Project title:	Herbs: A survey into the prevalence and severity of *Itersonilia* spp. in UK crops
Project number:	FV 381
Project leader:	Cathryn Lambourne, Stockbridge Technology Centre Ltd.
Report:	Final report, February 2011
Previous report:	None
Key staff:	Cathryn Lambourne Iwona Burdon* Matthew Goodson
Location of project:	STC Ltd
Industry Representative:	Tom Davies, Malvern View Herbs, Longdon Hill End, Upton upon Severn, Worcester, WR9 0RN
Date project commenced:	May 2010
Date project completed (or expected completion date):	December 2010

** Left STC December 2010*

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.

Cathryn Lambourne
Project Manager
Stockbridge Technology Centre

Signature ..... Date .....

Report authorised by:

Dr G M McPherson
Science Director
Stockbridge Technology Centre Ltd.

Signature ..... Date .....

CONTENTS

GROWER SUMMARY

Headline

- Survey results suggest that the highest risk of *Itersonilia perplexans* infection on dill occurs during September and October in each year, and that periods of high rainfall increase the risk of severe infection in crops at other times.

Background

In September 2009 a sample of dill with leaf-blight symptoms was received in the Plant Clinic at Stockbridge Technology Centre in North Yorkshire (see image below). The grower reported that several crops were similarly affected each year at around that time and that once the symptom was observed little or no control could be gained from applying fungicides. The affected crops were generally abandoned, particularly as the outdoor cropping season was drawing to a close.

Itersonilia leaf blight symptoms seen during 2009

Tests were carried out on the affected material, and a diagnosis of *Itersonilia* sp. was made. This fungal pathogen was later confirmed as the primary cause of infection following

pathogenicity testing, when the symptoms were reproduced in healthy dill plants following inoculation with the isolated organism. The same diagnosis of *Itersonilia* sp. was made on affected material supplied by the same grower to the diagnostic department at Fera. Additional work carried out by Fera later confirmed the pathogen as *Itersonilia perplexans*. Optimum conditions for the spread and development of this fungus are temperatures of 10-15°C and relative humidity >70%. Periods of heavy rainfall increase the risk of infection in susceptible crops.

As this was a newly recorded pathogen on dill in the UK some additional testing was carried out and the results were reported to the British Herb Trade Association (BHTA) at their meeting held at STC in March 2010. It was agreed that a better understanding of the incidence and severity of the leaf-blight pathogen on dill and other herbs was required to enable the BHTA to determine the potential impacts of this new pathogen/host combination on the UK herb industry.

Summary

With industry support, through HDC, information regarding the finding of this new threat to UK herb crops was circulated more widely to all herb growers via a survey and sample request letter, which was sent out via the HDC and the BHTA.

A relatively low number of samples were received during the early part of the 2010 season; however a flurry of samples were received between September and November as the weather conditions became cooler and wetter providing a more conducive environment for the spread and development of leaf-blight problems.

A total of 36 samples were received over the duration of the project. Samples of dill totaled 19, of which 15 were found to be infected with *Itersonilia* sp. Eleven coriander samples were received, but none of those examined were found to be infected with *Itersonilia* sp. Tests were also carried out on samples of flat leaf parsley, fennel and groundsel (growing in a heavily infected dill crop). *Itersonilia* was found on the various host species, although pathogenicity has only been confirmed on the parsley to-date. Unfortunately it was not possible to draw any conclusions on geographically high disease risk areas from the samples received as these came from relatively few growers overall.

I. perplexans is known to infect a number of herb species, particularly in the Umbelliferae e.g. coriander, parsley, cumin, anise, chervil, lovage and caraway, as well as members of the Asteraceae. The findings from this study suggest that the leaf-blight problem appears to be affecting dill predominantly, although this pathogen has been previously reported on coriander in the UK. However, the late findings of *Itersonilia* on parsley and fennel may be significant and may be a consequence of an increase in air-borne inoculum (spores) in herb crops generally. The potential impact of *Itersonilia* infection may vary from crop to crop. In fennel the leaf-blight, if occurring late in the season, is not likely to affect the harvested bulb, and therefore may not cause financial losses. However, if the infection arrives early, as was seen in a few dill crops in 2010, the loss of foliage would have a more dramatic effect on bulb development in fennel. Parsley is a high volume crop and loss of production due to leaf-blight symptoms would result in a severe financial impact for growers.

