

Bedding plants

Project No. PC 143, PC 38a and PC 38c

Control of downy mildew, black root rot and *Ramularia* leaf spot diseases on pansy and viola

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This factsheet collates information from several HDC funded projects to provide guidelines for achieving effective control of downy mildew, black root rot and *Ramularia* leaf spot on pansy and viola. Information is provided on the recognition and basic biology of each disease to assist in the selection of the most appropriate cultural and chemical strategies for disease control. The guidelines provided aim to not only minimise the risk of crop damage by inappropriate fungicide use, but also reduce the potential for the development of fungicide resistance.

Economic importance of the diseases

The value of the UK bedding plant industry is estimated to be in excess of £300 million, with the ‘farmgate’ value of autumn and spring pansies alone in the region of £70 million (Mr S Coutts, pers comm). Downy mildew, black root rot and leaf spots are some

of the most common and troublesome disease problems affecting bedding plants, particularly pansy, an important year round crop. Whilst losses due to these diseases vary from season to season and nursery to nursery, it is not uncommon for some nurseries to lose up to 10% of plants, a potential industry loss of up to £7 million per annum.

The presence of either downy mildew or *Ramularia* can quickly

render crops unsaleable. Plant losses as a result of black root rot can also necessitate extra handling and marketing costs as packs need to be made up by hand to replace missing or dying plants. Plant losses from black root rot peak during late summer and early autumn, whilst downy mildew and *Ramularia* are more prevalent on winter and spring crops, when cool, moist conditions prevail.

Disease symptoms, survival and spread

Downy mildew

Downy mildew (*Peronospora violae*) is one of the most common and destructive diseases of pansies and violas. Like most downy mildew diseases, it is host specific and will not cross infect other bedding plant species. On pansies the disease produces dull yellowish or grey green blotches on the upper leaf surface. On the underside of leaves the fungal spores of the disease give rise to a purple-brown felty mass. The leaves of infected plants often roll downwards at the margins. Plants suffer from a lack of vigour, delayed flowering and reduced growth.

Downy mildew is favoured by high humidity and free water on the leaves



Downy mildew of pansy: Infected leaves develop a pale colour on the upper surfaces

of plants. The spores are wind-borne or spread by water splash. Intermittent periods of dryness aid spore dispersal, the stalks on which the spores are produced twist round as they dry out, thus dislodging the spores. Once released, the spores require only a short period (just a few hours) of leaf surface moisture for successful germination and establishment. Thick walled resting spores may also be produced and survive for long periods within infected leaves and dried leaf debris.



Downy mildew of pansy: Dense mats of velvet-like spores appear on the undersides of leaves

Black root rot

Black root rot is caused by the soil-borne fungus, *Thielaviopsis basicola*. The disease is not host specific and has been isolated on several different bedding plant species. It is widespread and occurs commonly, and often severely, on pansies and violas.

The fungus attacks the roots of the plant and the symptoms can often be mistaken for a nutrient deficiency. Infected plants grow poorly and often develop a purpling of the older leaves. As the roots decay, the plant becomes severely stunted and quite often will rot off at the compost surface. If the disease is suspected, roots should be washed and examined for a characteristic black staining, but laboratory tests may be necessary for disease confirmation.

The fungus produces two types of spores on infected plants, short lived ones which aid in the rapid local spread of the disease and thick walled resting spores on infected roots which are capable of long term survival and re-infection.

The disease develops under a wide range of conditions though tends to



Plants infected with black root rot (*Thielaviopsis basicola*) develop poorly

be more severe where there is high compost moisture levels coupled with poor aeration. The fungus grows best at 17 to 23°C and at a pH of 5.7 to 5.9. The resting spores of the fungus can survive in contaminated compost, in old roots in pots and on matting, 'dirty' trays and pots. Effective nursery hygiene is therefore very

