

## Grey mould (*Botrytis*)

Project No. PC/HNS 121

# Control of grey mould (*Botrytis*) in container-grown ornamentals: unheated greenhouse crops

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Grey mould (*Botrytis cinerea*) remains one of the most damaging diseases of container-grown ornamentals grown in unheated greenhouses. This factsheet provides details of the disease and guidelines for achieving effective control.

## Summary of action points

### Reducing sources of infection

- Inspect plants arriving on the nursery for grey mould; if disease is discovered, reject plants or quarantine and treat.
- Remove plant debris and thoroughly disinfect between crops.
- Maintain stock plants free of grey mould and do not take cuttings from diseased plants.

### Maintaining healthy plants

- Handle plants carefully to avoid damage.
- Do not pot plug plants and liners too deeply.
- Minimise plant stress.

### Ventilation

- Space plants more widely to increase air circulation.
- Use fans to help air circulation.
- Keep humidity as low as possible by increasing ventilation.
- Gradually reduce misting in propagation beds as soon as possible after rooting.

### Irrigation

- Time irrigation to allow foliage to dry before nightfall.
- Use sub-irrigation to reduce leaf wetness.

### Fungicides

- Apply protectant fungicides to the most susceptible species soon after potting or trimming (see Table 1).
- Avoid build up of resistance by alternating fungicides from different chemical groups.



Calluna potted-plant – characteristic browning of foliage tips and sporulation (spore production) of the fungus

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## Crop damage and economic importance

Grey mould, caused by the fungus *Botrytis cinerea*, is one of the most common and damaging diseases affecting many of the major container-grown ornamental crops grown in unheated glasshouses and polythene

tunnels. The financial losses due to grey mould are serious, and it has been estimated that the disease causes annual crop losses to UK container ornamental growers in excess of £7M. Additional costs can be incurred in making affected plants marketable.

Serious damage may be seen on cuttings and potted-on plants as well as stock plants. The disease can

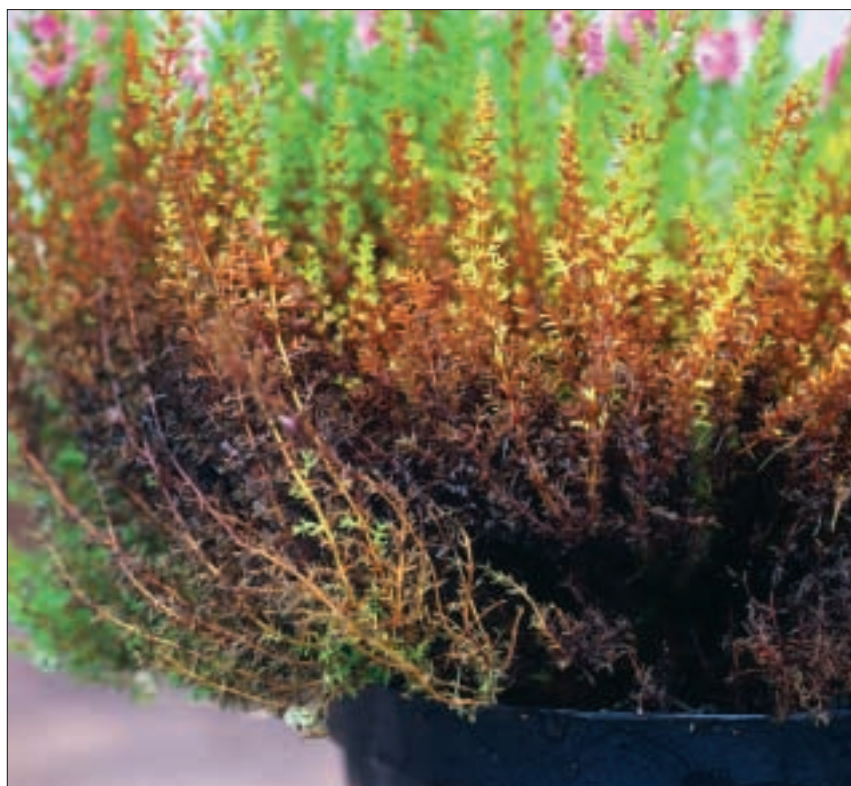
attack crops throughout the year, but is most common in cool, humid conditions, and especially in autumn and winter. Calluna, hebe, hедера, helianthemum, lavender and rhododendron are particularly susceptible when grown in unheated greenhouses. Affected plants suffer from reduced quality and/or lack of vigour and may die if severely affected.

