid dispersing spores to other plants. Destroy any infected plants either by burial at landfill or via incineration.
- Maintain an effective <u>protectant</u> fungicide programme on the crop, ensuring a range of products with different modes of action is included to minimise the risk of resistance development. Consider also the need for fungicides active against other important pathogens especially on pansy & viola e.g. black root rot (*Thielaviopsis basicola*) & leaf-spot (*Ramularia* spp.).
- Following the introduction of metalaxyl-M resistant isolates to the UK in 2011 care should be taken when compiling fungicide programmes. Consider producing programmes that are not based around metalaxyl-M.
- Prior to use of any fungicide for the first time treat a few test plants prior to widespread use on the crop to ensure freedom from phytotoxicity.
- Practice good nursery hygiene, clean up crop debris between crops and at the end of the season to minimise the risk of carry-over of the disease and maintain effective weed control (including 'volunteer' impatiens plants) in and around the growing areas. Use appropriate disinfectants responsibly to help minimise potential carry-over of inoculum.
- Where infected material is found notify the project team and, if possible, submit a sample for R&D purposes.
- Keep abreast with developments in fungicide approvals and changes to the Long Term Arrangements for Extension of Use (LTAEU) arrangements.
- Remove diseased plants and associated debris in floral displays and gardens as soon as possible. Do not leave them to decay *in situ* as this will allow resting spores (oospores) to contaminate the soil and infect impatiens planted the following year.
- Avoid planting impatiens into beds where the disease has previously been identified.

Future work

- The introduction of metalaxyl-M resistant *P. obducens* to the UK means that further efficacy studies are required to determine alternative effective spray programmes and also identify possible new active ingredients to replace metalaxyl-M.
- Monitoring the sensitivity of *P. obducens* isolates involved in any future outbreaks to metalaxyl-M (from both nurseries and parks/gardens) to help determine the

geographical spread and persistence of the metalaxyl-M resistant isolate in the wider environment.

- This project has indicated that *P. obducens* oospores are able to survive the harsh conditions encountered during the winter of 2010. Work is required to determine the length of time these structures are able to survive in soil and whether they are capable of re-infection, especially semi-mature plants from 6-packs or similar.
- Potential sources of inoculum in wild or introduced impatiens plant species need to be established, e.g. can *Impatiens noli-tangere* (a native Impatiens species to the UK) or Himalayan (Indian) balsam (*I. glandulifera*) as an introduced 'nuisance' species of Impatiens become infected by *P. obducens* and harbour inoculum, which may then act as an annual and persistent infection source to commercially grown impatiens.
- Are other cultivated *Impatiens* species susceptible to the disease e.g. *I. hawkeri* (New Guinea types) and could sources of resistance be transferred to *I. walleriana* to prevent future economic losses due to downy mildew.

