Factsheet 15/07

Pot and bedding plants

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Control of leaf miners on pot and bedding plants

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This factsheet aims to help growers recognise key leaf miner species, including those that are quarantine pests, and illustrate the damage they cause to bedding and pot plants. Guidelines on cultural, biological and chemical options for leaf miner control are provided.

Action points

- Learn to distinguish between native and quarantine leaf miners and their damage.
- Practice good nursery hygiene and weed control to minimise sources of infestation.
- Use yellow sticky traps to monitor for adults and check plants regularly for damage symptoms ie feeding punctures and mines on the leaves.
- Pay particular attention to favourite host plants and bought-in plant material.
- At the first sign of leaf miners or damage, start a planned control programme promptly.
- If a quarantine species is suspected, contact Defra Plant Health and Seeds Inspectorate (PHSI) immediately.

1 Adult feeding punctures (white spots) on the upper leaf surfaces are the first sign of damage

Introduction

Leaf miners cause damage to pot and bedding plants as the larvae tunnel within the leaf tissue. The resulting mines are disfiguring, cause a reduction in plant quality and photosynethetic capability and can lead to significant annual losses within the industry.

Chrysanthemum leaf miner and tomato leaf miner are the two species most commonly found on bedding plants and other protected ornamental crops. American serpentine leaf miner and South American leaf miner are two other important species that are non-indigenous and notifiable in the UK.

Late spring and summer is the most likely time for native leaf miners to fly in from outdoors. There is a risk of importing leaf miner species that are not native to the UK on plant material from overseas, at any time of the year, depending on the country of origin.

Damage symptoms

Both adults and larvae cause damage to plants that can make them unmarketable. Severely mined leaves can shrivel and die, which may weaken young plants and seedlings. Heavy infestations can lead to plant death and significant losses.

Adult feeding punctures

The first sign of leaf miner damage is the presence of the adult feeding punctures on the upper leaf surfaces. These appear as small bleached spots. Native *Chromatomyia* species usually make oval punctures up to 1 mm diameter, whereas *Liriomyza* species, including quarantine leaf miners make smaller, round punctures about 0.2 mm diameter.

Leaf mines

The larvae tunnel through the leaf between the upper and lower surfaces, causing the characteristic whitish leaf mines. The first mines should be visible 2–6 days after the first feeding punctures are seen. At first, they are very thin, becoming wider and longer as the larvae feed and grow. Several mines can occur in the same leaf, sometimes crossing over each other. Parts of the older mines can become brown or black.

Recognition of leaf miner species

There are many leaf miner species but only a few are pests of bedding and pot plants. These may include both native and quarantine species, which affect a wide host range. As a general guide, different species can be recognised on the nursery by the adult fly colour and markings, the shape of the leaf mines, distribution of the frass (droppings) within the mine and whether or not pupae are present in the leaves. However, expert laboratory identification is often needed to confirm the exact species.

Key recognition features and host plants of the most common leaf miner species that could occur on bedding and pot plants are summarised in Table 1.

Native leaf miner species and host plants

Native leaf miner species are more of a problem between spring and autumn, but breeding is continuous in heated glasshouses, and thus infestations can occur at any time on year-round crops such as chrysanthemum. They can over-winter both under protection and outdoors on either cultivated or weed hosts.

1 *Chromatomyia* species (formerly known as the *Phytomyza* species)
The main *Chromatomyia* species infesting bedding and pot plants are:

- *Chromatomyia syngenesiae* (chrysanthemum leaf miner). This is the most common species occurring on bedding and pot plants, particularly on Compositae including chrysanthemum, *Calendula* (pot marigold), *Gazinia,* gerbera, *Helianthus* (sunflower) and marguerite. Weed hosts include groundsel (*Senecio vulgaris*) and sow thistle (*Sonchus*).

- *Chromatomyia horticola* (recorded on chrysanthemum, *Nicotiana,* petunia).

