Factsheet 20/07

Cyclamen

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Disease control in cyclamen

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The objective of this factsheet is to provide guidelines for achieving effective disease control in cyclamen. It provides information on disease identification, the biology of the causal organisms, and methods of cultural and chemical control.

Introduction

Diseases such as grey mould (botrytis) and bacterial soft rot are found in many cyclamen crops. Others, such as phytophthora root rot and fusarium wilt, are more sporadic in occurrence but can cause severe damage. For example, fusarium wilt will often kill 10–30% of plants and may occasionally cause complete loss of a crop. With UK production of large-flowered and mini-cyclamen estimated at around 16 million plants per year (British Protected Ornamentals Association estimate, 2007), the total financial loss each year to diseases can be significant.

Early and accurate identification of a disease problem is critical, so that the most appropriate control measures can be applied before significant loss of plants or quality occurs. Laboratory testing may be required where the symptoms (eg root decay) could be indicative of a number of diseases.

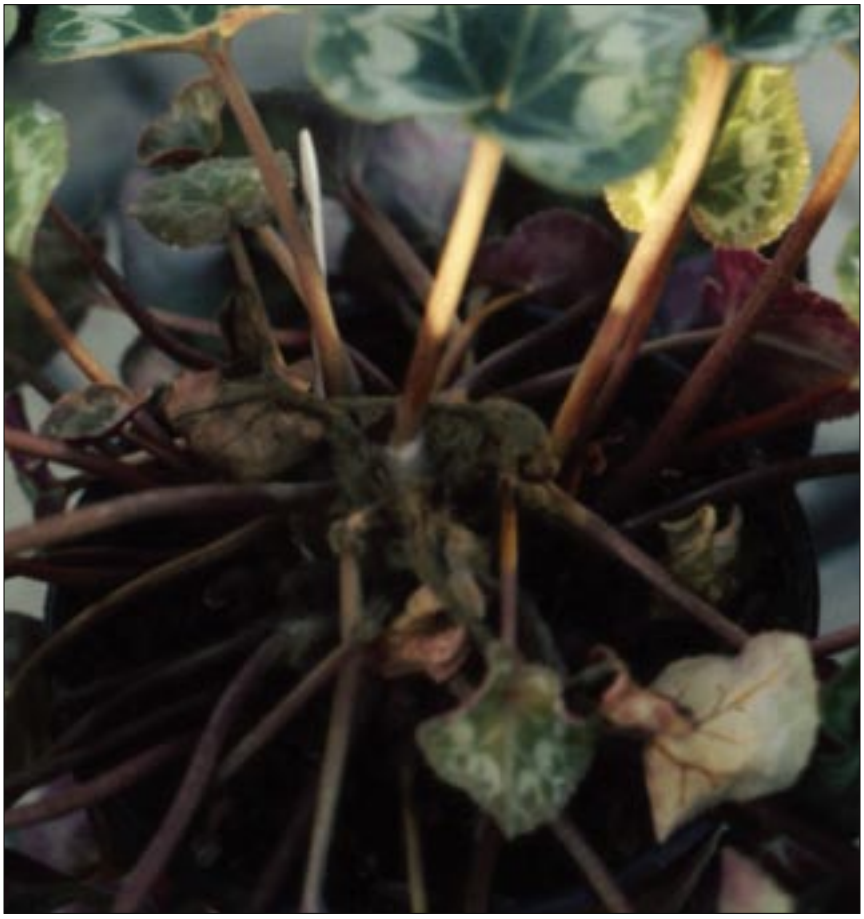
Disease recognition and biology

Foliar and corm diseases

The two most common foliar diseases of cyclamen are botrytis and fusarium wilt.