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## Symptoms

Grey mould on potted plants commonly starts around the stem base, on foliage in contact with the growing medium, on shoots after trimming or on dead flowers. On cuttings, it typically starts from the cut end or on the foliage tips. On stock plants, it may develop on the branches where cuttings were taken. The disease may also develop during transport, especially if high humidity or condensation occurs in transit.

Typical symptoms are dieback of individual branches followed by severe browning and scorching of the foliage. Affected tissues may develop a characteristic furry, grey-brown mass of spores, especially under conditions of high humidity. Occasionally, black resting bodies (sclerotia) develop in affected tissues and in this form the pathogen can survive for many months. Flowers can be affected and a light to dark brown rot develops.



Calluna potted-plant – severe browning and scorching around the stem base on foliage in contact with the growing medium

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## Sources and spread

The main sources of grey mould are diseased plants and crop debris. Infections can remain in a 'latent' (symptomless) state for several weeks and cuttings taken from apparently healthy stock plants may be infected.

Fungal spores (conidia) produced on diseased plants and on dead and decaying crop debris can spread to other plants on air currents and by water-splash. Any activity that causes a sudden fluctuation in relative humidity (RH) will result in a release of spores. Long distance spread between greenhouses and different

nurseries occurs through the transport of infected plants and cuttings.

Spores landing on susceptible plant surfaces can germinate and invade tissue immediately, or may remain dormant for up to 3 weeks. Environmental conditions favourable to infection include leaf wetness and prolonged high RH (greater than 95% for at least 3 hours at 10–20°C). Under these conditions, spores of the fungus will germinate readily on the leaf surface and may infect the plant within just a few hours. When infection has occurred, symptoms may develop almost immediately, or may exist in a latent form becoming active days, or even weeks later.

The grey mould fungus is a relatively weak pathogen and generally needs a food source before it invades healthy tissue. Nutrients leaking from wounded plant parts, the base of cuttings, or from dying tissues, serve as a food base. With these nutrients the pathogen becomes more aggressive and can invade healthy tissue.

In addition to spores, infections may arise from fungal strands (hyphae) growing from either dead plant parts or from organic matter in contact with the host. Also some insects, such as bees and aphids, can spread spores but little is known about the importance of this means of spread.

## Integrated control

***Botrytis cinerea* has proven to be a persistent, adaptable fungus that can cause crop damage under a wide range of conditions and via a number of different infection routes. A single disease management tool is unlikely to be effective under all conditions and against all infection routes. A combination of treatments, that each act by different means is more likely to provide effective and durable disease control than any single measure.**

### Cultural control

Good hygiene and careful management of the growing environment are key to avoiding serious outbreaks. When combined with other cultural control measures, discussed below, these will help to minimise disease pressure, reducing the reliance on the use of fungicide sprays.

#### Greenhouse and crop hygiene

- Inspect newly delivered cuttings or potted plants for evidence of grey mould and, if the disease is discovered, reject the consignment or isolate the plants whilst treatment is undertaken.
- Plants may carry latent infection for several weeks, so continue to monitor apparently disease-free plants for this time. When monitoring for disease, it is important to check foliage in contact with the growing medium surface and in the centre of dense plants. Close attention should be paid to areas where air-movement is poor, and to any batches that have been kept past their optimum stage for spacing or dispatch. It may be worthwhile separating new plants to reduce the risk of infecting other batches.
- Affected plant debris is a potent source of infection so remove it from greenhouse benches, floors and propagation beds, and thoroughly disinfect the greenhouse structure between crops.
- In recent trials, 'picking-over' on cyclamen at 2–3 week intervals (approximately 5 times during

cropping) to remove dead leaves at the plant base was shown to be as effective as a full fungicide programme. Such an approach may be worthwhile considering for other crops. It is likely that removal of trimmings from a crop after cutting back, or dead flowers (eg hebe, lavender), will also reduce disease risk.