The fungus is spread primarily by spores fired into prevailing wind currents, however it may also be relevant to consider alternative methods of spread e.g. seed-borne and also spores spread from weed species present in or around susceptible crops.

Financial Benefits

The scope of this study was to gather information on behalf of the UK herb industry. No financial benefits have resulted from this work to-date.

Action Points

- Herb growers should remain vigilant and become familiar with the host range of this pathogen i.e. dill, parsley, fennel, coriander, cumin, caraway and perhaps tarragon and chamomile. Particular attention should be paid during or following periods of high rainfall.

- Where possible plants affected by leaf-blight should be removed as soon as possible following detection to minimize risk of spread.

- No information on the potential of fungicide efficacy is known at this time, however broad spectrum fungicides such as the strobilurin fungicides e.g. Amistar (azoxystrobin) may be beneficial.

- As additional HDC funding has been provided to extend this survey for the 2011 season growers are kindly requested to send any suspect herb material to the STC Plant Clinic for diagnosis during the coming season. There will be no Plant Clinic charge for these samples. The quality of the information produced from that work will depend heavily on grower participation. All samples will be treated in confidence and anonymity in the final report is assured.

SCIENCE SECTION

Introduction

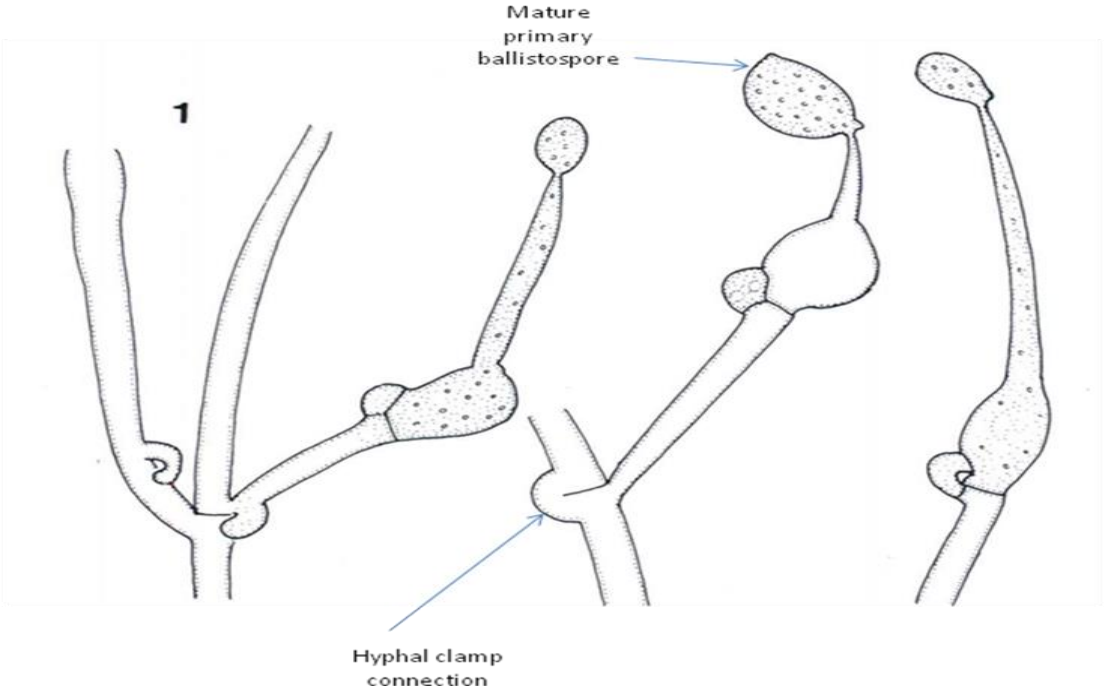
Leaf blight symptoms had been observed on both dill and coriander crops since 2003 (Peter Knight pers. comm.), though the primary cause remained unclear. Samples of dill with severe leaf blight symptoms were received at the Stockbridge Technology Centre (STC) Plant Clinic in September 2009. An *Itersonilia* sp. was diagnosed as the likely cause of the leaf blight and this was later confirmed by pathogenicity testing. Further confirmation of this diagnosis was provided by Fera, who subsequently carried out molecular tests and identified the organism as *Itersonilia perplexans*. Further samples received from other growers were also found to be infected with *Itersonilia* sp.