- *Chromatomyia primulae* (common on primula and polyanthus)

2 *Liriomyza* species
Four native *Liriomyza* species could occur on bedding and pot plants hosts. However, any leaf miners or damage symptoms on protected ornamentals that match the description of *Liriomyza* species should be reported to PHSI who will to check whether it is a quarantine species. This is particularly important if plants have been imported. Plant passporting is required for all herbaceous plants within the EU (when not packaged for final point of sale) as part of the controls for quarantine *Liriomyza* species.

2 The adult native chrysanthemum leaf miner has a grey-black body with no yellow spot on its back

- *Liriomyza bryoniae* (tomato leaf miner). This is established in the UK as an important pest of tomatoes. However, it is a regulated pest for Ireland and Northern Ireland and included in plant passporting controls. The main host plants are tomato and other edible crops eg cucumber, melon and lettuce, but it has also been recorded on ornamental plants, eg chrysanthemum and gerbera. Ornamentals grown on the same nursery or adjacent to nurseries growing tomatoes are likely to be more at risk. The recognition features are very similar to quarantine *Liriomyza* species.

- *Liriomyza strigata.* This has a wide host range including many ornamental plants and weeds, but has not caused problems on commercial crops. The flies are very similar to quarantine *Liriomyza* species and the mines are very characteristic, following the main leaf vein, and with short lateral branches.

- *Liriomyza pusilla* has been recorded on *Bellis*.

- *Liriomyza congesta* and *L. pisivora* can occur on *Lathyrus* (sweet pea).

Table 1 Summary of recognition features for key leaf miner species

Leaf miner species	Adult feeding punctures	Adult body colour	Leaf mines and larva	Pupa
Chrysanthemum leaf miner (*Chromatomyia syngenesiae*)	Oval, up to 1 mm in diameter.	Grey-black body, no yellow spot on back.	White loosely meandering serpentine mines with dark blobs of frass at irregular intervals. Greenish or off-white larva.	Whitish-grey to yellow/brown pupa inside leaf at end of mine.
Chromatomyia horticola	Oval or irregularly round up to 1 mm in diameter.	Grey-black body, no yellow spot on back.	Loosely meandering.	Whitish pupa inside leaf at end of mine.
Chromatomyia primulae	Oval, up to 1 mm in diameter.	Grey-black body, no yellow spot on back.	Silver-white linear mines, dark blobs of frass spaced far apart.	Whitish pupa inside leaf at end of mine.
American serpentine leaf miner (*Liriomyza trifolii*)*	Round, 0.2 mm in diameter.	Grey-black body with yellow markings and yellow spot on back.	Meandering to convoluted, tightly coiled mines, with continuous trail of dark frass. Yellow-orange larva.	Yellow-orange to golden brown pupa in soil, compost or substrate.
South American leaf miner (*Liriomyza huidobrensis*)*	Round, 0.2 mm in diameter.	Black body with yellow spot on back.	Linear or loosely meandering mines, usually close to mid-vein, with continuous trail of dark frass. Cream larva with yellow/orange patch at front.	Yellow-orange to blackish pupa in soil, compost or substrate, or occasionally hanging from underside of leaf or lodged on lower leaf.
Vegetable leafminer (*Liriomyza sativae*)*	Round, 0.2 mm in diameter.	Black body with yellow spot on back.	Meandering mines with continuous trail of dark frass. Yellow-orange larva.	Yellow-orange to golden brown pupa in soil, compost or substrate.
Tomato leaf miner (*Liriomyza bryoniae*)* for EU plant passports only	Round, 0.2 mm in diameter.	Black body with yellow spot on back.	Loose meandering mines with continuous trail of dark frass. Cream larva with yellow/orange patch at front.	Yellow-orange to dark brown pupa in soil, compost or substrate.

Note:

If the presence of an alien leaf miner species is suspected, contact your local PHSI.