- Dispose of severely affected plants and debris taking care not to spread spores around the greenhouse.

#### Crop management

Many factors are known to predispose plants to grey mould (see below). Avoiding these conditions by following the crop management practices below can significantly reduce the risk of the disease developing.

- Wounding predisposes plants to infection; handle plants carefully especially during potting, spacing and at dispatch.
- Potting of plug plants and liners too deeply results in deterioration of lower

leaves that become covered in damp compost; pot to the correct level.

- Manage the growing environment to ensure plants are not stressed, as stressed plants are more susceptible to infection.
- Do not take cuttings from grey mould-affected plants, keep stock plants well spaced and regularly monitor for grey-mould infection.
- Claims have been made that novel anti-botrytis film for cladding tunnels can reduce spore production, however, no reduction in disease levels was found in recent trials on calluna.

#### Reducing greenhouse humidity

Experiments with cyclamen leaves have shown that high humidity levels greater than 95% for a period of more than 3 hours, is the critical threshold for the germination of grey mould spores. Once this period is exceeded spore germination will continue even if the humidity is reduced to 80% or less.

#### Factors predisposing plants to botrytis

Predisposing factor	Example
Damaged tissue (especially at potting, spacing, dispatch)	Cracked leaves, broken stalks & branches; potting too deeply
Leaf age – young tissue – mature tissue	Lobelia seedlings, cuttings Primula leaves
Dead flowers	Hebe and lavender
Fallen flower parts; pollen	Cyclamen, geranium, primula, lavender
Secondary to other diseases	Tissue damaged by Fusarium, Cyllindrocarpon, mildew or rust
Frost damage	
Fertiliser scorch	
Pesticide scorch	
Nutrient deficiency	Low calcium or potassium
Nutrient excess	Nitrogen
Soft growth	Cuttings (eg calluna, hebe, rhododendron)
Physiological damage	Bract edge damage on poinsettia
Plant debris	Fallen or dead leaves; trimmings
Trimming stubs	On stock plants (eg calluna, lavender)
Yellowing (shaded) leaves	Dense crop
Sheltered site	Prolonged high humidity – see section on 'Reducing greenhouse humidity' above
Leaking vents and gutters	
Low glasshouse	
Overhead irrigation	
Poorly-managed sub-irrigation	
Poor ventilation/air-movement	

However, where high humidity periods are controlled to 3 hours or less, trials have shown there should be little germination or disease development even after 14 days of fluctuating high and low humidity periods. It is therefore vital to restrict high humidity periods to 3 hours or less in order to reduce the risk of infection from newly deposited botrytis spores.

Experiments with primula leaves have shown that leaf wetness is important for the development of grey mould symptoms, with disease severity increasing with daily leaf wetness duration.

In general it is recommended that:

- Where space is available, try to separate plants so that foliage does not touch.
- Improve ventilation and air circulation in polythene tunnels by opening the doors and raising the sides, and using circulation fans.
- Ventilate greenhouses early in the morning by opening the vents and using circulation fans, especially if moisture has condensed on plant surfaces during the night.
- Ventilate propagation beds by opening low polythene tunnels periodically. Note that prolonged high humidity is most likely to occur during the night or early morning.

#### Irrigation

- Manage watering carefully to minimise periods of prolonged leaf wetness.
- Preferably use sub-irrigation as overhead irrigation can increase grey mould by splashing spores, creating leaf wetness and enhancing the development of latent disease.
- Only carry out overhead irrigation when there is time for the foliage to dry before nightfall.

#### Fungicides

Fungicide sprays are important for effective control of grey mould and regular, preventative spray programmes are generally the most effective. The overriding strategy in the use of fungicides should be to:



Polytunnel with overhead irrigation, and sides raised to increase ventilation

- Use the minimum number of sprays necessary to provide effective control;
- Alternate different fungicide groups (see Table 1) to minimise resistance development;
- Avoid crop damage or spray deposits by applying fungicides that are safe to the crop.