Figure 1. Typical leaf-blight symptoms on dill.

Although *Itersonilia* sp. is a well recognised pathogen in a number of other crops in the UK and overseas, no records of this pathogen/host combination had been previously reported in the UK, although records of this leaf blight pathogen on dill had been reported in Australia (Aldaoud, 2009) and in Europe (Rodeva, 2009) in the same year.

Itersonilia is a genus of the Basidiomycete family of fungi. Fungi in this group produce specialist spores called ballistospores which are actively 'fired' into the air by the fungus under suitable environmental conditions to infect new material on wind currents. It is possible, though not yet proven in herbs, that the fungus may be seed transmitted. This is reported with *I. pastinaceae* on parsnip seed and therefore warrants further investigation. During this investigation we carried out tests on the weed species groundsel (*Senecio vulgaris*) which was exhibiting leaf-blight symptoms and confirmed the presence of *Itersonilia*. We were not able at the time to carry out pathogenicity tests to determine if this was the primary pathogen on this weed. However, the fact that it was able to be infected also suggests that it may act as a source of inoculum in various crops. There are two important plant pathogenic members of the *Itersonilia* genus – *I. perplexans* and *I. pastinaceae*. These organisms have been reported as pathogens on several economically important crops including parsnips, chrysanthemum, gerbera, parsley, parsnip and carrot. Early symptoms on dill are described as small grey/green spots on the leaves. However, infection progresses quickly to cause death of leaflets and eventually to the complete collapse of the plant when conditions are optimal for the pathogen. Development and spread of infection is favoured by high rainfall periods producing high RH (>70%) and cool temperatures (10-15°C).

Figure 2. *Itersonilia perplexans* (from Trans. Br. Mycol. Soc 82, 13-29, Webster, Davey, Duller & Ingold 1984)



Contact with several of the growers where the pathogen was confirmed on susceptible crops suggested that it was causing almost complete collapse of the dill crop and thus was incurring significant costs in terms of lost income. Further discussion with the UK herb growers resulted in the proposal for this project being developed. The primary aim being to carry out a survey of UK herb crops during 2010 to determine the incidence and severity of *Itersonilia* infection on herbs. It was hoped that this information would provide herb growers with a greater understanding of the infection and allow them to determine whether further work to investigate possible control measures for *Itersonilia* infection might be required in the future.

Materials and methods

Information and sample collection

In April 2010 a letter was circulated by the HDC and also the British Herb Trade Association to all herb growers in the UK (Appendix 1). This provided details of the problem and the project and invited growers to send any plant samples that they were suspicious of being infected with a leaf-blight organism to the STC Plant Clinic for diagnosis. Growers were requested to monitor all umbelliferous herb crops e.g. dill, coriander, parsley, fennel, cumin etc. for signs of infection. It was also requested that they monitor weed species in close proximity to the crops for signs of foliar pathogens as some weed species may be providing a source of infection for transfer to the crop.

Work and discussion on the pathogen from the previous year had indicated that the most likely time for infection in outdoor crops was September/October as environmental conditions prevalent at that time of year were most conducive to the spread and development of infection i.e. during cool, damp weather. Therefore, a second letter was sent out to growers to remind them of the project in October 2010.

As the end of project approached an additional letter and questionnaire was circulated to growers, again via HDC and BHTA, to gather information on growers experiences of the leaf blight problem during the season (Appendix 2). Following discussion at BHTA meetings and the provision of photographs of symptomatic plants it was considered possible that many growers were self-diagnosing in their crops. It was also thought that time limitations, experienced by all growers during the season, may have been reducing the number of samples sent in, thereby adversely affecting the data that could be collected.