Grey mould or botrytis (*Botrytis cinerea*)

A ubiquitous fungal pathogen with a very wide host range. It causes a soft decay of the petiole bases, particularly in the centre of the plant, resulting in plant collapse. Under humid conditions, large numbers of powdery grey or brown spores are produced, which are readily spread by water-splash and on air currents. Hard, black resting bodies (sclerotia), 2–8 mm in size, are sometimes produced on infected material. *B. cinerea* may also cause small watery spots to develop on the petals, without any obvious fungal growth. It can cause major problems during cold, damp conditions and will rapidly colonise damaged or senescent plant parts, especially where



1 Botrytis rot of petiole bases

there is a dense leaf canopy. It can be transmitted by seed, brought in as a symptomless infection on young plants, and arise from air-borne spores and plant debris.

2 Flower spotting caused by *B. cinerea*

Fusarium wilt (*Fusarium oxysporum* f. sp. *cyclaminis*)

The first symptom, often not seen until near flowering, is a yellowing of the older leaves, followed by wilting and collapse of the plant. A characteristic reddish brown staining of the vascular strands is visible if the corm is cut open. Roots may also turn brown in the latter stages of the disease. On severely affected plants, white, pink or orange spores of *Fusarium* develop on petiole bases. Sometimes plants of one colour or type, or from one particular supplier, show symptoms on a nursery while others remain free or largely free of the disease. The fungus is spread by splash-dispersed spores, whilst long-lived resting spores contaminate standing areas. It is active over a wide temperature range, but the disease develops rapidly under warm (20 – 25ºC) conditions. It can be transmitted by seed, introduced as a symptomless infection on young plants, and can survive on matting.

3 Fusarium wilt often results in bright yellow older leaves, prior to plant collapse

4 Browning of vascular bundles in the corm is characteristic of fusarium wilt; secondary bacterial soft rot is developing at one edge

Anthracnose (*Colletotrichum* species)

Newly developing leaves and flower buds at the top of the corm turn brownish-black, shrivel and fail to expand. Older leaves may develop blackened edges or show downward curling, whilst mature flowers sometimes collapse as a result of lesions forming on the stalk. Under humid conditions, small orange spore masses of the causal fungus develop on affected plant parts – these spores are spread by water-splash. Plants affected by this disease may also show some discolouration of the internal tissues of the corm. Anthracnose is favoured by warm, humid or wet conditions. Infection can be seed-borne. Both *Colletotrichum acutatum* and *Colletotrichum gloeosporioides* have been described as causes of cyclamen anthracnose in the UK.

In parts of Europe another anthracnose disease occurs, caused by the closely related fungus *Cryptocline cyclaminis*. This pathogen has yet to be recorded in the UK.

Symptoms and control measures are very similar to those for anthracnose caused by *Colletotrichum* species.

The spores are disseminated by water splash and possibly by insects. Seed transmission is considered likely.

5 Anthracnose caused by Colletotrichum species – note the blackened, shrivelled shoots

Bacterial soft rot (*Pectobacterium carotovorum*)

Infection by this bacterium results in a soft, cheesy, foul-smelling rot of the corm, and ultimately in death of the plant. The foliage of affected plants wilts suddenly and is easily pulled away, often bringing the top part of the corm with it. The bacterium infects through wounds, growth cracks, and damage caused by other pests and diseases. Plants affected by fusarium wilt readily succumb to bacterial soft rot. Deep planting enables bacteria to enter through the top of the corm. Mechanical damage at planting can also provide infection sites. The disease progresses rapidly at temperatures above 20°C.

In South America, the bacterium *Erwinia chrysanthemi* also causes a bacterial soft rot of cyclamen. Symptoms are similar to those described above. This pathogen has yet to be recorded on cyclamen in the UK.

6 Bacterial soft rot *(Pectobacterium carotovorum)* results in a sudden plant collapse

7 The corm becomes soft and foul-smelling

Powdery mildew (*Golovinomyces orontii*)

An uncommon disease on cyclamen. A white fungal growth develops on the leaf surfaces, becoming more powdery under humid conditions.

Root rots

Several root pathogens can affect cyclamen and they cause similar symptoms, including stunting, reduced vigour, leaf yellowing, wilting, root browning and decay, and excessive root branching. Laboratory examination of affected plants is usually required to determine which root disease is present; this is important as there is no single fungicide treatment effective against all of the pathogens.

