Factsheet **16/10**
Herbs

Horticultural Development Company
Stoneleigh Park
Kenilworth
Warwickshire CV8 2TL
T: 02476 692051
E: hdc@hdc.org.uk

Coriander Bacterial Blight

By Steve Roberts, Plant Health Solutions and Kim Green, ADAS

This fact sheet describes the symptoms of bacterial blight in coriander, its biology and a management strategy for disease control based on the results of recent HDC funded work as part of projects FV 318 and FV 403.

Background

Coriander (*Coriandrum sativum*) is one of the major field-grown herb crops in UK. Crops are grown at high densities for fresh leaf production.

Bacterial leaf spot/blight has been a recurring problem on these field-grown crops, and has also been reported in protected pot-grown production.

The disease was first seen in the UK in 1967, but was not formally reported in the scientific literature until 1980. It has also been reported in Australia, Germany, Hungary, Mexico, Spain and the USA. The disease is also described as umbel blight and seed decay in some of these reports.

Given that there is no formal requirement for coriander seed to be tested for bacterial blight, it is likely that it is more widely distributed, wherever coriander is grown.

There have been only a few studies on coriander bacterial blight, and these have tended to focus on crops harvested mature as a spice/seed crop.

In 2007, as part of project FV 318, the HDC agreed to fund work aimed at improving the management of this disease with a focus on seed health standards. The factsheet has been updated following more recent work to examine the host range of the pathogen (FV 403).

Symptoms

Lesions may occur on all plant parts, and initially appear as dark brown/black necrotic lesions with a water-soaked margin (Figure 1).

Infected seeds may fail to emerge. Early infections on seedlings and cotyledons are difficult to spot (Figure 2), and can lead to seedling death (Figure 3).

Leaf spots are often angular, delimited by veins (Figure 1), and clearly visible when viewed from both sides of the leaf. As they develop, and depending on conditions, individual lesions may coalesce into larger 'blighted' areas. Individual lesions may be surrounded by chlorosis (yellowing) and severely affected leaves also show yellowing and premature senescence. As they age, leaf spots may also develop a pale tan centre with a darker margin.

On plants allowed to bolt, stem lesions may result in collapse; on infected flowers, petals may become brown and fall prematurely. Water-soaked lesions can develop on the green unripe fruit; these can later become dark and shrivelled.

The disease can be confused with physiological disorders such as 'oedema', 'blue spot' or 'tip-burn', so it is important to obtain an accurate diagnosis. A characteristic feature of both 'blue spot' (Figure 4)

1. Typical brown necrotic leaf lesions caused by *Pseudomonas syringae* pv. *coriandricola*. Stem lesions are also visible to the left and right.

2. Dark water-soaked lesion on a cotyledon caused by *Pseudomonas syringae* pv. *coriandricola*

3. Seedling collapse as a result of infection by *Pseudomonas syringae* pv. *coriandricola*

4. 'Blue spot' symptoms are only visible on the upper leaf surface.

5. 'Oedema' symptoms are only visible on the upper leaf surface.

6. Symptoms on parsley leaves, caused by *Pseudomonas syringae* pv. *coriandricola.*

and 'oedema' (Figure 5) is that unlike bacterial blight, the lesions are only apparent when viewed from the upper leaf surface.

Parsley can also be infected and shows similar symptoms to those seen on coriander (Figure 6). These symptoms could easily be confused with septoria leaf spot.

For more information on disease symptoms caused by other pathogens, see the *HDC Herbs Best Practice Guide* at http://www.hdc.org.uk/herbs/.

The Pathogen

Leaf spot of coriander is caused by the bacterium *Pseudomonas syringae* pv. *coriandricola* (*Psc*) (Figure 6). Early reports of the disease did not identify the pathogen precisely but indicated that it was a strain of *Pseudomonas* or *Pseudomonas syringae*. It was formally proposed as a distinct pathovar by worker in Germany in 1996, with a host range limited to coriander, lovage (*Levisticum officinale*) and lady's lace (*Ammi majus*). However recent results from the USA, and confirmed in HDC project FV 403, indicate that it can also infect parsley and celery.