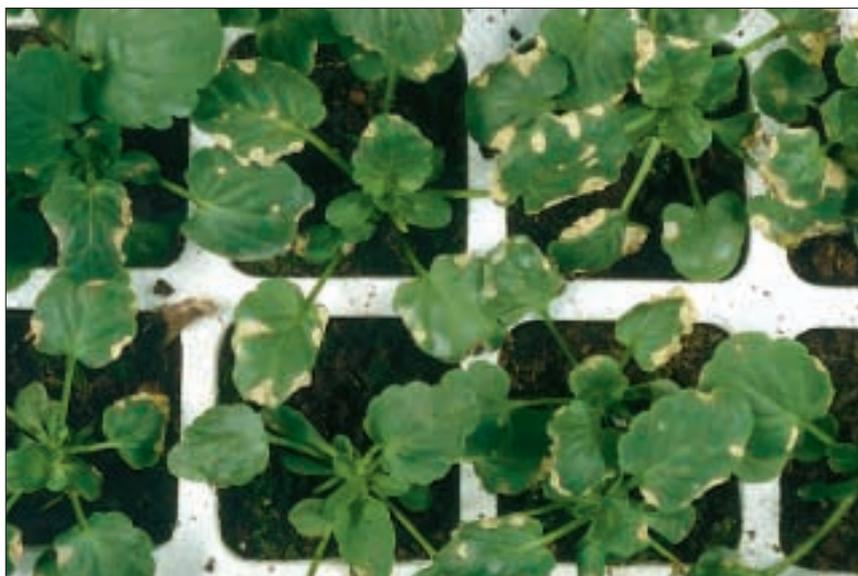
important for good disease control. Water splash will spread the spores locally whilst the longer lived resting spores of the disease can be wind blown in soil, dust and plant debris over greater distances. Spore dissemination by sciarid flies has also been demonstrated.

Ramularia leaf-spot

Two species of *Ramularia* (*R. lactea* and *R. agrestis*) have been reported causing leaf spotting on pansy. Both species can spread rapidly through crops but are host specific so do not usually pose a threat to other bedding plant species on the nursery.

Initial symptoms usually occur as distinct, small dark leaf spots often on the older lower leaves of plants. When severe, large areas of leaf tissue can be affected with a light brown necrosis which is 'papery' or scorched in appearance. The symptoms can often be mistaken for damage caused by chemical scorch or stress as a result of under watering.

The disease is usually most prevalent during cool, wet weather. The fungus produces a large number of spores on infected leaves which are spread on air currents or by water splash.



Severe *Ramularia* infection on pansy



Characteristic scorch-like symptoms caused by *Ramularia* on leaves of pansy

Control strategy

Cultural control

Careful management of environmental conditions is one of the key factors in avoiding serious disease outbreaks on the nursery and this is especially relevant in the case of leaf diseases such as downy mildew and *Ramularia* leaf spot. When coupled with the other cultural control methods listed below, disease pressure should be reduced, minimising the need for fungicide applications.

- Thoroughly clean the relevant glasshouse area, benches and standing areas of crop debris and compost dust before the arrival of new plants.
- Where possible, use new plug trays, packs and pots.
- Inspect plugs and other plants arriving on the nursery for symptoms of downy mildew, black root rot and *Ramularia* leaf spot. If any of the diseases are found, reject the consignment or isolate the plants whilst treatment is undertaken. Continue to monitor crops weekly for early detection of disease. Use specialist laboratories for early detection if required.
- Maintain a high level of hygiene during the production process; at propagation, transplanting, growing on and marketing. Ensure raw materials (peat, compost, pots, trays etc) are correctly stored and covered.
- Avoid standing plastic trays on the glasshouse floor where there is contact with debris or soil as this increases the risk of root disease infection. Keep the base of plug trays off bench tops and matting, prising plants off matting damages roots and allows entry points for root diseases.
- Do not hold plants in plug trays for any longer than necessary.
- Monitor environmental conditions carefully – use ventilation, fans and

heat to reduce humidity within the crop to control downy mildew and *Ramularia*. It is particularly important to reduce to a minimum the time when free water is present on the leaf surface.

- Avoid overhead irrigation if possible, particularly in the evenings when prolonged leaf wetness can result. Check the growing structure for leaks, or areas where condensation drips on to plants.
- Avoid plant stress to limit the severity of black root rot. Ensure watering is even, compost drainage is adequate, compost pH levels are around 6.0 and high temperatures or rapid temperature fluctuations are avoided.
- If downy mildew, black root rot or *Ramularia* leaf spot occur in a crop, dispose of severely infected plants

directly into bags. Avoiding spreading spores throughout the remainder of the crop during disposal. Ensure that there is a thorough clean-up once infection has been detected, disposing of all fallen leaves, other plant debris and compost.

