**Factsheet 17/09**

**Protected Ornamentals**

Project No. PC 252

**Horticultural Development Company**

Stoneleigh Park
Kenilworth
Warwickshire CV8 2TL
T: 0247 669 2051
E: hdc@hdc.org.uk

# Seed-borne diseases of ornamentals: prevalence and control

Tim O'Neill, Kim Green, ADAS and Martin McPherson, Cathryn Lambourne, STC

**Seed-borne diseases occur sporadically on a wide range of ornamental crops. This factsheet lists some reported seed-borne diseases of major ornamentals grown in the UK. Treatments for management of seed-borne diseases are described.**

## Action points

- Be aware of the potential seed-borne origin of key diseases affecting pot plants, bedding plants and cut flowers (Table 1).
- Examine plants for disease at an early growth stage, especially those species quite commonly affected by diseases of possible seed-borne origin (eg lupin anthracnose, stock fusarium wilt, leaf spot caused by *Alternaria alternata* on lobelia).
- Take action promptly to control any disease of possible seed-borne origin when found at an early growth stage; continue monitoring the crop for the disease.
- Discuss the availability and use of seed treatments for control of seed-borne pathogens (eg with your seed supplier).

## Background

Seed-borne diseases affect a wide range of ornamental crops and potentially may result in substantial and widespread crop losses, disruption to production schedules and increased use of plant protection products. The true impact of seed-borne pathogens may be greater than is commonly appreciated due to the uncertain origin of many disease outbreaks and the potential for latency in specific pathogen groups. There is little information in the public domain on the prevalence of plant pathogens on seeds of ornamental species. HDC project PC 252 was undertaken to provide a comprehensive listing of seed-borne diseases of protected ornamental crops commonly grown in the UK, to determine the current prevalence of fungi and bacteria on some commercial seed lots and to investigate a range of potential treatment options.

**1 Botrytis stem base rot on zinnia seedlings. *Botrytis cinerea* was one of the fungi most commonly found on seed**

## Types of seed-borne diseases

Seed-borne plant pathogens may occur as:

- Contamination – the pathogen is carried as trash with the seed but is not attached to it (eg sclerotia of *Sclerotinia sclerotiorum*).
- Superficial inoculum – the pathogen is located on the outside of the seed or fruit coat.
- Internal inoculum – the pathogen is located within the seed, either in seed or fruit coat tissues, in storage tissues (eg endosperm or cotyledon) or deep-seated in the embryo.

The presence of a plant pathogen on (or in) seed does not necessarily mean that an infected seedling will result. For example, if the pathogen is present in the seed coat, this may become detached from the seedling before there is opportunity for the pathogen to infect the growing plant. A disease is only said to be seed-transmitted once it has been demonstrated that a seed-borne pathogen can give rise to infected seedlings. There is a risk that all the three types of seed-borne infection listed above may give rise to infected seedlings. However, the risk of seed transmission is greater where there is internal inoculum and the pathogen grows systemically with the plant; this is also the most difficult type of inoculum to eliminate by seed treatment. Any resultant occurrence of external disease symptoms occurring as a result of this systemic infection will also depend on the prevailing weather conditions.

## Reported seed-borne diseases

Examination of the scientific literature on protected ornamentals indicates that there are at least 246 confirmed seed-borne diseases affecting 36 crop species. A majority of these (68%) are caused by fungi, with *Botrytis cinerea* and species of *Alternaria* the most common. Some common diseases such as downy mildews, have only been confirmed as seed-borne on a few hosts largely due to the difficulties associated with their detection as they cannot be grown in culture. The advent of modern molecular diagnostic techniques for the detection of pathogens on seed is anticipated to increase the reported occurrence of such pathogens on seed, including downy mildews. It must be noted, however, that detection of DNA of a pathogen does not confirm viability of the organism or transmission from seed to seedlings. Confirmed seed-borne diseases (fungi and bacteria) of some protected ornamental species commonly grown in the UK are given in Table 1. A more comprehensive listing, covering fungal, bacterial, virus and viroid diseases on 36 crops, and suspected seed-borne diseases, is available in the 2007 annual report for PC 252. It should be noted that the frequency of a disease occurrence in a particular year does not necessarily reflect current occurrence on seed due to the possibility of various other sources of outbreaks, and environmental and other factors affecting their establishment.