Pythium root rot (*Pythium* species)
Pythium causes poor growth and root decay, as described above. Favoured by high moisture levels in the growing medium, the fungus infects roots via microscopic spores that swim in water films. Non-mains water is a potential source of this relatively common disease, and water from any source can become contaminated if stored in uncovered tanks. *Pythium* also produces long-lived resting spores that can contaminate standing areas, pots and growing media.

Phytophthora root rot (*Phytophthora* species)
Phytophthora is closely related to *Pythium,* but infection is less common on cyclamen. *Phytophthora* species spread through the crop and persist on the nursery in the same way as *Pythium*, and also cause very similar symptoms. Root decay can be severe.

8 Plant collapse due to Phytophthora root rot

9 Phytophthora usually results in extensive root decay

Black root rot (*Thielaviopsis basicola*)
This causes similar symptoms to *Pythium*, although heavily infected roots may show blackened areas if they are washed and examined very closely. It produces two spore types, both of which are capable of spreading the disease through a crop. The black thick-walled spore type can readily contaminate standing areas, pots, trays, and growing media. *T. basicola* has a wide host range; winter-flowering pansies can be badly affected and will increase the threat to cyclamen if grown on the same nursery.

Rhizoctonia root and stem rot (*Rhizoctonia solani*)
This is an infrequent problem on cyclamen. In addition to root decay, *Rhizoctonia* can cause a firm, brown, dry rot of the corm, starting at substrate level. Rhizoctonia rot develops especially under humid conditions but can be a problem if the growing medium is alternately wet and dry. The fungus is spread by fragments of mycelium that can contaminate most parts of a nursery.

10 Rhizoctonia can cause a severe root rot

Brown root rot (*Cylindrocarpon destructans*)
In addition to root browning, this fungus can also cause brown spots on the corm (sometimes penetrating quite deeply) and small lesions at the base of individual leaves, which may lead them to yellow, wilt or become detached. Lesions may also develop at the top of the main roots, causing them to separate from the base of the corm. Whilst it is not a common problem in the UK, the disease is found more frequently on younger plants, and on plants that receive a growth check.

Virus diseases

Virus diseases of cyclamen have generally not been troublesome in recent years.

Tomato Spotted Wilt Virus (TSWV) and Impatiens Necrotic Spot Virus (INSV)

These two closely related viruses are transmitted by thrips species, particularly western flower thrips (WFT). Both viruses have wide host ranges and cause a bewildering array of symptoms. The symptoms caused by each of the viruses on cyclamen, are very similar. These commonly consist of round, brown necrotic leaf spots, brown or yellow ringspots or line patterns on the leaves, browning at the petiole end of the leaf blade and flower distortion. In recent years INSV has been more common on cyclamen and other ornamentals than TSWV.

11 Brown spotting on leaves caused by TSWV

12 Leaf necrosis caused by INSV

Cucumber Mosaic Virus (CMV)

This is another virus with a very wide host range. The most striking symptom on cyclamen is 'flower breaking', in which flowers develop stripes or streaks of a second colour. Transmitted by a number of aphid species, CMV can also be mechanically transmitted in sap from infected plants.

13 'Flower breaking', a consequence of infection by CMV

Cultural control

Detailed attention to cultural control measures, as listed in the Action Points, can help prevent the development of disease problems, and hence reduce the need for fungicide use. In most cases an integrated approach, using cultural methods and applying fungicides only when necessary, is likely to give the best results. It is always unwise to rely on fungicides alone (see the section on fungicide resistance).

For control of botrytis, 'picking-over' at intervals during crop production to remove dead leaves at the plant base, and removal of any dead flowers in the later stages of crop production, can be as effective as a full fungicide programme. However, this approach is labour-demanding and may not be economic.