Sample handling

When samples of infected leaf material were received they were booked into the STC Plant Clinic. Samples were examined using low and high power microscopy to determine whether any spores consistent with *Itersonilia* spp. were present. Diagnostic tests were then initiated e.g. aseptic direct isolations on to potato dextrose agar and also selective suspended tissue tests.[1] which involve attaching plant tissues to the lid of a petri-dish using double sided tape

[1] The suspended tissue test is a selective isolation technique that relies on the ability of basidiomycete fungi to actively 'fire' ballistospores from infected tissues. The approach prevents growth of faster growing saprophytic fungi and bacteria, allowing selective growth of the slower-growing *Itersonilia* species.

or Vaseline and placing over artificial growth media (PDA or similar). This method is particularly suited to basidiomycete fungi as ballistospores are 'fired' onto the agar and resulting isolations are often free from other contaminating fungi or bacteria that might be present in the plant tissues. The isolation tests were checked after approximately 48hours for the presence of mycelium and spores consistent with *Itersonilia* spp. A report on the findings was sent back to the originator of the sample and details were retained for inclusion in the project report.

Results

A total of 36 samples of plant material with leaf-blight symptoms were received between May and November 2010.

Tests were carried out on all received samples with the following findings.

Table 1. Details of the samples received and the outcome of laboratory tests.

Crop	No. of samples received	Month received (2009)	*Itersonilia* spp. detected +/-
Coriander	1	May	-
Dill	1	May	+
Coriander	1	May	-
Coriander	1	May	-
Coriander	1	June	-
Coriander	5	July	all -
Red Chard	1	July	-
Dill	3	August	all -
Coriander	2	August	both -
Parsley	1	August	-
Dill	1	September	+
Dill	1	September	+
Dill	1	September	-
Dill	1	September	+
Dill	1	September	+
Dill	1	October	+
Dill	2	October	both +
Groundsel	1	October	+
Dill	5	October	all +
Fennel	1	October	+
Parsley	1	October	+
Dill	2	November	both +
Groundsel	1	November	+

In summary:-

- 19 dill samples were received, 15 of which tested positive for *Itersonilia*.
- 11 coriander samples were received, no *Itersonilia* was detected.
- 2 parsley samples were received, *Itersonilia* was detected on 1.
- 1 fennel sample was received which tested positive for *Itersonilia.*
- 2 groundsel samples were both found to be infected with *Itersonilia.*

One dill sample was found to be infected with *Itersonilia* early in the season – May, whilst the vast majority of the *Itersonilia* infected dill samples were received from September onwards

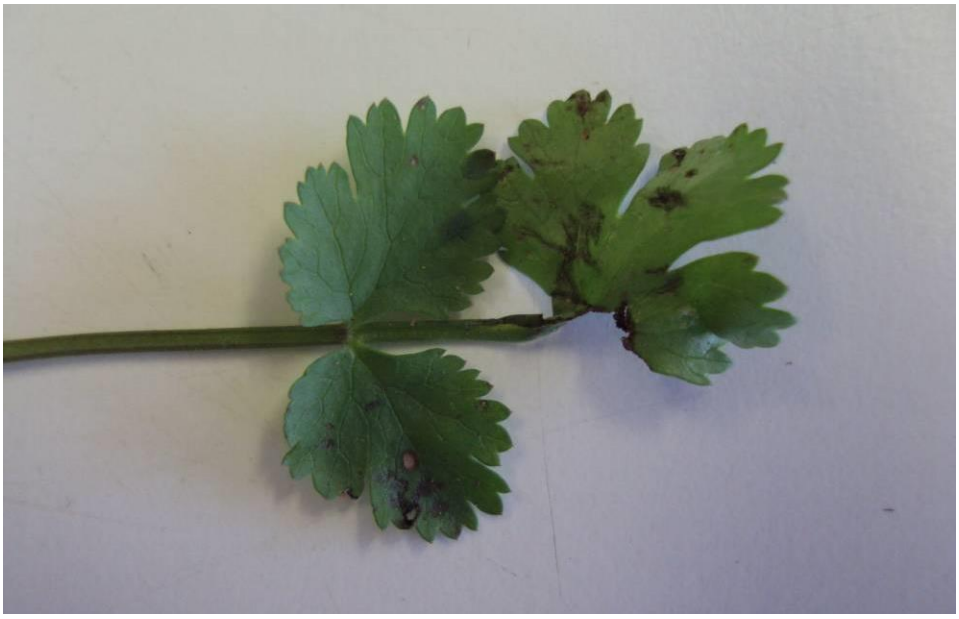
and this corresponds with the periods of cool weather with high humidity which are most conducive to disease development and spread.