**Table 1 List of some confirmed fungal and bacterial seed-borne diseases of important bedding and pot plant species grown in the UK**

| **Ornamental species and associated pathogen(s)** | **Disease** |
|---|---|
| **Alyssum** | |
| *Alternaria* sp. | Leaf spot |
| *Stemphylium botryosum* | Leaf spot |
| *Sclerotinia sclerotiorum* | Tissue rot |
| ***Antirrhinum majus* (snapdragon)** | |
| *Alternaria alternata* | Seedling malformation |
| *Botrytis cinerea* | Grey mould |
| *Colletotrichum antirrhini* | Anthracnose |
| *Heteropatella antirrhini* | Leaf spot |
| *Phyllosticta antirrhini* | Leaf spot and stem rot |
| *Pleospora herbarum* | |
| *Pseudomonas syringae* pv. *Antirrhini* | Bacterial leaf spot |
| *Puccinia antirrhini* | Rust |
| ***Cheiranthus* spp. (wallflower)** | |
| *Alternaria brassicicola* | Black leaf spot |
| *Alternaria cheiranthi* | Black mould |
| *Ascochyta cheiranthi* | Leaf and stem rot |
| *Phoma* spp. | |
| *Sclerotinia sclerotiorum* | |
| *Xanthomonas campestris* | Bacterial wilt |
| ***Cyclamen persicum* (cyclamen)** | |
| *Botrytis cinerea* | Grey mould |
| *Colletotrichum gloeosporioides* | Anthracnose |
| *Fusarium oxysporum* f. sp. *cyclaminis* | Wilt |
| *Ramularia cyclaminicola* | Leaf spot/stunt |
| *Septoria cyclaminis* | Leaf spot |
| ***Impatiens* spp. (busy lizzie)** | |
| *Alternaria zinniae* | Leaf spot |
| *Plasmopara obducens* | Downy mildew* |
| *Rhizoctonia solani* | Stem rot |
| **Lobelia** | |
| *Alternaria alternata* | Leaf spot and stem rot |
| ***Lupinus* spp. (lupin)** | |
| *Botrytis cinerea* | Grey mould |
| *Colletotrichum acutatum* | Anthracnose |
| *Fusarium oxysporum* | Wilt |
| *Sclerotinia sclerotiorum* | |
| *Verticillium albo-atrum* | Wilt |
| ***Nicotiana* spp. (tobacco)** | |
| *Alternaria zinniae* | Leaf spot |

**Table continued...**

| | |
|---|---|
| *Botrytis cinerea* | Grey mould |
| *Peronospora tabacina* | Downy mildew |
| ***Pelargonium* spp. (pelargonium, geranium)** | |
| *Pseudomonas* sp. | Bacterial leaf spot |
| ***Phlox drummondii* (phlox)** | |
| *Rhizoctonia solani* | Damping off |
| *Septoria drummondii* | Leaf spot |
| ***Primula* spp. (primrose, polyanthus)** | |
| *Botrytis cinerea* | Grey mould |
| *Ramularia agrestis* | Leaf spot |
| ***Senecio cruentus* (cineraria)** | |
| *Alternaria cinerariae* | Leaf spot |
| *Botrytis cinerea* | Grey mould |
| *Erysiphe cichoracearum* | Powdery mildew |
| **Viola (pansy, violet)** | |
| *Mycocentrospora acerina* | Halo blight |
| *Ramularia lactea* | Leaf spot |
| *Rhizoctonia solani* | Stem rot |
| ***Zinnia elegans* (zinnia)** | |
| *Alternaria zinniae* | Leaf spot/blight |
| *Botrytis cinerea* | Grey mould |

