Factsheet 12/03

Lisianthus *(Eustoma)*

Project No. PC 179

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Control of lisianthus downy mildew

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Lisianthus crops in the UK have been severely affected by downy mildew (*Peronospora chlorae*) in recent years. This factsheet summarises current knowledge on the biology of the disease and describes integrated methods of control.

Background

Lisianthus, also known as eustoma or Texas bluebell, is a relatively new glasshouse flower crop in the UK. However, it is very susceptible to infection by *Peronospora chlorae*, the cause of lisianthus downy mildew, and in recent years the disease has resulted in crop losses estimated at £200–400k per year.

Symptoms

Downy mildews are primarily foliar diseases although they are also capable of affecting other plant parts. Symptoms are generally of two types:

- Stunted and distorted plant growth with pale foliage. This symptom results from systemic infection, where there is extensive fungal growth within the plant tissues. Profuse spore production may occur on both leaf surfaces or over the entire plant. In some cases, there are no spores on the plant surface but resting spores (oospores) may be produced in large numbers in internal tissues.
- Localised symptoms on leaves, usually resulting from secondary spread of the fungus. Discoloured patches, often angular in shape, develop on the leaf surface and there may be 'downy' or felty growth on the leaf underside due to fungal spore production.

Lisianthus plants affected by downy mildew exhibit both types of symptom, systemic and localised. Established plants tend to show yellowing and down-curling of affected leaves (particularly the lower leaves of younger plants), often with a purplish-brown fungal growth on the underside (Fig 1). Affected leaf areas become desiccated and turn pale brown (Fig 2), most commonly in the leaf axil. Severely affected leaves eventually wither. Attack is often most severe on the younger leaves, as leaves tend to become less susceptible as they age.

The fungus can also infect the stem, sometimes leading to stem bending or distortion (Fig 3), and brown lesions may develop. These stem lesions tend not to produce fungal fruiting bodies but are often full of resting spores (oospores), as are ageing leaves and occasionally roots.

1 Spore production *(Peronospora chlorae)* on underside of lisianthus leaf

2 Pale brown leaf lesions due to downy mildew disease

3 Distortion and bending of stems due to downy mildew infection

Symptoms on young seedlings are often indicative of systemic infection. They range from yellowing of the whole seedling through to tissue death and collapse of the plant. There is often no production of fruiting bodies but affected tissues will again contain resting spores.

Sources of the disease

There is increasing circumstantial evidence to suggest that development of downy mildew on young lisianthus seedlings may arise from seed-borne infection.

It is unlikely that weeds are a source of the disease as the host range for *P. chlorae* is restricted to a few members of the Gentianaceae family only. In addition, weeds in this family have a limited occurrence in the UK and the fungus may exist as a different race on each host. The only reports of downy mildew. (*P. chlorae*) on wild hosts in the UK have been on Yellow-Wort (*Blackstonia perfoliata*).

Resting spores of downy mildews can survive for extended periods (several years for some species) in plant debris or soil. While the precise role of resting spores in the infection cycle of *P. chlorae* is not known, it is likely that affected material could act as a source of the disease. Fruiting bodies (conidia) may also survive for days or even weeks, given appropriate environmental conditions (usually low relative humidity).

Environmental conditions

Circumstantial evidence suggests that, like most downy mildews, development of lisianthus downy mildew is favoured by conditions of high humidity and leaf wetness. However, little is known about *P. chlorae* in terms of the precise environmental conditions that are optimal for infection, symptom development, spore production and release. Nevertheless, there are certain conditions required by most downy mildews that are likely to be directly relevant to the important stages in the disease cycle of *P. chlorae*:

Spore germination and infection
Free moisture on the surface of the plant is essential for downy mildew spores to germinate and produce a germ tube, which penetrates the host either through the stomata or directly via the leaf cuticle. Once the fungus is inside the plant, it is protected to a certain extent from adverse environmental conditions. The optimum temperature and duration of the wet period for *P. chlorae* infection are not known, although work in China has shown that spores of *P. chlorae* germinate at temperatures ranging from 8–32°C.

The incubation period (time from infection to symptom appearance) varies between downy mildews but will depend largely on temperature and to a lesser extent relative humidity.

Spore production
Spore production in most downy mildews requires moist, dark conditions after a period of light. High relative humidity is essential although free water is not usually required.