Chemical control

Surface sterilants

Careful use of surface sterilants to routinely clean glasshouses, production areas, recycled plug trays and pots and trolleys, will reduce the incidence of disease infection in crops of pansy and viola. Before applying any chemical sterilant, remove as much dirt and debris as possible to maximise the effectiveness of the treatment as the products tend to be inactivated by the presence of large quantities of organic matter.

There is a known risk of infection from the black root rot fungus,

T. basicola, from plug trays when they are re-used, especially repeatedly during the same season. Previous work funded by the HDC (PC 38c) examined the use of chemical disinfectants on contaminated plastic plug trays for the control of black root rot disease. Loose peat was shaken from the trays prior to treatment with the disinfectant. After treatment, trays were dipped once in water to rinse. Jet 5 (peroxyacetic acid), used according to the manufacturers recommended rate with a one hour dip, was particularly effective in reducing the level of the disease. No detrimental effects on plant quality or phytotoxic symptoms were observed in any of the plants grown subsequently in the treated trays. Panacide M (dichlorophen), Ter Special (quaternary ammonium compound) and sodium hypochlorite (10 to 14% available chlorine) were also effective, reducing disease incidence to 15% or under.

Fungicide selection

Whilst a number of fungicides possess label recommendations for use on protected ornamental plants, growers of non-edible crops also have access to a wide selection of other products under 'The Revised Long Term Arrangements for Extension of Use'. For the most up-to-date information on LTAEU visit the PSD website at 'www.pesticides.gov.uk' **It should be noted that use of such products are at the growers own risk.**

To assist growers in identifying safe and effective fungicides for use against downy mildew, *Ramularia* and black root rot in pansies a number of new products were screened for their efficacy in trials conducted over a 3 year period (HDC project PC 143). The pansy series used in the trials was Ultima.

Black root rot

A stern test of the fungicides was conducted by incorporating a spore suspension of *T. basicola* (the causal agent of black root rot) into the compost prior to potting up of the plug plants. The fungicides were applied as high volume drenching spray applications, once at planting and again 12 days later.

Amistar (azoxystrobin), Bavistin DF (carbendazim), Octave (prochloraz), Plover (difenoconazole), and Stroby WG (kresoxim-methyl) all reduced the level of the disease and none caused a noticeable reduction in plant growth or quality. In addition, fungicide resistance screening tests against carbendazim (Bavistin DF) showed that few resistant strains of *T. basicola* were found amongst the fungal population studied.

Growers should note that whilst Scala (pyrimethanil) was effective in controlling black root rot infection, it caused a reduction in plant quality, with evidence of scorching and stunting of plants. Scala is permitted for use on protected ornamentals under the 'The Long Term Arrangements for Extension of Use 2002'.

Downy mildew

Downy mildew is very difficult to eradicate once the disease is established and hence early protection against the disease is important.

In the trials, a selection of fungicides were applied 12 days after potting up the plug plants and prior to the introduction of the downy mildew pathogen. Favour 600 SC (metalaxyl + thiram), provided excellent control of downy mildew whilst Aliette 80WG

(fosetyl-aluminium), Amistar (azoxystrobin), Filex (propamocarb hydrochloride), Fongarid (furalaxyl), and Stroby WG (kresoxim-methyl) also provided good control, significantly reducing the levels of downy mildew compared to the untreated control.

Whilst not screened in these trials, protectant fungicides, such as those listed in Table 2, containing either chlorothalonil, mancozeb or thiram should also provide some protection from downy mildew when applied preventatively to pansy.

Ramularia

The main fungicides used by industry to control *Ramularia* leaf spot disease in pansy crops are Bavistin DF (carbendazim) and Octave (prochloraz).

In the HDC trials, Amistar (azoxystrobin) provided excellent control of *Ramularia* leaf spot disease particularly when applied as a protectant spray. Octave also gave good control whereas Bavistin DF failed to significantly reduce the disease symptoms. This suggests that resistant strains of the pathogen(s) may be developing to carbendazim, the active ingredient in Bavistin DF.

Table 1 lists fungicides tested in the HDC trial, approved for use on

ornamental crops grown under protection and with activity against either downy mildew, black root rot and/or *Ramularia* leaf spot diseases.

Table 2 lists some additional fungicides **not** tested in the HDC trial, approved for use on ornamental crops grown under protection and with

potential activity against either downy mildew, black root rot and/or *Ramularia* leaf spot diseases.