#### Timing

Regular preventative sprays are particularly important on stock plants to prevent the pathogen contaminating or causing latent infections on cuttings. Our trials have shown that once grey mould becomes established in a crop, spraying often provides very poor disease control. This is because the spores may have already spread to other plants and initiated new infections before the disease is discovered. The period from initial infection through symptom development to production of fresh inoculum (spores) can be as short as a few days. In our trials, fungicide spray programmes commencing from soon after potting on calluna, helianthemum and lavender gave very good control. When conditions are less favourable to grey mould such as warm, dry weather or very cold weather, spray intervals can be

extended providing one or two early protectant sprays have been applied.

#### Fungicide activity

Some of the older contact fungicides (eg chlorothalonil and dichlofluanid) prevent spore production. Newer fungicides (eg azoxystrobin and pyrimethanil) may prevent initial infection. However, once the pathogen is established within plant tissue it is extremely difficult to eradicate.

A summary of the mode of action of fungicides commonly used against grey mould and approved for use on protected ornamentals is given in Table 1.

#### Crop safety

Crop safety trials have revealed that most fungicides we evaluated (see Table 1) caused no visible damage or harmful effects in the majority of plant species (calluna, helianthemum, lavender and primula) and varieties tested when used at their recommended rates and intervals. However, a reduction in growth was seen in some calluna varieties when treated with Amistar or Scala.

- It is impossible to provide definitive crop safety guidance for the range of ornamental species grown commercially and so specific advice should

be sought or where practicable, test treat a small batch of plants first before a fungicide is used widely on a species or variety for the first time.

- As a general guide, crop damage is more likely to occur: on young plants and soft growth; plants treated in hot, sunny weather or at high humidity; where products are used in mixture with an additional wetter or other adjuvant (modern pesticides are usually pre-formulated with wetters/spreaders); when several spray treatments are applied to a crop in close succession.
- Cuttings may also be more susceptible to damage than rooted plants, particularly if fungicides are applied at high humidity.
- Ensure that your sprayer is calibrated correctly and that you apply fungicides at the recommended dose rates and intervals.

#### Spray application

Trials results indicate the best control of grey mould is likely to be achieved if plants are sprayed at a high water volume, sufficient to achieve full coverage. On many container grown ornamentals, including calluna, hebe and helianthemum, grey mould often develops around the stem base on foliage in contact with the growing medium. Consequently, it is important

to get the fungicide onto foliage near the base of plants for good protection. For plants with a dense canopy, such as calluna stock plants, treatment using a single nozzle, pushed into the centre of each plant, may be required. Water-sensitive paper attached to plants at different positions is a useful way to assess the spray coverage you achieve.

#### Devising a spray programme

- Select products that are safe to use on the crops you grow. Test treat a small batch of plants/cuttings before large-scale application if using a fungicide for the first time.
- To minimise the development of resistant strains, select products from two or more different 'groups' for alternate sprays; or use no more than two sprays of the same fungicide or fungicide 'group' in sequence, then use a completely different fungicide group.
- Start your fungicide programme early before grey mould is established; apply two initial sprays soon after potting/striking.
- Spray intervals of 10-14 days are often adequate; they can be extended to 21-28 days when conditions do not favour the disease, or other effective control measures against grey mould are being used.

- Ensure good coverage of leaves close to, or in contact with, the growing medium surface.
- Routine preventative spray programmes are very important for stock plants from which cuttings are taken.
- If you are dissatisfied with the level of disease control achieved, consider having isolates (at least 10) tested for fungicide resistance. Consult a Plant Pathologist to investigate your disease management strategy.

#### Example fungicide spray programmes

Fungicide programmes designed to investigate the efficacy of new products and the influence of sprays applied at different crop stages were tested in HDC trials. Those found to be effective on calluna cuttings, potted calluna plants and helianthemum are listed in Tables 2, 3 and 4 respectively. Numerous other programmes could be devised for these and other crops from the products listed in Table 1 that would probably result in equivalent control. Some alternative programmes found to be effective on cyclamen and primula are listed in the accompanying factsheet (24/02) – Control of grey mould (*Botrytis*) in container-grown ornamentals: heated glasshouse crops.