Infection

The bacterium infects via natural openings and wounds, and can spread through the vascular system.

Precise conditions for infection and disease development have not been established, but coriander bacterial blight is considered a disease of cool, wet weather.

Epidemiology

Inoculum sources

Work at the National Vegetable Research Station in the 1970s showed that the disease was seed-borne. This was confirmed in later studies in Germany and Australia, so the disease is considered to be primarily seed-borne.

Tests on coriander seed lots from several different seed companies done as part of FV 318, confirmed the presence of *Psc* in some seed lots, with infection levels as high as 5%.

There has been no specific work to examine the survival of the pathogen in the field in the soil or in crop debris. By analogy with seed-borne diseases of other crops caused by similar pathovars of *P. syringae* (e.g. pea bacterial blight) long-term survival in the soil/field is unlikely.

Crop debris and residues from a previously infected crop may provide an inoculum source over the short-term, especially within a growing season, and particularly if the rate of debris breakdown is limited by dry or cold conditions.

Epiphytic survival

Again by analogy with other similar diseases caused by *P. syringae* pathovars, it is likely that *Psc* can survive and possibly multiply on leaf surfaces in the absence of symptoms. (i.e. as an epiphyte). Thus, the absence of symptoms does not necessarily mean that the pathogen is also absent; an aspect that is particularly important in the context of seed crops.

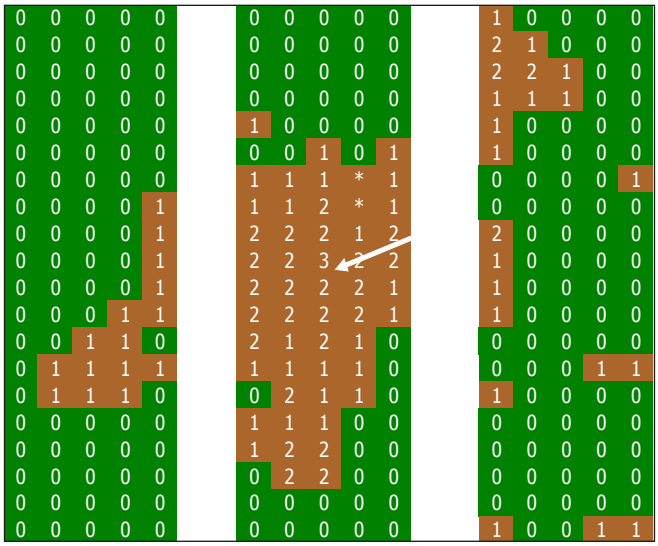
Recent studies

Studies done as part of HDC project FV 318 focussed on two aspects that are important for determining seed health standards:

- Quantifying the rate of transmission from seed to seedling.
- Quantifying the rate of spread in the field.

7. Examining the rate of disease spread from a point source in the centre of the plot.

8. (Right) Map of disease spread in field trial. The arrow indicates primary infection. Numbers represent disease severity (0-4 scale).



Seed to seedling transmission

Using dose-response data from glasshouse experiments the 'one-hit' probability of transmission is estimated as 0.00018; this is the probability that a single bacterium on a single seed will be transmitted to the resulting emerged seedling(s).

Spread in the field

In common with many other bacterial diseases secondary spread within a crop occurs by water-splash (rain or irrigation), wind-driven rain and via the movement of people, animals, insects and machinery.

FV 318 looked at the rate of disease spread from a single primary infection, initiated soon after emergence, in a series of field trials simulating crops for fresh leaf production (Figure 7).

Inevitably the rate of spread varied from trial to trial depending on the weather conditions during the trial period. In the worst case, spread resulted in disease incidence of up to 30% (in a 10 m x 3 bed plot) by eight weeks after sowing (Figure 8).