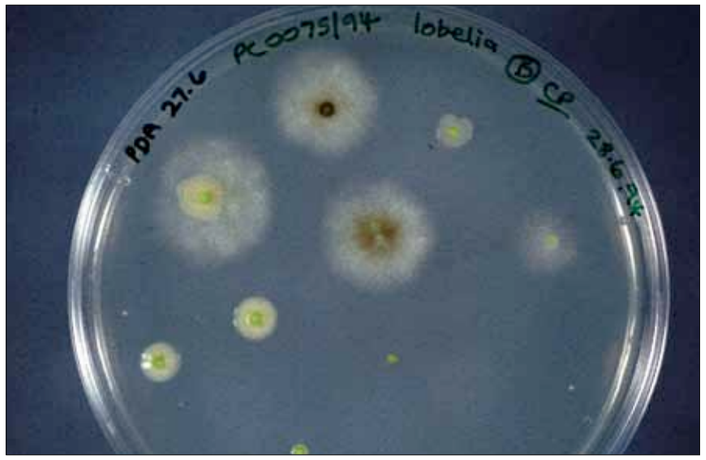
**Table 1 notes** – See the 2007 Annual Report for PC 252 for more detailed crop and pathogen lists.

*Although DNA of *P. obducens* has been detected on impatiens seed, seed transmission has not been demonstrated.

## Prevalence of fungi and bacteria associated with seed

Packets of ornamental seeds obtained from commercial growers in 2006, 2007 and 2008 were tested for seed-borne fungi and bacteria by plating onto selective agar under aseptic conditions to avoid extraneous contamination (Figure 2). Seeds were also examined for contaminating sclerotia of *Sclerotinia sclerotiorum*. From a total of 86 seed lots of 24 ornamental species tested, a majority (55%) were found to be free of fungi that might cause disease in these species. The suspect plant pathogens found most frequently were *Alternaria* species (24% of seed lots on 10 ornamental species) and *Botrytis cinerea* (17% of seed lots on 11 ornamental species). Other suspect plant pathogens detected were *Fusarium* sp. (3% of seed lots, affecting two ornamental species), *Pythium* sp. (on one lot each of aquilegia and stock) and *Phoma* sp. (on 2 lots of lychnis). Bacteria were recovered from 9% of seed lots, affecting six ornamental species, but none were identified as species of *Pseudomonas* or *Xanthomonas*, the two bacterial genera that most commonly cause bacterial diseases on ornamentals. It should be noted that not all strains of a particular fungus carried on seed will necessarily cause disease. Strain differences in pathogenicity have been demonstrated in *B. cinerea* and *F. oxysporum*, for example. Where a suspect plant pathogen recovered from seed has been identified only to genus level (eg *Alternaria* sp., *Pythium* sp.), the same qualification applies as both pathogenic and non-pathogenic species of these fungal genera occur.

Some of the more common seed-borne diseases are illustrated below. For a full listing of fungal and bacterial pathogens associated with seed, see PC 252 Annual Report 2007.




**2 Growth of *Alternaria* sp. from lobelia seed in a culture plate test to check for seed-borne fungi**

## Fungal leaf spot diseases

**Anthracnose (*Colletotrichum* spp.)**

- Seed-borne on cyclamen, lupin, lavatera and some other species
- Pink/orange-coloured spore masses develop on lesions under moist conditions (Figure 3a, 3b)
- Heat treatment reduced infection on field lupin seed

**3a, 3b Orange growth of *Colletotrichum acutatum* on lupin seed pods (left) and associated with the longitudinal lesion on the twisted lupin stem (right)**

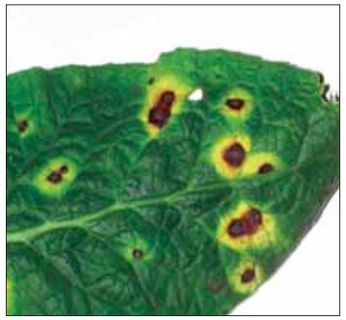
**Alternaria leaf spot (*Alternaria* spp.)**

- Seed-borne on antirrhinum, cineraria, lobelia, zinnia and some other species (Figure 4a, 4b)
- Also causes a stem rot
- Can be reduced on lobelia by aerated-steam treatment and fungicide (eg iprodione) seed treatment

**4a, 4b Leaf spot and stem browning of lobelia caused by *Alternaria alternata***

**Ramularia leaf spot (*Ramularia* spp.)**

- Suspected as seed-borne on pansy and primula (Figure 5a, 5b)
- Variable symptoms on pansy; dark spots with a yellow halo on primula
- Spread by water-splash
- Early symptoms can be mistaken for spray damage