* quarantine pest

Quarantine leaf miner species and host plants

These *Liriomyza* species are not native to the UK and are quarantine pests, notifiable to Defra PHSI whenever found or suspected. If the presence of a quarantine species is suspected, you must immediately inform your local Plant Health and Seeds Inspector (contact details are available on the Defra website at: **www.defra.gov.uk/planth/senior.htm** or from the:
PHSI, York
Tel. (01904) 455174

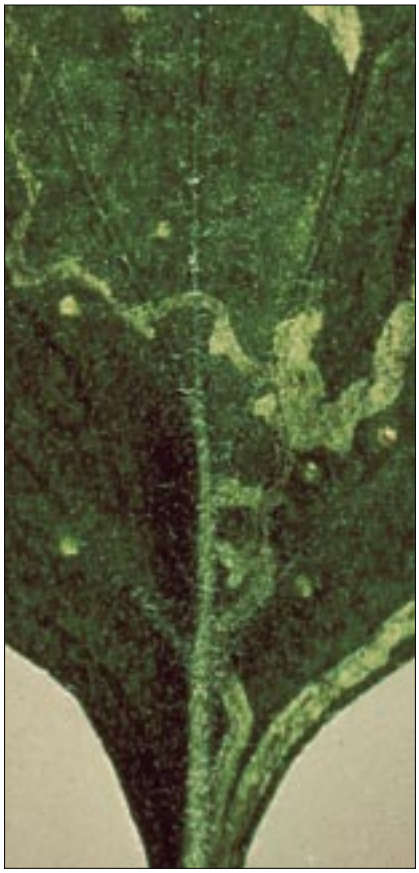
Although unlikely to over-winter and survive outdoors, alien leaf miners can breed continuously under protection if temperatures are suitable. *Liriomyza* spp. pupae can survive in the ground in unheated glasshouses for several months, so any surviving the winter can emerge as adults and re-infest protected crops in the following season.

Three quarantine leaf miners could occur on bedding and pot plants:

- *Liriomyza trifolii* (American serpentine leaf miner).
- *Liriomyza huidobrensis* (South American leaf miner).
- *Liriomyza sativae* (vegetable leaf miner). So far this has not been recorded in the UK, but it is a potential threat.

These species have a very wide host range, including both edible and ornamental plants. They may be introduced with imported cuttings (eg chrysanthemums), young plants and produce. However, *L. sativae* is more likely to occur on vegetable crops. UK outbreaks of *L. trifolii* or *L. huidobrensis* have occurred on a range of bedding and pot plants, including aster, chrysanthemum, *Lantana*, primula, verbena and viola. Weed hosts include bittersweet (*Solanum dulcamara*), chickweed (*Stellaria media*), common ragwort (*Senecio jacobaea*) and groundsel (*Senecio vulgaris*).

3 The adult quarantine South American leaf miner has a bright yellow spot on its back, like other *Liriomyza* species



4 Mines of South American leaf miner follow a loose meandering or linear pattern, often starting alongside the mid-vein

5 Mines of American serpentine leaf miner are usually tightly coiled and almost blotch-like

Sources of infestation

On glasshouse crops, leaf miner infestations may develop from several sources:

- Taking or buying in cuttings or young plants infested with adults, eggs, larvae or pupae. Importing plant material increases the risk of quarantine *Liriomyza* species.
- Native *Chromatomyia* species pupae may survive in leaf debris from previous crops, and *Liriomyza* species pupae may survive in the soil, compost, ground or bench-cover matting, pots or trays used for growing previous crops. Adults emerging from these pupae can infest following crops.
- Adult leaf miners can fly from infested crops within the glasshouse or from cultivated or weed hosts outdoors between spring and early autumn.

Being aware of possible sources of leaf miners is very important when planning methods for avoiding infestation (see 'Cultural control').

