Project title:	Monitoring metalaxyl-M sensitivity of Downy Mildew infections of Impatiens
Project number:	PO 011b
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The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

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

Metalaxyl-M resistant downy mildew has been detected in 2014 samples from impatiens for the first time since 2011.

Background

Impatiens downy mildew (IDM), caused by *Plasmopara obducens*, is a foliar disease specific to impatiens. During early 2011, a metalaxyl-M resistant strain of *P. obducens* was introduced into commercial impatiens production resulting in widespread downy mildew infections which were difficult to control. To try and minimise the risk posed by the resistant strain, pro-active action was taken by the industry to restrict impatiens production from cuttings. This action appeared to have been successful as no IDM infections, caused by the resistant strain, were detected during monitoring in 2012 (PO 011) or 2013 (PO 011a); in 2013 no downy mildew infections of impatiens were reported at all. However, the risk of infection by the resistant strain still remains, particularly in areas where infection has occurred previously.

This small scale project aims to continue the monitoring work undertaken during 2012 and 2013 to provide growers with:

1. An early warning system for identifying the presence of metalaxyl-M resistance, in order to assist with decisions on suitable spray programmes.
2. Guidance as to the prevalence, persistence and geographical distribution of the metalaxyl-M resistance compared to metalaxyl-M sensitivity in the wider environment.

Summary

Resistance testing consists of washing sporangia from downy mildew impatiens samples sent to Fera and inoculating three replicate impatiens plants treated with a Subdue (metalaxyl-M) soil drench prior to inoculation. An additional three plants, drenched with an equivalent volume of water, are also inoculated as untreated controls. Inoculated plants are then grown at 20ºC until symptoms develop on the controls (8-10 days) at which point the metalaxyl-M sensitivity of the inoculated isolate can be determined based on the pattern of

infection; resistant isolates infect both the treated and control plants whereas sensitive isolates only infect the control plants.

In 2014, five samples were received from four locations (one nursery and three private gardens), with the first sample arriving late July and the last mid-September. The detection of disease late in the season suggests that the disease had not established from the plant material but from other inoculum sources. The locations of samples ranged from West Sussex in the south east of England to North Yorkshire in the north of England.

Metalaxyl-M resistant isolates of *P. obducens* were present on samples sent in from two sites (the nursery and a garden in Warwickshire). The garden sites in North Yorkshire and West Sussex were both infected by metalaxyl-M sensitive isolates.

This contrasts with previous monitoring (2012 and 2013) where no metalaxyl-M resistant isolates were detected.

Financial Benefits

In the UK, the annual retail value of the impatiens crop before 2008 was estimated to be £40 million; however the onset of impatiens downy mildew has considerably reduced this value. The outbreak of downy mildew in 2011 demonstrated that the disease has potential to destroy whole site annual production as well as undermine consumer confidence in this commercially important bedding plant/pot plant product.

Prompt (up to 10 days after sample receipt) and widespread (sample originator and the wider network of growers) reporting of the metalaxyl-M resistance status of any infections occurring in 2012 and beyond will allow growers to ensure that any spray programmes adopted are effective in minimising losses that may result from any outbreaks.

Action Points

- Where possible grow impatiens from seed not vegetative cuttings.
- Apply a protectant fungicide programme to seed-raised crops during the production phase.
- Monitor crops carefully for signs of the disease, provide good levels of ventilation and don't water crops late at night.
- Send infected plants to Fera for metalaxyl-M sensitivity testing.
- Dispose of infected plant material into sealed bags or bins.

SCIENCE SECTION

Introduction

Downy mildew of impatiens caused by *Plasmopara obducens* first arrived in the UK during 2003 and caused considerable economic damage to commercial crops and municipal plantings, especially 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 to moderate levels in 2007. In 2008, the disease was once again quite widespread and damaging, especially in municipal & other outdoor plantings. In 2011 early outbreaks originating from cutting raised product, but spreading to seed raised crops, proved difficult to control due to the emergence of metalaxyl-M resistance and resulted in devastating impacts on UK production.

Work in HDC funded projects (PC 230, PC 230a and PC 230b) has contributed to a greater understanding of the disease and hence provided guidance for minimising outbreaks (e.g. HDC briefing notes issued in 2011 and updated in 2012). It was clear from this work that spray programmes including metalaxyl-M were the most effective against the disease. With the discovery of resistance to this active ingredient late in 2011 however, growers now have to make educated guesses on suitable spray programmes. This project aimed to provide prompt identification of resistant isolates in 2012 and beyond to assist growers in making informed decisions on suitable action against outbreaks, helping to minimise spread where infections do arise. Results for 2014 are reported here.

Materials and methods

Collection of impatiens infected by downy mildew

The need for downy mildew infected impatiens to be sent to Fera was publicised to HDC levy payers through weekly news, HDC news and broadcast mail systems as well as via the HDC briefing note update on IDM.