14 Remove fallen flowers to reduce risk of botrytis leaf rot

Chemical control

Some growers apply one or more fungicide treatments for control of the most common diseases: botrytis, fusarium wilt and root rots. It is important to manage fungicide programmes carefully in order to:

- Achieve effective disease control.
- Reduce the risk of fungicide resistance.
- Minimise occurrence of visible spray deposits.
- Avoid flower damage.

For further information about suitable fungicides for control of cyclamen diseases, see Tables 2 and 3 overleaf.

Devising your own programme

Fungicide use will vary between nurseries according to the production system, the extent of cropping, the occurrence of disease problems in cyclamen on the nursery in previous years, and occurrence of any diseases in the current crop. Key points to consider when using fungicides are:

- Monitor crops carefully to identify disease outbreaks as soon as possible.
- Ensure that disease problems are accurately identified so that the most appropriate product is applied.
- Start botrytis preventative treatment early, when plants are small and it is easier to get good cover of lower leaves.
- Preventative treatments are generally the more effective.
- Always use two or more active ingredients from different fungicide groups (where available) for sequential treatments against any particular pathogen, to help avoid disease resistance developing (see Table 2 overleaf).
- Be aware of the potential of some chemicals to cause crop damage or to leave a visible deposit, especially once flower buds are present.
- Use the application method and dose rate listed on the label or off-label approval document. Check for any limitation on the maximum number of treatments or maximum total dose allowed per crop.

Fungicide resistance

There has been a gradual increase in the occurrence of fungicide resistance since the introduction of systemic fungicides. These fungicides often have very specific activity against their target pathogen, unlike many of the older generation chemicals. Resistance is recognised when disease control is no longer achieved despite the fungicide having been applied at the correct timing and at the recommended rate and under appropriate environmental conditions.

Factors affecting the development of fungicide resistance include: the type of fungicide, its frequency of use, the target fungus, the ability of the resistant forms to survive and the fungicide programme used (where more than one application is used). It is most important to use a programme that incorporates a wide range of fungicide groups and rotates their application. Of the diseases affecting cyclamen, botrytis is the most important with regard to resistance management; populations of *B. cinerea* resistant to carbendazim and iprodione are already common in the UK, for example. Resistance to anilinopyrimidine fungicides has been detected overseas in some crops. Root pathogens such as *Pythium* spp., *Phytophthora* spp. and

T. basicola also have the potential to develop fungicide resistance. Where the choice of fungicide is limited for a particular disease, it is even more important that cultural control techniques are fully utilised as part of an integrated control strategy.

Control of botrytis

There are now several new botrytis fungicides available and many variations of spray programmes are possible. Please refer to Tables 2 and 3 overleaf to select appropriate products. Scala (pyrimethanil) can cause flower distortion and colour fading if used when flower buds are present. Experimental work in PC/HNS 121 demonstrated that an alternating four or five spray programme of a botrytis-specific fungicide (eg pyrimethanil) with a broad-spectrum fungicide (eg chlorothalonil) provided very good control of botrytis. Omission of preventative sprays at potting resulted in significantly reduced botrytis control.

Some batches of cyclamen seed have been found to carry *B.cinerea* and more recently there is evidence of symptomless systemic infection by *B.cinerea* throughout individual cyclamen plants. Although further work is needed to determine the importance of this type of infection, it may indicate that treatment to eliminate any seed-borne or young plant infection (if such a treatment becomes available), could be particularly useful. As a precaution against systemic latent botrytis, treat plants at an early stage of growth, preferably using a fungicide with some systemic activity (eg pyrimethanil).

An example programme for control of botrytis is shown in Table 1. This programme alternates a broad-spectrum protectant fungicide (chlorothalonil) with two fungicides (pyrimethanil and iprodione) having more botrytis-specific activity in order to reduce the risk of resistant isolates arising. Scala is applied soon after potting with the aims of reducing any latent infection and providing fungicide cover on leaves close to the growing medium surface.