**5a, 5b Ramularia leaf spots on pansy (left) and primula (right)**

**Septoria leaf spot (*Septoria* spp.)**
- Seed-borne on phlox, Chinese aster, foxglove and other species
- Light brown blotches which develop small dark-coloured spore cases within them (Figure 6)
- Seed-borne infection is both superficial and deep-seated in phlox

**6 Septoria leaf spot on phlox**

## Other fungal diseases

**Grey mould (*Botrytis cinerea*)**
- Can occur on many species (Figure 7a, 7b)
- Symptomless systemic infection has recently been described in primula
- *B. cinerea* may be superficial or more deep-seated on seed

**7a, 7b Grey mould (*Botrytis cinerea*) on primula (left) and zinnia (right)**

**Fusarium wilt (*Fusarium oxysporum*)**
- Seed-borne in cyclamen, Chinese aster, lupin, stock, tagetes
- Suspected as seed-borne in lisianthus (eustoma)
- White fungal growth, turning pink, develops around the stem base or petiole bases; vascular discolouration common as well as wilting (Figure 8a, 8b)

**8a, 8b Fusarium wilt in stock (left) and cyclamen (right)**

**Downy mildews (*Peronspora* and *Plasmopara* spp.)**
- Seed-borne on brassicas, sunflower, and nicotiana (systemic infection on the latter)
- Suspected to be seed-borne on lisianthus (Figure 9a, 9b)
- The importance of DNA detection of *Plasmopara obducens* on impatiens seed is still to be established

**9a, 9b Downy mildew on brassica (left) and impatiens (right)**

**Rusts, rhizoctonia and *Sclerotinia sclerotiorum***
- There are a few reports of seed-borne infection (Figure 10a) by rusts (eg antirrhinum) and rhizoctonia (eg impatiens)
- *Sclerotinia sclerotiorum* may be found as a contaminant with seed of alyssum, sunflower and other susceptible ornamentals (Figure 10b)
- For a full listing of fungal and bacterial pathogens associated with seed, see PC 252 Annual Report, 2007

**10a, 10b Antirrhinum rust (left) and *Sclerotinia sclerotiorum* on lobelia (right)**

**Bacterial leaf spot and wilt diseases (*Pseudomonas,* and *Xanthomonas species*)**
- Seed-borne leaf spots on antirrhinum, pelargonium, primula and zinnia (Figure 11a, 11b)
- Seed-borne bacterial wilt (*Xanthomonas*) on wallflower
- Suspected seed-borne infection on alyssum and salvia

**11a, 11b Bacterial leaf spots on salvia (left) and antirrhinum (right)**

# Disease management

## Seed health

The risk of introducing a seed-borne disease onto a nursery can be greatly reduced by use of good quality seed from reputable suppliers. Where required, further assurance on the health of a seed batch with regard to specified pathogens can be obtained by submitting a sample to a diagnostic plant pathology laboratory where tests for specific fungi, bacteria, viruses and viroids can also be done.

## Fungicides

Rovral Aquaflo (iprodione) is currently the only fungicide approved for treatment of seeds of ornamental plants in the UK. A greater range of seed treatments are available for ornamental seed prior to importation. Seed can be soaked for 8 h in a suspension of 1 mL of Rovral Aquaflo in 1 litre of water. The label states that lobelia, nemesia, wallflower and zinnia may be safely treated. A soak treatment may not be suitable for some species (eg alyssum, *Salvia splendens*, pansy) which have a gelatinous coat, are very hairy or are very small. The specific recommendation is for control of seed-borne *Alternaria* species. Treatment may also reduce any seed-borne *Botrytis cinerea* and *Phoma* spp. although there is no experimental work on seed-crops to support this. This seed treatment would be ineffective against some seed-borne pathogens eg downy mildews. Resistance to iprodione has been recorded in *Botrytis cinerea* (various crops) and *Alternaria alternata* (lobelia).