Little information regarding the cultivars of dill was provided by growers, although information provided by Tom Davies (Project co-ordinator) suggests that most growers are growing just one main variety – Dukat which is available from many suppliers in the UK. Samples received during the project were often repeat samples from approximately 5 growers, and whilst it was useful to carry out regular crop monitoring at these sites, this factor does mean that no clear indication of the potential for geographical high-risk areas was observed.

Only one or two growers provided information on fungicides that had been applied when sending in samples. In these instances Amistar (azoxystrobin) or Signum (pyraclostrobin + boscalid) were being used, but with little reported control of the problem. Most growers report that once the infection is seen, usually in patches or corners of the field, it is too late to gain any control with fungicides and the area of affected crop must be considered un-harvestable.

The findings of *Itersonilia* on flat leaf parsley, fennel and groundsel are of much interest and are potentially significant. The isolate collected from the infected parsley was re-inoculated on to fresh parsley material and found to be pathogenic. Although bacterial cultures isolated at the same time were also found to be causing lesions. This suggests that the infection on the parsley was mixed, but that both organisms were pathogenic.

Figure 3. Leaf blight symptoms on flat leaf parsley.



Pathogenicity tests were not carried out on fennel or groundsel, however this may be included in later work to be carried out during the extension to this project FV 381a (2011).

All collected isolates were added to the STC culture collection in case of further studies being carried out.

There was a very low response rate to the 'end of season' questionnaire with only five responses being received.

Of these:-

- 4 had seen leaf-blight symptoms that they believed to have been caused by *Itersonilia*.
- Four felt they had seen similar symptoms in previous years.
- Four had had symptoms confirmed as being caused by *Itersonilia* during the 2010 season.
- 1 grower saw only 10% of his crop affected, other respondents reported between 50 and 100% of the crop affected and destroyed. Financial losses in 2 crops were £2,500 and £12,000.
- 4 respondents felt that further investigation regarding the incidence and control of infection was required.

Discussion

The results of the survey of UK herb crops gathered during the 2010 season support our initial knowledge of the leaf-blight pathogen. The majority of the confirmed *Itersonilia* sp. infections resulted from samples received from September through to November when the majority of outside crops have been harvested. Although one sample received in May was also found to be infected. This sample came from a crop sown under fleece in February for harvest in May.

No pot-grown dill samples were received and this may suggest that the different environmental conditions experienced by these crops is far less conducive to the development and spread of infection, being a more controlled, drier and warmer regime. Samples collected from a soil-grown crop in a polytunnel in November were found to be heavily infected with *Itersonilia*, however the grower described drainage and irrigation problems in the patches of the crop most severely affected and this supports the view that high humidity conditions are required for infection.

Discussion with growers following receipt of samples or at BHTA meetings suggests that few growers have had success with controlling infection in the field, and that once the symptoms are seen it is too late to apply fungicides or gain control and the area of the crop affected was generally unmarketable. Mostly infection was reported to be patchy, affecting certain areas of the crop, notably those areas with poor drainage. However some growers have reported entire crops being affected with severe economic losses incurred and often causing shortages in fulfilling orders for growers.

The diagnosis of *Itersonilia* on parsley and fennel are potentially significant. Leaf-blight late in the season may not be too damaging in fennel when the harvested bulb is already well developed. However, if infection were to occur early in the season this might be expected to have greater consequences for crop development and quality. Parsley is one of the more widely grown and high value herb crops in the UK and loss of leaf quality at any stage in the crop development would have the potential to impact heavily on sales.