Control

The most effective way to manage coriander bacterial blight is to use 'clean' seed which has been tested and shown to meet minimum seed health standards.

It is important that seed is tested, as visual inspection of seed crops is not a reliable indicator of the health of the harvested seed.

Seed health standards

The transmission and spread data obtained in FV 318 have been used in mathematical models to examine the risks of sowing seed with different infection levels in relation to the probability of detecting them; some example scenarios are shown in the table below. Based on these results it is recommended that seed health test protocols should be designed to achieve a tolerance standard of 0.03% (i.e. less than 1 infested seed in 3,000) and an analytical sensitivity of 900 CFU (colony forming units, a measure of bacterial numbers) with 95% probability. This means testing at least 9,000 seeds.

Seed treatment options

There are currently (03/2010) no approved chemical seed treatments for the control of coriander bacterial blight in the UK.

Results of tests, done as part of FV 318, indicate that hot water treatment has considerable potential to reduce or even eliminate seed-borne *Psc*. Infection was reduced to undetectable levels in five out of six seed lots, and with a 20-fold reduction achieved in the remaining seed lot by treatment at 53°C for 30 minutes.

This temperature-time regime is at the borderline of safety for germination, and so there was a slight reduction in germination compared to untreated seed for some seed lots (improvement in others). In these seed lots reducing the temperature by 1°C achieved similar levels of control without loss in germination.

Other bio-treatment options were also examined in FV 318: thyme oil, Subtilex and Serenade. Although not as effective as hot water, all gave useful reductions in seed infection levels. Note that none of these products have approval as a seed treatment in the UK. The use of general disinfectants such as peroxyacetic acid or sodium hypochlorite (bleach) as seed treatments is not permitted without a specific approval.

Table 1. Example risk scenarios for a sowing of 1 million coriander seeds (~0.36 ha, ~10 kg) with different seed infection levels

Seed infection			Prob.	Spread[3]		Pr +ve seed test[4]		Overall risk[5]	
1 in	%	CFU[1]	Trans.[2]	Max %	Avg %	1 x 3k	3 x 3k	1 x 3k	3 x 3k
30,000	0.003	1 x 10^2	0.019	19	0.37	0.03	0.08	0.02	0.02
		1 x 10^3	0.037	19	0.70	0.09	0.25	0.03	0.03
		1 x 10^4	0.069	19	1.31	0.10	0.26	0.06	0.05
		1 x 10^5	**0.128**	19	2.43	0.10	0.26	0.12	0.09
15,000	0.007	1 x 10^2	0.038	33	1.26	0.06	0.16	0.04	0.03
		1 x 10^3	0.072	33	2.38	0.18	0.44	0.06	0.04
		1 x 10^4	**0.133**	33	4.40	0.18	0.45	0.11	0.07
		1 x 10^5	**0.240**	33	7.91	0.18	0.45	0.20	0.13
10,000	0.010	1 x 10^2	0.057	45	2.56	0.08	0.23	0.05	0.04
		1 x 10^3	**0.106**	45	4.78	0.25	0.58	0.08	0.04
		1 x 10^4	**0.193**	45	8.70	0.26	0.59	0.14	0.08
		1 x 10^5	**0.337**	45	15.17	0.26	0.59	0.25	0.14
5,000	0.020	1 x 10^2	**0.111**	70	7.75	0.16	0.40	0.09	0.07
		1 x 10^3	**0.201**	70	14.07	0.44	0.82	0.11	0.04
		1 x 10^4	**0.349**	70	24.45	0.45	0.83	0.19	0.06
		1 x 10^5	**0.561**	70	39.25	0.45	0.83	0.31	0.09
1,000	0.100	1 x 10^2	**0.444**	95	42.14	0.57	0.92	0.19	0.03
		1 x 10^3	**0.674**	95	64.08	0.94	1.00	0.04	0.00
		1 x 10^4	**0.883**	95	83.92	0.95	1.00	0.04	0.00
		1 x 10^5	**0.984**	95	93.45	0.95	1.00	0.05	0.00

Notes:
[1] No. of bacteria per infested seed. [2] Probability of transmission. [3] Predicted disease incidence by 8 weeks after sowing. [4] Prob. of positive test result for a test on one or three sub-samples of 3,000 seeds. [5] Probability of transmission x probability of a negative test result; dark shaded values are considered to represent an unacceptable level of risk (i.e. > 10%).