Testing Plasmopara obducens isolates for metalaxyl-M sensitivity

On arrival at the laboratory, samples were treated in one of two ways depending on state of the sample.

1) Samples with high levels of fresh sporulation

Infected leaves were removed and sporangia washed from the leaf surface. The spore suspension was filtered through a double layer of lens tissue to remove any leaf or soil debris and the spore concentration adjusted to give 10^4 sporangia mL^{-1}. The spore suspension was then used to inoculate three replicate impatiens plants (6 week old) treated with a Subdue soil drench (at 12.5 mL product/100L water @ 10% of pot volume) two days prior to inoculation. An additional three plants, drenched with an equivalent volume of water, were inoculated as untreated controls.

2) Samples with low level of fresh sporulation or low spore viability

Sporangia were washed from the leaf and filtered through a double layer of lens tissue. The sporangial suspension was then inoculated on to a single untreated impatiens plant in order reinvigorate the disease before testing.

Directly after inoculation all plants were incubated in the dark at 5°C for approximately 18hrs. Plants were kept in a propagator top to prevent drying out of inoculum. Plants were then transferred to a glasshouse and maintained at a constant 20°C, with 12hr day period and grown on for 8-10 days. During this period plants were watered from the bottom to ensure sporangia were not produced prematurely. Sporangial production was stimulated by wetting the upper surface of leaves and incubating overnight in a propagator top. The presence of disease was confirmed by assessing the underside of leaves for the white downy growth associated with a sporulating downy mildew infection. Sporulation only on the control plants indicated metalaxyl-M sensitivity, whereas sporulation on both control and metalaxyl-M treated plants indicated metalaxyl-M resistance.

Results were sent to the HDC research manager for appropriate dissemination.

Results

In 2014, five samples were received from four locations (Table 1) with the first sample arriving late July and the last sample in mid-September. The detection of disease late in the season suggested that disease had not established from seed raised material but from other sources of inoculum e.g. previous infections. The locations of samples ranged from West Sussex in the south east of England to North Yorkshire in the north of England.

Metalaxyl-M resistant isolates of *P. obducens* were present on samples from 2 sites (the nursery and the Warwickshire garden). The garden sites in North Yorkshire and West Sussex were both infected by metalaxyl-M sensitive isolates.

This is the first time that metalaxyl-M resistant isolates have been responsible for downy mildew infection of impatiens since 2011. Summary results from the previous monitoring are shown in Table 2.

Table 1. Metalaxyl-M sensitivity of *Plasmopara obducens* isolates collected in 2014.

Sample	Date	Site	Location	Metalaxyl-M sensitivity
1 a	28/07/2014	Nursery	Cambridge	Resistant
b	04/08/2014			Resistant
2	08/08/2014	Garden	Warwickshire	Resistant
3	01/09/2014	Garden	North Yorkshire	Sensitive
4	16/09/2014	Garden	West Sussex	Sensitive

Table 2. Metalaxyl-M sensitivity of *Plasmopara obducens* isolates collected during the 2012 and 2013 monitoring.

Year	Number of samples	Date	Site	Metalaxyl-M sensitivity
2012	9	June to September	3 Nursery 6 Garden	All sensitive
2013	0	-	-	-

Discussion

In 2014, impatiens downy mildew infections caused by metalaxyl-M resistant isolates of *P. obducens* were detected for the first time since 2011. However, the level of incidence was much lower than that reported in 2011. Both the sites where the metalaxyl-M resistance was detected in 2014 previously had downy mildew infections. This leads to the possibility that the metalaxyl-M resistant isolate has lain dormant in the soil rather than being introduced from another location. Samples from these sites have not been tested before so it is not possible to be certain which scenario is correct. However, this may not be the whole story. During June there were reports of downy mildew infections on impatiens being grown on the continent. As a result it cannot be discounted that infected finished material has been transported into the UK with infections caused by the metalaxyl-M resistant strain of downy mildew.

Even so, this is the first data to suggest that metalaxyl-M resistance in *P. obducens* has the potential to persist and establish itself in the wider environment.

Conclusions

The low level of disease on nurseries may reflect the success of the decision by the majority of UK growers to produce only seed raised impatiens.

The detection of metalaxyl-M resistant isolates of *P. obducens* in the wider environment suggests that it has been able to persist. The late season expression of the disease suggests that inoculum from the metalaxyl-M resistant strains in the wider environment would arrive too late to affect nursery production of impatiens, however the transport of infected impatiens material from continental Europe may be a concern.

Knowledge and Technology Transfer

- Continued management of impatiens downy mildew. Factsheet 05/14 (HDC projects PO 011, PO 011a and PO 012).
- HDC News article (Feb 2014)