Crop safety

With the exception of Scala, there were no visible symptoms in the HDC trials of foliage scorch, stunting, flower inhibition or detrimental effects on plant growth and quality following application, at the label recommended rate, of any of the fungicides listed in Table 1 to pansy plants cv Ultima.

Phytotoxic symptoms were however observed following application of Folicur (tebuconazole) to pansy in the HDC trial, but it should be noted that Folicur is not approved for use on protected ornamentals and therefore is not listed

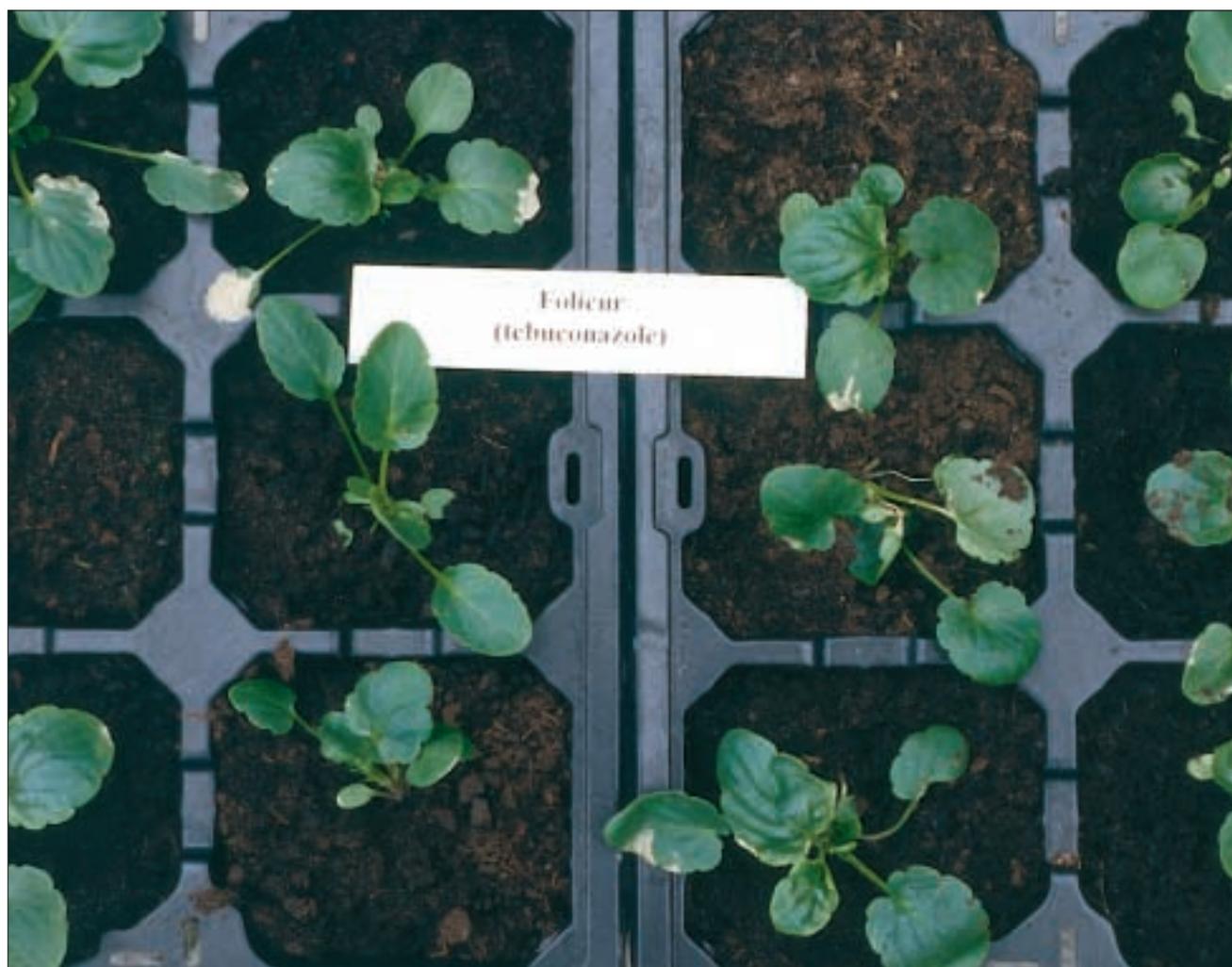
in Table 1. Growers should also note that whilst no crop damage was observed following application of Octave in the HDC project, there is circumstantial evidence from some growers to suggest that crop damage can occur where Octave is used as a drench on plants. This product should therefore **only** be applied as a foliar spray ensuring excess product does not run down into the compost.