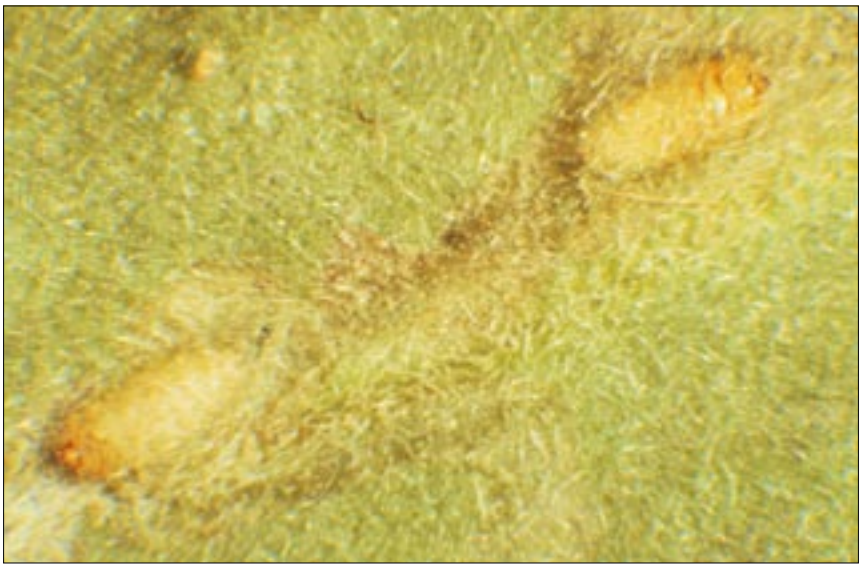
Life cycle

The life cycle is dependent on species and temperature. Adult leaf miners live for 2–4 weeks during which time the females can lay between 75 and several hundred eggs, depending on species. The eggs are laid singly into the leaf tissue through the feeding punctures and are not visible to the naked eye.

Young larvae hatch from the eggs after 2–6 days. At first, they are colourless and about 0.5 mm long. They grow to about 3 mm and become off-white or yellow-orange, depending on a species, as they feed between the upper and lower leaf surfaces causing the characteristic white mines. After 1–2 weeks larvae are fully grown and they pupate.

Pupae are oval, about 2 mm long and can be whitish, yellow, brown or black, depending on species. Native *Chromatomyia* species pupate in the leaf tissue and can be seen at the end of the mines on the leaf undersides. *Liriomyza* species may be seen hanging from their tips from the underside of the leaf, or lodged on lower leaves before they drop to the ground to pupate.

The pupal stage can last from 9–10 days up to several months. When pupation is complete, the adult leaf miner emerges.



6 Chrysanthemum leaf miner pupae can be seen at the end of the mine

7 *Liriomyza* spp. may hang from the leaf or lodge on a lower leaf before dropping to the ground to pupate

Control of leaf miners

Control strategies for leaf miners include cultural, biological and chemical options, together with regular monitoring for the presence of the pests and plant damage. The control strategies described here are relevant to both native and quarantine species. However, do not rely on the information in this factsheet if you suspect a quarantine leaf miner species may be present, as if confirmed, PHSI will issue a Notice outlining specific measures to eradicate the pest and prevent it spreading to other nurseries. This will be designed in consultation with the grower and will include full details of the required cultural, biological and/or chemical control methods, as appropriate for the nursery concerned.

Monitoring

Regular monitoring is critical for successful pest management. Spotting the first sign of leaf miners will allow prompt action to be taken to avoid a serious problem developing. Monitoring should include the use of yellow sticky traps as well as checking plants. This should continue throughout the year, whenever susceptible crops or imported plant material is present.

Sticky traps

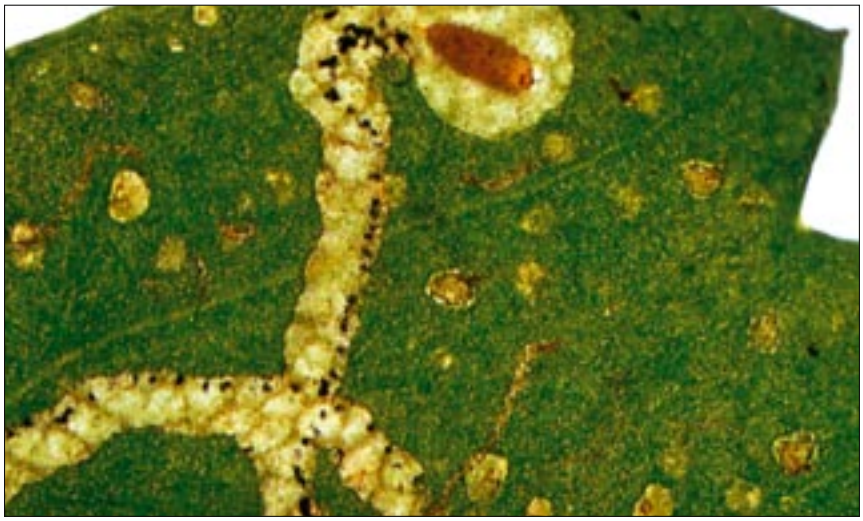
- Yellow sticky traps are useful for detecting adult leaf miners, particularly in low densities.
- *Liriomyza* adults can be readily recognised because of the yellow spot on their backs. However, native *Chromatomyia* flies are less easy to recognise amongst other insects attracted to yellow traps, so monitoring should be done by a trained member of staff.
- Some proprietary traps are less sticky than others. Leaf miner adults are quite robust and may escape from traps more suitable for catching delicate insects eg thrips and whiteflies.
- Position traps over favourite host plants, imported plants and near doorways and heating pipes.
- Only use as many traps as can practically be checked every week. As a guide, use at least one trap every 500 m². PHSI may recommend more traps if a quarantine species is present.
- Position traps just above the plants and move them up as the plants grow. If using IPM, placing the traps a foot above the plants will reduce the numbers of flying beneficials caught.
- Check traps weekly and record numbers of leaf miners caught.