Plant debris is an important source of infection, increasing localised spread – remove it from the greenhouse



Crops such as helianthemum overwintered in unheated polythene tunnels will be exposed to cool, humid conditions which favour the development of botrytis

**Table 1**  
**Fungicide mode of action for products with activity against grey mould (*B. cinerea*) and currently permitted on protected ornamental crops (November 2002)**

Fungicide group and product	Active ingredient	Activity as stated by the manufacturer	Observed activity*		Standard spray rate (product)	Approval status/comments
			Protectant	Curative		
<b>1 Anilinoimidazole</b> Frupica Scala	Mepanipyrim Pyrimethanil	Protectant Protectant	✓ ✓	✓ –	0.8 g/l 1.0 – 2.0 ml/l	LTAEU <sup>a</sup> extension from label LTAEU <sup>a</sup> extension from SOLA (3411/02)
<b>2 Dicarboximide</b> Rovral WP	Iprodione	Protectant with some curative	✓	✓	1.0 g/l	Label recommendation Resistant strains common
<b>3 Dithiocarbamate</b> Unicrop Thianosan DG	Thiram	Protectant	n/t	n/t	4.0 g/l	Label recommendation
<b>4 DMI</b> Octave	Prochloraz	Protectant	n/t	n/t	1.0 g/l	Label recommendation
<b>5 MBC</b> Bavistin DF	Carbendazim	Systemic	✓	✓	1.0 g/l	SOLA 0009/99 Resistant strains common
<b>6 Phthalonitrile</b> Bravo 500 <sup>b</sup>	Chlorothalonil	Protectant	✓	✓	2.2 ml/l	Label recommendation
<b>7 QoI</b> Amistar Stroby WG	Azoxystrobin Kresoxim-methyl	Systemic, protectant Protectant	✓ n/t	– n/t	1.0 ml/l 0.3 kg/ha	LTAEU <sup>a</sup> extension from SOLA (1684/01) LTAEU <sup>a</sup> extension from label
<b>8 Sulphamide</b> Elvaron WG	Dichlofuanid	Protectant, sporulation suppression	✓	✓	1.0 g/l	SOLA 0167/93 Do not use on soft growth in spring & summer

\* Demonstrated on strawberry leaves in HDC-funded trial (SF 47); n/t – not tested

<sup>a</sup> Permitted under the PSD Long Term Arrangements for Extension of Use 2002 (LTAEU)

<sup>b</sup> Similar products are available

Regular changes occur in the approval status of pesticides, so growers should check with a professional supplier or with the Information Office at the Pesticides Safety Directorate (PSD). (Tel: 01904 462 500; or [www.pesticides.gov.uk/raid\\_info/rep-fp.cfm](http://www.pesticides.gov.uk/raid_info/rep-fp.cfm); e-mail: [p.s.d.information@psd.defra.gsi.gov.uk](mailto:p.s.d.information@psd.defra.gsi.gov.uk))

- **Off-label use (SOLA and LTAEU) is at grower's own risk. The conditions relating to off-label use are statutory and must be complied with. The conditions of use are listed on the SOLA document, a copy of which must be obtained before the product is used.**
- **Always read the product label or SOLA before applying pesticides. Use pesticides safely.**
- **Check with suppliers for full details of any side effects on biological control agents.**

**Table 2**

**Example fungicide programmes for control of grey mould on calluna cuttings during propagation**

Spray programme	Spray timing (weeks after striking)						Reduction in disease severity compared with untreated (12 weeks after striking)
	0	2	4	6	8	10	
1	Amistar	Scala	Amistar	–	Scala	–	61–80%
2	Scala	Elvaron Multi	Scala	–	Elvaron Multi	–	41–60%
3	Amistar	Scala	–	Amistar	–	Scala	41–60%
4	–	–	–	Amistar	–	Scala	21–40%

**Note:** Elvaron Multi is not currently permitted for use on protected ornamentals, use Elvaron WG or Bravo 500 as an alternative.