It is generally suggested that:

- Before using a new product test treat a few plants first to check for potential phytotoxicity as some

species/cultivars are likely to be more sensitive than others.

- To minimise leaf scorch, avoid spraying in hot, sunny conditions.
- Pesticides applied to protected bedding plants either as Specific Off-Label Approvals (SOLAs) or under the Long Term Arrangements for Extension of Use (2002) are undertaken at the grower's own risk. Before use, you must obtain a copy of the product label or the SOLA notice of approval and comply with the conditions therein.



Phytotoxic symptoms on pansy caused by application of Folicur in HDC trial PC 143 (Note: Folicur (tebuconazole) is not approved for use on protected ornamentals)

Fungicide strategy

The overriding strategy in the use of fungicides should be to:

- 1 Use the minimum number of treatments to provide effective control, ideally alternating between multi-site protectant fungicides eg mancozeb in the early stage of crop development and site-specific eradicant products once a specific pathogen has been identified
- 2 Only apply fungicides that are safe to the crop, spray operator, and the environment
- 3 Try and devise a programme that does not encourage resistance development.

To achieve effective disease control it is recommended that:

- Crops are regularly inspected and monitored for diseases and other problems.

- Spray programmes are geared to the outcome of crop inspections.
- Fungicides are applied preventatively to avoid any build up of disease, particularly where there is a history of disease outbreaks on the site.
- Fungicides are applied during the early stages of disease development to provide more effective control and minimise the risk of resistance developing. It is important not to allow the pathogen to build up within the crop making disease control more difficult.
- Full use is made of multi-site protectant fungicides (eg mancozeb, thiram and chlorothalonil), as these are less prone to resistance development.
- Spray programmes are devised alternating products based on the

mode of action and chemical groups (see Tables 1 and 2 for a listing of products by their 'fungicide group').

- The method of application, spray pressure and volume are adjusted in order to treat the lower as well as the upper leaf surface whilst trying to avoid excess spray run-off into the compost.
- The approved dose rate, either from the manufacturers label or the Specific Off-Label Approval (SOLA) document, is followed.
- The risk of crop damage from the intended fungicide treatments is assessed prior to use.

Avoiding fungicide resistance

It is in the interests of all growers to adopt integrated disease control strategies to minimise the occurrence of fungicide resistance.

In the fungicide screening trials (PC 143), Amistar (azoxystrobin) showed good broad-spectrum activity and proved to be effective in controlling all three pathogens studied. However, the risk of resistance developing is relatively high with the strobilurin fungicides such as Amistar and Stroby WG and they must not be over-used. Instead, they should form a component of an integrated spray programme incorporating fungicides from other

chemical groups. To reduce the risk of fungicide resistance:

- Minimise disease pressure by non-chemical methods, especially through good levels of hygiene, appropriate ventilation and plant spacing, to avoid creating conditions ideal for disease development.
- Minimise the use of fungicides and particularly avoid repeated applications of fungicides from the same group.
- Alternate products based on their chemical groups and mode of action.
- Make full use of multi-site protectant fungicides in the early stages of crop development as

these tend to be less prone to resistance development.

- Follow rates recommended by the manufacturers label.

To avoid resistance development with the strobilurin fungicides (eg Amistar, Stroby WG):

- Use a maximum of one treatment of these fungicides to three other fungicide applications
- Do not apply consecutive applications of Amistar or Stroby WG
- Apply Amistar or Stroby WG in alternation with products from other fungicide groups.

Table 1

Fungicides tested in HDC project PC 143 with demonstrated activity against downy mildew, black root rot and/or *Ramularia* leaf spot diseases and which can be used on various ornamental crops grown under protection