Equal control may be possible using a fungicide programme containing some of the newer botrytis fungicides (eg Signum, Switch, Teldor), but currently information on the safety of these fungicides to cyclamen, and their efficacy in controlling botrytis on cyclamen, is sparse.

The potential benefit of using one or more fungicide treatments for control of botrytis will vary according to the production system; the risk of botrytis is greater in poorly heated, poorly ventilated, older glasshouses, where crops are densely packed and where overhead irrigation is used. Further information on botrytis control is given in Factsheet 24/02.

Control of fusarium wilt

Since infection occurs largely through the roots, fungicide treatments are usually targeted at the roots by drench application. Fungicides with a label or off-label approval for drench application and with activity against *Fusarium* include benzimidazole fungicides (eg Cleancrop Curve) and Scotts Octave (prochloraz). Use of products containing carbendazim is not permitted after 30 June 2008. Amistar (azoxystrobin) is permitted as a high volume spray and may give some control, but information on crop safety is limited. Note that prochloraz drench treatment can result in stunted growth if used frequently or applied above the recommended rate.

Control of anthracnose

This disease is now uncommon on cyclamen and there have been no recent studies investigating chemical control. Amistar (azoxystrobin), Signum (boscalid + pyraclostrobin) and Switch (cyprodinil + fludioxonil) are reported to have good activity against *Colletotrichum* species, while chlorothalonil and benzimidazole fungicides have some activity.

Control of bacterial soft rot

There are no fungicide products with a recommendation for control of this disease. Croptex Fungex (cupric ammonium carbonate) has activity against bacteria and may provide limited control if applied as a preventative treatment.

Control of root rots

Fungicides for control of root rots are applied by incorporation in the growing medium pre-planting (eg etridiazole, fosetyl-aluminium) or as a drench to the growing medium after planting (eg carbendazim, etridiazole, fosetyl-aluminium, metalaxyl-M, propamocarb hydrochloride). Treatment is generally repeated once or twice at 4 – 6 week intervals where the risk of root disease is considered to be high (see product labels for specific details). It is important that the cause of root rot is correctly identified in order to select an effective fungicide treatment (see Table 2 overleaf).

Table 1 An example programme for control of botrytis

Growth stage	Active ingredient	Fungicide (example product)
Within 7 days of potting	Pyrimethanil	Scala
2 – 3 weeks later	Chlorothalonil	Bravo 500
Full leaf canopy	Pyrimethanil	Scala
2 – 3 weeks later	Chlorothalonil	Bravo 500
Flower buds present	Iprodione	Rovral WP

Table 2 Fungal diseases of cyclamen and fungicides for their control arranged by chemical group

Fungicide group	Disease							
	Botrytis	**Fusarium wilt**	**Anthracnose**	**Powdery mildew**	**Pythium and Phytophthora root rots**	**Black root rot *(Thielaviopsis)***	**Brown root rot *(Cylindrocarpon)***	**Rhizoctonia root rot**
Acylalanine					Fongarid Gold, Subdue			
Anilinopyrimidine	Frupica, Scala			Frupica, Scala				
Benzimidazole	Cleancrop Curve, Delsene 50 Flo	Cleancrop Curve, Delsene 50 Flo	Cleancrop Curve, Delsene 50 Flo	Cleancrop Curve, Delsene 50 Flo		Cleancrop Curve, Delsene 50 Flo	Cleancrop Curve, Delsene 50 Flo	Cleancrop Curve, Delsene 50 Flo
Carbamate					Filex, Pan PCH, Proplant			
ChlorophenylNitroaniline								Basilex
Dicarboximide	Rovral WP *							Rovral WP *
Ethyl-phosphonate					Aliette 80 WG, Standon Fosetyl-Al *			
Heteroaromatic					Standon Etridiazole 35 *			
Hydroxyanilide	Teldor							
Imidazole		Scotts Octave		Scotts Octave				
Phthalonitrite	Bravo 500 *		Bravo 500 *	Bravo 500 *				
Strobilurin	Amistar		Amistar	Amistar				Amistar
Anilide + Strobilurin	Signum		Signum					
Anilinopyrimidine + Cyanopyrrole	Switch		Switch					