Foliar treatments

Research in Australia on seed/spice crops suggested that the use of copper sprays may give a reduction in disease in some circumstances, when applied at the early stages of crop development and before disease symptoms are seen, but results were variable and unlikely to be economic. In any case there are currently no approvals for the use of copper compounds on coriander.

The biological control agent Serenade ASO (based on a strain of *Bacillus subtilis*) has an extension of authoraisation (EAMU) for use on herbs, and is known to have activity against bacteria, but its efficacy as a foliar spray for control of coriander bacterial blight has not been examined.

Action points

For growers

- Check with seed suppliers that seed has been tested and meets the minimum recommended health standard of <0.03% with a test sensitivity of ca. 900 CFU.
- Be aware of the potential for cross-infection with parsley.
- Inspect parsley for signs of bacterial disease - do not assume that leaf spots on parsley are caused by Septoria.
- Minimise the movement of machinery and people within and between crops.
- Incorporate or destroy crop debris as soon as possible after harvesting.
- Do not grow crops in the same field more than once every two years.
- Do not enter crops when wet.
- Wash hands/clothing when moving between crops.
- Clean/disinfect drilling equipment between seed lots.
- Clean/disinfect machinery between crops/at the end of the season.

For seed companies/ suppliers

- Take precautions to avoid cross-contamination between seed lots via dust/debris.
- Vacuum, clean and disinfect machinery, storage areas/bins between seed lots.
- Test seed prior to cleaning and processing.
- To ensure accuracy, it is important that samples for seed testing are obtained according to the *International Rules for Seed Testing*.
- Discard or hot-water treat seed lots with infection levels >0.03%.
- Re-test treated seed.
- Process/clean the cleanest seed first.
- Consider applying a more stringent seed health standard for seed used for seed crops.
- Consider hot-water treatment of seed used for seed-crops regardless of health status.
- Consider testing parsley seed for *Pseudomonas syringae* pv. *coriandricola* as well as *Septoria petroselini.*

Laboratory testing

Diagnosis

For general diagnosis and confirmation of disease symptoms, send samples with a range of symptoms (wrapped in absorbent paper towel inside a polythene bag) to a laboratory specialising in the diagnosis of bacterial diseases, e.g.

Plant Health Solutions - www.planthealth.co.uk

FERA - www.fera.defra.gov.uk

Seed health testing

There is no generally accepted/ published or standard method for the detection of *Psc* in coriander seed.

Plant Health Solutions offers a commercial testing service for the detection of *Psc* in coriander seed. Other seed health testing laboratories (e.g. NIAB, SASA, FERA) may also be able to offer a test, but it is important to establish the level of validation and that the test can reliably achieve the required standards.

Further information

More information on the work done as part of Projects FV 318 and FV 403 can be found on-line at http://www.hdc.org.uk/. Copies of the complete final reports are available by contacting the HDC at hdc@hdc.org.co.uk.

Acknowledgements

We are grateful to the seed companies that supplied seed for use in HDC project FV 318. All images except for Figure 5 are copyright Plant Health Solutions. The ‘oedema’ image is courtesy of Nathalie King, University of Birmingham.

Whilst publications issued under the auspices of the HDC are prepared from the best available information, neither the authors or the HDC can accept any responsibility for inaccuracy or liability for loss, damage or injury from the application of any concept or procedure discussed.

© 2012
Agriculture and Horticulture Development Board. No part of this publication may be reproduced in any form or by any means without prior permission of the Horticultural Development Company.

June 2012

Design: Plant Health Solutions