The finding of *Itersonilia* on the common crop weed groundsel warrants further investigation. This may be providing an inoculum source within crops aiding spread of infection. Cross-inoculation studies to confirm inoculum transfer are advisable.

Conclusions

The information gathered on the incidence and severity of *Itersonilia* in UK herbs during the 2010 season does suggest that some growers are experiencing problems with the pathogen, but that their experiences are variable and generally dependent on weather conditions in their location and drainage within the crops. When *Itersonilia* infection takes place it can be in localized patches or can, in some cases, affect the whole crop when weather conditions are conducive to spread. When this occurs serious financial losses are experienced.

Preliminary results reported here were reported to the BHTA at their technical meeting, albeit before the end of the project period in October 2010. Association discussed the findings at their closed meeting later in the day and concluded that the collection of additional data from another season (2011) was required to gain a clearer picture of the true impact of this new pathogen on UK herbs.

The number of respondents to the various requests for samples and feed-back on growers' experiences of the leaf-blight problem in crops was low, and if further work over another season is to be conducted, this problem must be overcome to enable the project team to draw clearer conclusions and to make recommendations regarding the potential need for further work e.g. to investigate better control methodologies.

Knowledge and Technology Transfer

March 2010 – Poster & Presentation to BHTA
October 2010 - Presentation to BHTA
Article for BHTA Newsletter
Article for HDC News

References

Aldaoud R, et al, (2009) First record of *Itersonilia perplexans* on Anethum graveolens in Australia, Australian Plant Disease Notes, 4, 60-61.

Rodeva R, et al (2009) First evidence of *Itersonilia perplexans* on dill in Bulgaria, Scientific works of the Lithuanian Institute of Hort. and Lithuanian University of Ag. Sodininkysté ir Daržininkysté.

Acknowledgements

STC would like to thank all the growers who sent in samples or provided information for the 2010 survey. Thanks also to Tom Davies and Peter Knight for generously sharing their knowledge and experience.

Finally, thanks to the industry and HDC for funding the completed survey and for providing funding for further work in 2011.

Appendices

Appendix 1 – Sample request letter

BHTA Members
UK Herb Growers

Stockbridge Technology Centre
Leaders in Technology Transfer to Agriculture and Horticulture

April 2010

Dear all

HDC Project FV 381 – Surveying leaf-blight (*Itersonilia* spp.) in herb crops

As many of you will be aware, samples of UK field dill with a leaf-blight symptom were diagnosed as being infected with *Itersonilia* sp. at STC in Sept/Oct 2009. This was subsequently confirmed as *I. perplexans* by Fera. Although the *Itersonilia* fungus is a well recognised pathogen in other crops e.g. parsnip and chrysanthemum it has not previously been recorded in the UK on this host. It has since also been confirmed on UK coriander.

So far, whilst these findings are few in number, they have caused significant crop losses to at least one UK grower. The BHTA feel it is important that the problem is monitored during the 2010 season to get a better impression of the severity and distribution of the problem to umbelliferous (and possibly asteraceae) herb crops in the UK. The HDC have funded a small-scale study (FV 381) to be undertaken from April – December 2010 to gather the required information.

I would therefore like to invite you to take part in this national survey of UK protected and field herbs to enable STC to meet this goal. You can help by monitoring your umbelliferous herb crops (dill, coriander, fennel, cumin, parsley, anise, chervil, caraway and lovage) for any signs of leaf-blight (see the attached sheet for pictures). However, it may also be worth checking on any umbelliferous weeds that may be present around field/site margins e.g. cow parsley and also weeds of the Asteraceae e.g. dandelion, groundsel, mayweed, thistles, as these may be providing a 'green bridge' for the leaf infection. As the fungus can also be pathogenic on members of the Asteraceae (previously the Compositae) family you should also check these crops e.g. tarragon, chicory, globe artichoke etc. if grown and submit samples if required.