Plant monitoring

Sticky traps alone should not be relied upon for monitoring. Native *Chromatomyia* leaf miners can be difficult to recognise, but the first adult feeding punctures should be easily spotted.

- Check plants regularly, ideally every week throughout the growing season.
- Pay particular attention to favourite host plants and recently bought-in plants or cuttings, especially if imported.
- Late spring and summer is the most likely time for native leaf miners to fly in from outdoors.
- Look out for adult leaf miners on the plants and their feeding punctures.
- Small mines should be visible within a week of seeing the first punctures.
- If the leaf miner is a native *Chromatomyia* species, pupae should be visible at the end of the mines 7–10 days afterseeing the first mines, depending on temperature.
- If no pupae are visible in any of the mined leaves, adult leaf miners on plants or traps have a distinct yellow spot on their backs, and/or the mines look typical of a quarantine *Liriomyza* species, notify PHSI immediately.
- Take prompt control action at the first sign of leaf miners (see Cultural, Biological and Chemical Control sections).

8 Quarantine South American leaf miner adults on sticky traps can be recognised by the yellow spot on their backs



9 Mines of the native chrysanthemum leaf miner, showing the blobs of frass (droppings) and pupa at end of mine

Cultural control

Prevention of pests is better than cure, and cultural control methods play an important part in any pest management strategy, whether using biological control methods within IPM or using chemical control. Cultural control methods for leaf miners include:

Start clean

- Consider likely sources of leaf miners (see 'Sources of infestation') and plan practical methods for minimising the risks of infestations developing.
- Aim to start with a glasshouse or tunnel free from leaf miners. If a previous crop has been infested, use a thorough clean-up programme to minimise carry-over of the pest to following crops. See HDC factsheet 15/05 for more information.
- Check stock plants and sticky traps regularly.
- Do not take cuttings from infested mother plants.
- Seek assurance from suppliers that imported plant material is free from leaf miners.
- Check all bought-in plant material on arrival. Leaf miners or damage symptoms may not be immediately visible. If possible, place imported plant material temporarily in a quarantine area, or monitor these plants particularly carefully.
- Use new or clean pots, trays and matting for each crop.

Weed control

- Weeds are important potential hosts for leaf miners and many other pests.
- Maintain strict weed control inside and around the glasshouses or tunnels, including any empty structures. Aim for a 3 metre weed-free strip around the edges.
- Ideally, floor surfaces should be concreted or covered with ground-cover matting.
- Any weeds removed by hand should be sealed in plastic bags before disposal.

Physical barriers

- Screening vents and doors will reduce adult leaf miners flying in from outdoors or other glass-houses, but proper insect screening is expensive and reduces ventilation unless fans are also used.
- Long 'curtain' traps eg 'Mastertrap' can be useful for mass trapping in heavy infestations, between infested crops and new batches of plants, or in empty glasshouses. They may be recommended by PHSI if a quarantine species is present. However, they can also catch flying biological control agents so they should be positioned and timed with care.