**Table 3**

**Efficacy of fungicide spray programmes for control of grey mould on potted calluna plants using 9-month old rooted liners**

Spray programme	Spray timing (weeks after re-potting [Sept])								Reduction in disease severity compared with untreated (24 weeks after potting)
	Within week 1	3	6	9	12	15	18	21	
1	Elvaron Multi	Scala	–	Elvaron Multi	–	Scala	–	Elvaron Multi	61–80%
2	Amistar	Scala	–	Amistar	–	Scala	–	Amistar	61–80%
3	Amistar	Amistar	Scala	Elvaron Multi	Amistar	Amistar	Scala	Elvaron Multi	41–60%
4	Elvaron Multi	Elvaron Multi	Amistar	Scala	Elvaron Multi	Elvaron Multi	Amistar	Scala	61–80%

**Note:** Elvaron Multi is not currently permitted for use on protected ornamentals, use Elvaron WG or Bravo 500 as an alternative.

**Table 4**

**Efficacy of fungicide spray programmes for control of grey mould on potted helianthemum plants using rooted cuttings in 1 litre pots**

Spray programme	Spray timing (weeks after re-potting [mid Sept])								Reduction in disease severity compared with untreated (25 weeks after potting)
	Within week 1	2	4	7	11	15	19	23	
1	Scala	Elvaron Multi	Scala	Elvaron Multi	Scala	Elvaron Multi	Scala	Elvaron Multi	61–80%
2	Scala	Bravo 500	Scala	Bravo 500	Scala	Bravo 500	Scala	Bravo 500	61–80%
3	Scala	Amistar	Scala	Amistar	Scala	Amistar	Scala	Amistar	41–60%
4	Scala	Elvaron Multi	–	–	Scala	Elvaron Multi	Scala	Elvaron Multi	61–80%

**Note:** Elvaron Multi is not currently permitted for use on protected ornamentals, use Elvaron WG or Bravo 500 as an alternative.

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## Fungicide resistance

Resistance has been confirmed in grey mould to carbendazim (Bavistin DF) and iprodione (Rovral WP). There have also been a few reports of resistance to dichlofluanid (Elvaron WG). Where resistant isolates are present, treatment with these fungicides will provide little or no disease control. Where strains of the grey mould fungus are resistant to one fungicide in a particular group (see Table 1) there is usually also resistance to other members of the same fungicide group. Testing of isolates from various ornamental and edible species indicate that resistance to iprodione and carbendazim is probably widespread in UK greenhouse crops. With some fungicides (eg iprodione), the population may revert to a sensitive one, and therefore can be controlled, if use of

fungicides of that type is halted. However, if the fungicide is reintroduced into a spray programme, use it only occasionally to avoid recurrence of resistance.

Testing is available as a chargeable service from CSL, HRI and SAC to determine the resistance status of a particular botrytis population.

The following procedures should be followed in order to preserve the effectiveness of fungicides:

- Only use fungicides when needed.
  - Use no more than two sprays of the same fungicide, or fungicide group, in sequence, then use a completely different fungicide group.
  - Use no more than 50% of the total sprays of the same fungicide, or fungicide group, per crop.
- Follow the label recommendations carefully and keep to the manufacturer's recommended dose rate.
  - Do not rely on fungicides alone for disease control; follow the cultural control measures detailed in this factsheet, especially regarding good hygiene and avoiding prolonged leaf wetness and high relative humidity.
  - For further advice on strategies to minimise the risk of selecting resistant strains of botrytis, see the FRAG-UK Technical leaflet: Fungicide Resistance, published in August 2001, which can be downloaded from: [www.pesticides.gov.uk](http://www.pesticides.gov.uk)

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## Additional information

The information in this factsheet was obtained in part from a series of

experiments and greenhouse trials conducted between 1997–2001 under Horticulture LINK Project 25 (HDC Project PC/HNS121 and DEFRA Project HL0107). A summary report (August 2002) and five annual reports,

available from the HDC, provide detailed results. Information on strategies for managing botrytis on container-grown ornamentals in heated greenhouses is given in factsheet 24/02.

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Further information may be obtained from the HDC Project Report available from the Office.

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