*** and others**

Table 3 Details of some fungicides with activity against diseases of cyclamen

Product	Active ingredient	Disease controlled or partially controlled	Approval status
Aliette 80WG	Fosetyl-aluminium	Phytophthora root rot, Pythium root rot.	Label recommendation.
Amistar	Azoxystrobin	Anthracnose, Botrytis, Powdery mildew, Rhizoctonia.	Extrapolation from SOLAs on protected crops (eg 2001/1041, 2005/1194).
Basilex	Tolclofos-methyl	Rhizoctonia.	Label recommendation.
Bravo 500	Chlorothalonil	Anthracnose, Botrytis, Powdery mildew.	Label recommendation.
Cleancrop Curve	Carbendazim	Anthracnose, Black root rot, Botrytis*, Fusarium wilt, Powdery mildew, Rhizoctonia.	SOLA 2004/1004. Use permitted until 30 June 2008.
Croptex Fungex	Copper ammonium carbonate	Bacterial soft rot.	Extrapolation from label recommendation on chrysanthemum/ protected tomato.
Filex	Propamocarb HCl	Phytophthora root rot, Pythium root rot.	Label recommendation.
Frupica SC	Mepanipyrim	Botrytis, Powdery mildew.	Extrapolation from protected strawberry.
Rovral WP	Iprodione	Botrytis*, Rhizoctonia.	Label recommendation; expires 31/12/08.
Scala	Pyrimethanil	Botrytis.	Extrapolation from SOLAs on protecte crops (eg 2006/1379, 2004/0516).
Scotts Octave	Prochloraz	Anthracnose, Botrytis, Fusarium wilt, Powdery mildew.	Label recommendation.
Signum	Boscalid + pyraclostrobin	Anthracnose, Botrytis.	Extrapolation from label recommendation on protected edible crops.
Standon Etridiazole 35	Etridiazole	Phytophthora root rot, Pythium root rot.	Label recommendation; expires 31/08/08.
Switch	Cyprodinil + fludioxonil	Botrytis.	Extrapolation from label recommendation on protected edible crops.
Subdue	Metalaxyl-M	Phytophthora root rot, Pythium root rot.	Label recommendation.
Teldor	Fenhexamid	Botrytis.	Extrapolation from label recommendation on protected edible crops.

***Sensitive strains only.**

Please see overleaf for further comments on available fungicides.

Table footnotes

- Information obtained from LIAISON pesticide database
- This table is not intended to be a comprehensive list of all of the products that can be used on cyclamen. Other fungicides are available, many as off-label uses.
- Regular changes occur in the approval status of pesticides, arising from changes in the pesticide legislation or for other reasons. For the most up to date information, please check with a professional supplier or with the:
  Pesticides Safety Directorate (PSD)
  Tel. (01904) 462500
  Email. **p.s.d.information@psd.defra.gsi.gov.uk**
  www.pesticides.gov.uk
- Off-label use 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 labels before applying pesticides. Use pesticides safely.

Biological control

At present there are no biological control products marketed in the UK for control of any of the common diseases of cyclamen. 'Plant strengtheners' and similar products containing micro-organisms and/or plant extracts that claim to increase a plant's resistance to disease are becoming increasingly available. Growing medium containing a non-pathogenic *Fusarium* sp. that is reported to help to prevent fusarium wilt has been marketed in the UK. Work is required to determine the efficacy of such materials in comparison with fungicide treatments.

Incorporation of various organic amendments into the growing medium has been shown to reduce development of fusarium wilt. Effective materials include composted or well-matured bark, wood fibre and crustacean shells. Crop nutrition and irrigation may need to be adjusted when the growing medium is amended (see Action points).