Rogueing/de-leafing

- Removal of the first leaves showing feeding punctures or mines can delay the infestation if biological or chemical control measures cannot be put into place immediately.
- Removing punctured or mined leaves can also be done to 'clean up' plants before sale, and is a requirement under PHSI Notice if a quarantine leaf miner is confirmed on a production nursery.
- Heavily infested plants should be removed completely. If a quarantine leaf miner is confirmed, destruction of infested plant material is the most effective means of eradication and avoids a protracted treatment programme.

Nursery hygiene and end of crop clean-up

- Adult leaf miners can be carried on nursery staff clothing. Staff should avoid wearing yellow, and work in 'clean' glasshouses before known infested areas in any one day.
- Any crop debris, unmarketable plants, weeds, pots, trays and old ground/bench-cover matting should be promptly disposed of by placing into sealed bags or covered containers, sited as far away from the glasshouse as possible, before taking in covered skips or trailers to a local authority disposal site.
- Any pots or trays to be re-used should be promptly sterilised.
- Benches and floors should be swept, pressure washed and dis-infected between crops.
- Yellow traps should be used in empty glasshouses following infested crops.

10 Long curtain traps can be useful for mass trapping in heavy infestations between infested crops and new batches of plants, or in empty glasshouses

Biological control

If using IPM, leaf miner biological control agents should be used as relying on chemical control would disrupt IPM. Three biological control agents are available for control of both native and quarantine leaf miners. Choice will depend on the crop, time of year and leaf miner density.

Dacnusa sibirica

Dacnusa sibirica is a small black parasitic wasp, about 2–3 mm long, with long antennae. The females lay their eggs through the leaf mines into the leaf miner larvae (one egg per larva) and the parasites develop inside. Whether this has been successful can only be checked under a microscope. The parasitised leaf miner larvae continue to cause damage and develop to the pupal stage, but then the adult parasite emerges from the pupa instead of the adult leaf miner.

Dacnusa is best used during the winter and spring, at low leaf miner densities ie at the first sign of leaf miner adult feeding punctures or small larval mines. It will work at temperatures as low as 10°C but is less effective in hot sunny weather.

11 ***Dacnusa sibirica*****, a small black parasitic wasp with long antennae, lays its eggs inside leaf miner larvae**

Diglyphus isaea

Diglyphus isaea is a small metallic green parasitic wasp, about 2–3 mm long, with short antennae. It can be supplied alone, or in a mixture with *Dacnusa*. *Diglyphus* females lay their eggs on the surface of the leaf miner larvae. The *Diglyphus* larvae lie alongside the leaf miner larvae and feed externally on their body contents. *Diglyphus* larvae are colourless when young and are pale green when older. They pupate inside the mine and the pupae are pale turquoise, turning black just before emergence from the leaf as adults. *Diglyphus* larvae and pupae can be seen inside the mines with the dead leaf miner larvae if the leaf mines are split open.

Diglyphus can be used at any time of year at temperatures as low as 10°C, but establishes better at higher leaf miner densities as the adults need to 'host-feed' on the young leaf miner larvae in order to produce eggs. Thus

12 ***Diglyphus isaea*****, a small metallic green parasitic wasp with short antennae, lays its eggs onto leaf miner larvae**

both *Diglyphus* adults and larvae kill leaf miner larvae and stop further mining. This is useful in ornamental crops where there is little tolerance of damage. An indicator of good *Diglyphus* establishment is the presence of small, narrow 'stopped' leaf mines.

Steinernema feltiae

These insect-pathogenic nematodes have been shown to be effective as foliar sprays against *Liriomyza* larvae in trials on protected vegetable crops, eg lettuce, Chinese brassicas and tomato. Several growers of pot chrysanthemum are now using *S.feltiae* (eg 'Nemasys F') as a weekly spray for control of western flower thrips, and some control of native leaf miners is being given. The nematodes enter the leaf mines through the leaf miner feeding punctures or exit holes, thus they are more effective in higher leaf miner densities. Once inside the mine they swim to find a leaf miner larva, enter the body and release a symbiotic bacteria which kills the leaf miner. The nematodes need to be applied carefully, following all label recommendations, eg they should be applied to just before run-off, with a recommended wetter, in the late afternoon or early evening when relative humidity is high.