Fresh crops of spores may develop on the same lesion for several successive nights. This means that large numbers of spores could be produced during the lifetime of a single, large lesion. Spore production tends to be more profuse on younger rather than older foliage.

Spore release
Detailed studies on other downy mildew species suggest that there are two main methods of spore release:

- Physical disturbance of leaves due to air movement, watering, humans or equipment.
- Decreasing humidity. As the humidity drops, the stalks on which the spores are produced begin to dehydrate and twist sufficiently for spore release to occur.

Spores are normally produced during the night and released into the air in the morning, as the temperature rises and humidity falls. Increasing solar radiation may also play a role in spore release. On a dry day, spores are generally present in the air in greatest quantity in the early morning and decline through the day.

Integrated control

A combination of control measures that act by different means is more likely to provide effective and durable control of downy mildew than any single measure. Careful management of environmental conditions, coupled with other cultural control methods should reduce the need for fungicide treatment.

Cultural control measures

Prevention of prolonged leaf wetness and high humidities is the most critical aspect of cultural control for downy mildew. Therefore:

- Only use overhead irrigation when there is sufficient time for leaf surfaces to dry before nightfall. Overhead watering of plants in the evening can result in high humidities at night, which will trigger the production of large numbers of spores. If any leaf wetness persists into the following morning, these spores could immediately infect the plant. Ideally, if rapid drying is not practicable, an alternative to overhead watering should be used.

4 Avoid prolonged leaf wetness to minimise the risk of spores germinating and infecting the plant

- Water droplets tend to remain on lisianthus leaves for extended periods (2–3 days) (Fig 4). Avoid prolonged leaf wetness and reduce overall humidity to lower the risk of spores germinating and infecting the plant. Use fans, ventilation, or heating and ventilation, to improve airflow through the canopy, especially in the early morning to avoid condensation.

Growers should also follow the guidelines outlined below:

- Thoroughly clean the relevant glasshouse area of crop debris before the arrival of new plants.

- Check plants on arrival at the nursery. Do not use seedlings or transplants with symptoms of downy mildew.

- Avoid susceptible varieties where possible. Varieties with larger and more succulent leaves, particularly Kyoto Sky Blue, tend to be more susceptible. Varieties with a tendency to rosetting (eg Fuji Rose Pink) also seem prone, perhaps due to longer retention of water droplets on the foliage.

- Monitor the crop regularly for early symptoms of the disease particularly in mid-summer (June/July) when the disease is most likely to occur. One of the first symptoms to look out for in rapidly growing plants (30–45 cm high) is elongation, twisting and distortion of stems.

- If just a few plants are affected, remove them from the crop. Destroy any visibly affected material as it is likely to contain fungal resting spores, which may play a role in re-infection.

Chemical control measures

When devising a fungicide strategy:
i) use the minimum number of treatments to provide effective control
ii) only apply fungicides safe to the crop
iii) use a programme that does not encourage fungicide resistance.

HDC project PC 179 evaluated the crop safety and efficacy of a number of existing and novel fungicides for downy mildew control in propagation and post-planting. Those fungicides approved for use as foliar sprays on protected lisianthus and shown to be safe and effective in controlling downy mildew are listed in Table 1.

Table 1
Fungicides tested in HDC project PC 179, approved for use on protected lisianthus and found to be crop safe and effective in controlling downy mildew

Product and fungicide group	Active ingredient	Application rate per litre water	Comments and approval status
Phosphonic acid Aliette	Fosetyl-aluminium	1.5 g	Useful when used in a post-planting preventative spray programme. [Full approval]*
Strobilurin Amistar	Azoxystrobin	0.8 ml	Effective for propagation or when used in a post-planting preventative spray programme. Maximum of 3 sprays per crop [SOLA 1684/01]*
Carbamate Filex / Proplant	Propamocarb hydrochloride	1.0 ml	Useful when used in a post-planting preventative spray programme. [Full approval]*
Dithiocarbamate + phenylamide Fubol Gold WG	Mancozeb and metalaxyl-M	1.33 g	Useful when used in a post-planting preventative spray programme. [SOLA 1610/01]* Maximum of 3 kg/ha/year; 14 day harvest interval and 14 day spray interval.