Commercial product	Active ingredient(s)	Mode of action	Fungicide group	Products evaluated in HDC trials			Comments
				Black root rot*	Downy mildew	<i>Ramularia</i> leaf spot	
Aliette 80 WG	Fosetyl-aluminium	Systemic	Organo-aluminium	n/t	✓	n/t	Label recommendation for protected ornamentals
Amistar	Azoxystrobin	Protectant	Strobilurin (QoI fungicide)	✓	✓	✓	Extrapolation from various SOLAs on protected crops eg 1533/02, 1294/02, 1295/02, 1684/01, 1041/01
Bavistin DF	Carbendazim	Systemic (curative/protectant)	MBC or benzimidazole	✓	n/t	✓ (suppression only in trials)	Extrapolation from various SOLAs on protected crops eg 0009/99, 2078/99
Favour 600 SC ¹	Metalaxyl + thiram	Systemic and protectant	Phenylamide	n/t	✓	n/t (some suppression expected from dithiocarbamate component)	Extrapolation from On-Label use on protected lettuce
Filex/Proplant	Propamocarb hydrochloride	Protectant	Thiocarbamate	n/t	✓	n/t	Label recommendation for protected ornamentals
Fongarid ¹	Furalaxyl	Protectant and curative	Phenylamide	n/t	✓	n/t	Label recommendation for protected ornamentals
Octave	Prochloraz	Protectant and eradicant	Triazole	✓	n/t	✓	Label recommendation for use on ornamentals and extrapolation from SOLAs eg 0650/01
Plover	Difenoconazole	Protectant and curative	Triazole	✓	n/t	✓ (suppression only)	Extrapolation from various SOLAs on protected crops eg 1729/97 & 1665/01
Scala	Pyrimethanil	Protectant	Anilinopyrimidine	X	n/t	X	Extrapolation from various SOLAs on protected crops eg 1590/00, 1321/02, 1888/00
Stroby WG	Kresoxim-methyl	Protectant	Strobilurin (QoI fungicide)	✓ (suppression only)	✓	X	Extrapolation from On-Label use on protected roses and strawberries

✓ Efficacious and no evidence of phytotoxicity in HDC trials
X Not efficacious in HDC trials
n/t Not tested as activity against the listed pathogen not expected

¹ Favour 600 SC and Fongarid were not supported through the EU Pesticide Review Programme (EEC/91/414) and are due to be phased out of production.

* For black root rot control, fungicide drench applications are required to effectively target the pathogen. Whilst no phytotoxicity was observed in the trials following drench application of

the fungicides listed, growers are urged to check in detail the approval status of the product with respect to application method and to treat a few plants first to ensure crop safety on specific cultivars. In particular, there have been some reports of plant damage where Octave has been applied at high volume and allowed to run down into the compost.

Table 2

A selection of additional fungicides approved for use on protected ornamentals with potential activity against important pathogens of Pansy but which were not evaluated in HDC project PC 143

Commercial product	Active ingredient(s)	Mode of action	Fungicide group	Activity against primary pathogens of Pansy			Comments
				Black root rot	Downy mildew*	Ramularia leaf spot	
Various products	Chlorothalonil	Protectant	Phthalonitrile	No	Yes	Yes	Extrapolation from On-Label use for various protected crops
Various products	Mancozeb	Protectant	Dithiocarbamate	No	Yes	Yes	Extrapolation from various SOLAs on protected crops eg 0936/99, 2446/01 & 2447/01
Fubol Gold WP Fubol Gold WG	Metalaxyl-M + mancozeb	Systemic and protectant	Phenylamide + dithiocarbamate	No	Yes	Yes (protection via the dithiocarbamate component only)	Extrapolation from various SOLAs on protected crops eg 0936/99, 2446/01 & 2447/01
Unicrop Thianosan DG	Thiram	Protectant	Dithiocarbamate	No	Yes	Yes	Extrapolation from On-Label uses for various protected crops

* Products with activity against downy mildew (not powdery mildew) could also be expected to have some activity against *Pythium* and *Phytophthora* species

The majority of products listed in Tables 1 and 2 are permitted for use off-label via the Revised Long-term Arrangements for Extension of Use (2002). Although approved, off-label uses are not endorsed by the product manufacturer and such treatments are made entirely at the risk of the user. Before use, you must obtain a copy of the product label or the SOLA notice of approval and comply with the conditions within.

Note

Regular changes occur in the approval status of pesticides arising from changes in pesticides legislation or from other reasons. For the most up to date information, please check with a professional supplier or with the Information Office at the Pesticides Safety Directorate (PSD) Tel: 01904 640500; or on their website listing revocations (www.pesticides.gov.uk/raidinfo/rep-fp.cfm)

- **Always read the label or Specific Off-Label (SOLA) notice of approval.**
- **Use pesticides safely.**
- **Check with suppliers for full details of any side effects on biological control agents.**