Action points

Pre-cropping

- Thoroughly clean and disinfect standing areas, including capillary matting if it is to be re-used. If fusarium wilt or phytophthora root rot occurred in the previous cyclamen crop, or any of the root diseases occur at a high level, replace the matting. HDC Factsheet 15/05 gives detailed information on the use of chemical disinfectants in protected ornamental production.
- Cover water storage tanks to prevent contamination by pathogens such as *Pythium* and *Phytophthora* (which are also known as 'water moulds'). If either is a persistent or serious problem on the nursery, arrange for the water to be tested for fungal pathogens.
- Keep sacks of bulk growing media covered to prevent contamination by dust or crop debris containing resting spores of root pathogens.

Growing the crop

- Consider using a growing medium containing up to 40% well-matured or composted pine bark, or 1% crushed crustacean shells. If using pine bark, add ammonium nitrate to compensate for nitrogen immobilised by the bark at a rate of approximately 100 g/m³ for every 10% bark added, in addition to the normal amount of base fertiliser (for further details, see HDC project PC 50a).
- Make sure the young plant specification fits the method of planting you are using; long petioles may be damaged by planting machines.
- When potting, ensure that the top of the corm is well above the growing medium surface to reduce the risk of bacterial soft rot.

15 Growth cracks in the corm predispose plants to bacterial soft rot

- Apply an even and balanced irrigation programme. Irregular watering can lead to growth cracks in the corm through which the bacterial soft rot pathogen can enter, whilst overwet growing media will favour the development of *Pythium*, *Phytophthora* and black root rot.

- Use of overhead irrigation will lead to water-splash of spores of anthracnose, botrytis and fusarium and will create conditions conducive for infection by increas-ing leaf wetness and humidity.
  A sub-irrigation system will greatly reduce this risk, although some form of water treatment (eg slow sand filter, sodium hypochlorite, copper or UV treatment) may be required if the water is recirculated.

- Avoid high nitrogen feeds that lead to soft growth and probably increased susceptibility to disease.

- Avoid physical damage to the foliage and flowers, as this increases susceptibility to botrytis.

- Avoid overcrowding – space the plants before they need it rather than when it is too late.

- Use glasshouse shading and/or shade screens to reduce stress on plants.

- Good air movement will help to harden plants and reduce petiole length.

- With pack cyclamen sold as autumn bedding, try to avoid holding them past their optimum stage; botrytis can become a serious problem due to the dense foliage and fallen flowers.

Environmental control

- Use ventilation fans and shading to reduce very high temperatures. At 20–25ºC or higher there is an increased risk of fusarium wilt, anthracnose and bacterial soft rot, as well as a risk of delayed establishment of the crop.

- The risk of botrytis problems can be greatly reduced by closely monitoring humidity levels and reducing them as required by a combination of adequate plant spacing, ventilation, fans and, sometimes, heat boosts. HDC Factsheets 24/02 and 25/02 give further information on controlling humidity to minimise the incidence of grey mould in heated crops.

- At flowering especially, avoid sudden drops in air temperature which can lead to condensation; wetness on petals, even for an hour or two, greatly increases the risk of flower botrytis.

Hygiene

- Ensure that senescent leaves and flowers are removed promptly as they can be quickly colonised by botrytis which then spreads through the plant.

- Ensure that virus-vector pests such as thrips and aphids are adequately controlled. Also keep on top of sciarid and shore fly infestations, as research has shown that they can spread spores of *Thielaviopsis* and *Pythium*. It is also possible that they could carry the spores of *Colletotrichum* and *Fusarium*.

- Remove any diseased plants promptly so as to reduce secondary spread. Bag up plants before removing them, to avoid spreading spores of fungi such as *Botrytis* or *Fusarium*.

- Ensure that diseased material and other crop debris is removed off-site or kept in covered skips or heaps, well away from production areas, prior to disposal. HDC Factsheet 10/07 gives further information on nursery hygiene.

16 Remove diseased plants promptly

Acknowledgements

We are grateful to Harry Kitchener, Mike Holmes and David Stokes for commenting on a draft of this factsheet.

Additional information:

November 2007

Design and production: HDR Visual Communication