A SOLA application for the use of the fungicide Apron XL (containing metalaxyl-M) as a seed treatment for floriculture crops is being submitted by HDC. This treatment has potential to reduce seed-borne diseases caused by oomycetes, including downy mildew. It may also have benefits in the early control of soil-borne infection by other oomycetes such as *Pythium* and *Phytophthora* spp. A wide range of fungicides are available for management of various fungal diseases in the early stages of crop growth. See the section on further information.

## Hot water

Hot water has been used to treat seed since the 1920s and will reduce some deep-seated and more superficial infection. The optimum temperature and duration required for effective treatment varies with crop/pathogen combination and also with age and vigour of the seed batch. In an EU project on several vegetable seed diseases, the optimum treatment was 50–53°C for 10 to 30 minutes. In most cases efficacy of treatment against *Alternaria* species was high (>95%). For *Xanthomonas campestris*, good results were obtained at 50°C for 30

minutes. Hot water treatment was not tested in this project.

## Steam-air

A steam-air treatment was originally developed and validated for control of *Alternaria* spp. on lobelia by Nickerson-Zwaan. In HDC project PC 252 the original steam-air equipment was provided on loan by the company and used to investigate potential effects on seed germination and reduction of fungi on lupin, primula and tagetes seeds. A series of experiments was carried out using a range of temperatures and treatment durations. Germination rates were reduced at temperatures over 60°C in seeds of all three species. Microbial contamination was reduced on tagetes seed by treatment at 55°C for 10 minutes though germination was reduced from 98% to 64%. Steam-air treatment of lupin and primula seed either greatly reduced germination or did not reduce microbial contamination.

## Microwave

Microwaves have been used to eradicate both surface-borne and deep-seated infection on seeds of a diverse range of crops. Adverse effects on germination are reduced when smaller seeds or those with a lower moisture content are treated. In PC 252, we found germination of lupin seed was reduced when microwave duration exceeded 60 seconds, while germination of tagetes and lobelia seed was not affected after 240 seconds microwave treatment. For lobelia, lupin, primula and tagetes, microwaving for 240 seconds did not eliminate microbial contamination from seed.

## Biological control

Although some commercial preparations of microorganisms for seed treatment are available overseas, none are currently approved for use on seed in the UK.

## Plant extracts and natural products

The anti-fungal properties of some essential oils (eg thyme, eucalyptus) have been reported in research publications and their use in the liquid or vapour phase may have potential for seed treatment, especially for superficial or surface contaminants. The use of plant oils is permitted in organic agriculture under EU Regulation 2092/91. There are no essential oil products currently approved in the UK for use as seed treatments to control disease.

## Disinfectants

Commercial disinfectants cannot be used as seed treatments unless they are specifically approved for this purpose. Currently, the only approved use in the UK is sodium hypochlorite for control of *Pepino Mosaic Virus* on tomato seed.

# Further information

HDC Factsheet 11/09. Impatiens downy mildew. HDC Factsheet 13/09. Guidelines for minimising latent grey mould (*Botrytis cinerea*) in cut flowers and pot plants. HDC Factsheet 20/07. Disease control in cyclamen. HDC Factsheet 10/07. Guidelines on nursery hygiene for outdoor and protected ornamental crops. HDC Factsheet 17/04. Control of *Pythium*, *Phytophthora* and *Rhizoctonia* in pot and bedding plants. HDC Factsheet 12/03. Control of lisianthus downy mildew. HDC Factsheet 24/02. Control of grey mould (*Botrytis cinerea*) in container grown ornamentals: heated glasshouse crops. HDC Factsheet 19/02 Control of downy mildew, black root rot and *Ramularia* leaf spot disease on pansy and viola. HDC Factsheet 09/02. Control of rust diseases of protected bedding plants.

# Acknowledgements

We are grateful to seed companies, plant propagators and growers for supply of seed and plant samples. Special thanks also to Stuart Coutts for his constant encouragement and enthusiasm for the subject of seed-borne diseases, to Nickersons-Zwaan for the loan of the steam-air equipment at STC Ltd and to Simon Honey of Bath University for help with seed testing at ADAS. All photographs are copyright of ADAS except for figures 2, 5a and 9b, which are copyright of STC.



**March 2010**

**Design and production: HDR Visual Communication**