***Approved under Revised Long Term Arrangements for Extension of Use (2002)**

Note
Regular changes occur in the approval status of pesticides arising from changes in pesticide legislation or for other reasons. For the most up to date information, please check with your professional supplier, BASIS registered adviser or with the Information Office at the Pesticides Safety Directorate (PSD) (Tel 01904 455775; www. pesticides.gov.uk).

- **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.**

Fungicide use during propagation
Amistar was shown to be particularly effective in reducing the severity of downy mildew during propagation (applied at 0, 2 and 4–5 weeks after planting). No phytotoxicity symptoms were observed following application of Aliette, Amistar or Filex to the cultivars tested (Picotee Pink and Malibu Dark Blue), and there were no adverse effects on seedling germination.

Results are not available for Fubol Gold WG (mancozeb and metalaxyl-M) as it was not included in the propagation trial. However, metalaxyl-M applied as SL 567A (not approved) significantly reduced the level of lisianthus downy mildew during propagation with no phytotoxic effects, although it did reduce germination in one cultivar (Picotee Pink).

Fungicide use post-planting
The following protectant spray programmes are based on trial programmes that gave complete control of the disease post-planting with no symptoms of phytotoxicity on the cultivars tested (Ventura White and Ventura Rose). It should be noted that there is a maximum permitted application of 3.0 kg/ha/year for Fubol Gold WG; this equates to two sprays per year if using the maximum permitted dose of 1.5 kg/ha and a spray volume of 1,000 litres/ha.

- Amistar, Amistar, Filex, Filex, Amistar, Aliette, Filex, Filex (8 sprays)
- Fubol Gold WG, Amistar, Aliette, Filex, Amistar, Aliette, Filex (7 sprays)

Spray programmes that commenced with Amistar or Fubol Gold WG were the most effective.

Fungicide timing
Fungicide timing was most effective when trial spray programmes commenced 2 days after planting and were applied at approximately 14 day intervals until the first visual symptoms of downy mildew were seen in control plots, when the spray interval was reduced to 7 days. Delaying spray applications until the appearance of the first visible symptoms of downy mildew reduced the efficacy of spray programmes and this was further reduced when the spray interval was increased from 7 to 14 days.

Growers should be aware that there are reports that use of high-volume fungicide sprays in a mature crop can result in unacceptable spray deposits on plants at harvest; no obvious deposits were seen using Aliette, Amistar, Filex and Fubol Gold WG on cultivars Malibu and Picotee Pink in this trial.

Avoiding fungicide resistance
Although no resistance to fungicides has been reported in lisianthus downy mildew, resistance development is a real risk with this group of fungi. Where resistant strains are present, treatment with these fungicides will provide little or no disease control. Where strains of downy mildew are resistant to a fungicide in a particular group (see Table 1) there is usually also resistance to all other members of the same fungicide group. The following procedures should be followed in order to preserve the effectiveness of fungicides:

- Use fungicides according to the programmes listed, or similar programmes that have been designed to avoid resistance development.
- Use no more than two sprays of the same fungicide, or fungicide group, in sequence, then use a completely different fungicide group.
- For strobilurin fungicides, use no more than 50% of the total sprays of this type of fungicide per crop.
- Follow the label or SOLA 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.
- For further advice on strategies to minimise the risk of selecting resistant strains of downy mildew, see the FRAG-UK Technical leaflet: Fungicide Resistance, published in August 2001, which can be downloaded from: www.pesticides.gov.uk

Action points

- Reduce the risk of lisianthus downy mildew through use of good sanitation, avoidance of susceptible cultivars and, most importantly, manipulation of the glasshouse environment to reduce the occurrence and duration of leaf wetness periods and high humidities.
- Amistar may be used during lisianthus propagation to reduce the severity of downy mildew. Post-planting, a protectant fungicide programme (commencing with Amistar or Fubol Gold WG), starting before the development of first symptoms, can provide effective disease control. If symptoms are visible before a spray programme commences, apply at least two sprays of fungicides at 7 day intervals.
- Application of high volume fungicide sprays may leave unacceptable deposits on plants so avoid treatment close to harvest.
- When devising a spray programme, follow the guidelines on avoiding fungicide resistance.

Further information: A full copy of the final report for HDC project PC 179 is available from the HDC office (01732 848383).

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