I have enclosed a sample submission form with details of how to package and send samples to me at the STC plant clinic. Samples received will be examined and tested for *Itersonilia* **free of charge**. **Results from these samples will be forwarded to you by email** in the first instance, but will also feed into the project anonymously to allow us to build a complete picture of the problem. Some of the gathered information should be available by October – hopefully in time for the next BHTA technical meeting. The full project results and report will be available in December 2010.

Many thanks in anticipation of your help.

Yours sincerely

Cathryn Lambourne
Plant Pathologist
Stockbridge Technology Centre Ltd.

PS – this letter has been kindly circulated via BHTA and HDC – apologies to any growers who receive this communication twice.

Stockbridge Technology Centre
PLANT CLINIC SERVICES – Herb Survey work FV 381

Name	
Company	
Address Postcode	
Phone Mobile Email	

The Sample	
Plant type – Genus, species, variety/cultivar / common name	
Distribution of the problem (% of crop affected)	
Source of plant material e.g. cutting, seed, weed	
Where is the crop grown? e.g. protected, shaded, outdoors etc.	
What are the symptoms? Briefly describe the problem as you see it.	
Have you seen this symptom in previous years? Please give details	
Are nearby crops affected if susceptible? e.g. either on your site or neighbouring fields	
Previous cropping history? Can you give details of the previous 2 crops if field grown.	
Weather conditions – can you provide brief details of prevalent conditions immediately prior to seeing the problem, especially temps & rainfall?	
Fungicides applied – and impression of the level of control seen?	

Sample selection

On dill the leaf-blight symptoms appear as shown below. However, on other crops the symptoms may vary slightly, possibly including stem lesions or smaller more discrete spots.

Please feel free to send more than one sample over the growing period as the problem may show up on crops at different times of year (it was first seen in September on dill). Also remember to check umbelliferous weeds around the field margin if crop plants are affected.

Sending the samples

Samples can be sent by post, courier or dropped off directly at Stockbridge Technology Centre. In all cases it is important that samples arrive in excellent condition to enable accurate diagnosis, therefore please:

- Select plant material immediately before sending to the clinic; if there is any delay then store in a cool place out of sunlight.
- Wrap the plant material in newspaper or paper towel and pack in a strong padded envelope or box. If sending in a box, then pad-out with newspaper to restrict movement.
- Where possible pack the samples to avoid soil/compost contamination of the foliage.
- Ensure all samples are clearly labelled.
- Complete the Plant Clinic form, place it in an envelope and send it with your sample.

DO NOT SEND SAMPLES ON A FRIDAY UNLESS THEY ARE SURE TO ARRIVE BEFORE THE

LABORATORY CLOSES AT 5PM.

The Plant Clinic
Stockbridge Technology Centre
Cawood, Selby
North Yorkshire YO8 3TZ
Tel: + 44 (0) 1757 268275
Email: plantclinic@stc-nyorks.co.uk
cathrynlambourne@stc-nyorks.co.uk

Appendix 2 – End of season survey letter

Stockbridge Technology Centre
PLANT CLINIC SERVICES – Herb Survey FV 381

Name	
Company	
Address Postcode	
Phone Mobile Email	

Itersonilia leaf blight symptoms seen during 2009

Have you observed foliar blight on any crops which you attributed to *Itersonilia* during 2010?..... Yes/No

Do you believe you have experienced this blight in previous years?.....Yes/No

Did you have the cause of the blight identified at STC or elsewhere? ..... Yes/No

Please turn over

If you have experienced *Itersonilia* blight problems during 2010 please fill in the table below with as much information as possible.

Crop	Cultivar	Location	% crop affected	Action taken (crop destruct, fungicide app. etc)	Estimated financial loss

Fungicides used

Please give details of any fungicides applied that you felt showed some effect on the leaf blight.

.....

.....

.....

.....

.....

Do you feel deeper investigation of this blight needs to be developed at this time? Yes/No

Many thanks for completing this form. Any information provided and used in the final report will be done so anonymously.
Please return to:

Cathryn Lambourne
Stockbridge Technology Centre
Cawood
Selby
North Yorkshire
YO8 3TZ