Guideline biological control programme for leaf miners if using IPM

Any biological control programme should be designed according to the individual nursery conditions, crops grown and pest species and densities present. Input from a specialist IPM consultant is beneficial. A guideline programme for leaf miner control is given below:

- Consider preventive releases of parasites to new crops if a leaf miner problem has occurred in a previous or neighbouring crop.
- Otherwise, order a weekly supply of parasites as soon as the first adult leaf miners or feeding punctures are found.
- If the leaf miner density is very low, use *Dacnusa* or the commercial mix of *Dacnusa* (90%) and *Diglyphus* (10%).
- The guideline rate is 0.5 per m² per week.
- If the leaf miner density increases, use *Diglyphus* at any time of year.
- The guideline rate is one per m² per week.
- An entomologist can help by monitoring the level of parasitism and advising when parasite releases can stop.
- If *Steinernema feltiae* is being used against thrips, this will also give some control of leaf miner larvae, particularly at higher leaf miner densities.
- If a pesticide is needed to control leaf miners within IPM, choose the safest to biological control agents being used (see Table 2 overleaf).
- Continue monitoring weekly throughout the season.
- An IPM programme is also an option for quarantine leaf miners but details will need to be agreed with PHSI and monitored carefully.

Chemical control

Leaf miners are difficult to control with pesticides. Larvae are protected within the leaves and pupae are either in the leaf tissue or in the growing medium or substrate, depending on species. Choice and timing of pesticides will depend upon the leaf miner life stages present, the species (eg *L. huidobrensis* may be resistant to some pesticides), glasshouse temperatures, possible phytotoxic effects and whether or not IPM is being used. Pesticides available for leaf miner control and factors affecting choice are summarised in Table 2 overleaf.

Guidelines for chemical control

- Confirm whether leaf miners are native or quarantine species if there is any doubt.
- If a quarantine leaf miner is confirmed, PHSI will design a pesticide programme in consultation with the grower, as part of the eradication Notice.
- Insecticides effective against adults or systemic compost treatments (see Table 2 overleaf) should be applied when adults or first feeding punctures are seen.
- Foliar sprays against larvae should be applied when the first small mines are seen and repeated at intervals of one week or longer, depending on temperatures and species.
- Pesticides with translaminar and systemic activity (see Table 2 overleaf) are most effective against larvae. Good spray coverage is important. See HDC factsheet 14/06 for more information.
- Avoid using the same chemical or chemical group repeatedly, as this can select for pest resistance.
- Full details of compatibility of pesticides with biological control agents are available from biological control suppliers or consultants.

Table 2 Approved pesticides for control of leaf miners on protected ornamental plants

Active ingredient	Product name (examples)	Insecticide group	Approval status	Application method	Leaf miner stage killed	Compatability with biological control agents	Comments
Abamectin	Dynamec	Avermectin	On label for leaf miners.	High volume spray	Larvae	Harmful to nematodes for 7 days and to other biocontrol agents for up to 3 weeks.	Translaminar action. *L. huidobrensis* can be resistant.
Cypermethrin	Cyperkill 5	Pyrethroid	Specific Off-label approval.	High volume spray	Adults	Safe to nematodes. Harmful to other biocontrol agents for up to 12 weeks.	Contact action. *L. huidobrensis* can be resistant.
Deltamethrin	Bandu Decis Decis Protech	Pyrethroid	On label for other pests.	High volume spray	Adults	Safe to nematodes. Harmful to other biocontrol agents for up to 12 weeks.	Contact action. *L. huidobrensis* can be resistant.
Deltamethrin	Decis Decis Protech Cleancrop Decathlon	Pyrethroid	Specific Off-label approval.	Fog	Adults	Safe to nematodes. Harmful to other biocontrol agents for up to 12 weeks.	Contact action. *L. huidobrensis* can be resistant.
Dimethoate	BASF Dimethoate 40 Danadim Danadim Progress	Organophosphate	On label for leaf miners.	High volume spray	Adults and larvae	Slightly harmful to nematodes. Harmful to other biocontrols for up to 12 weeks.	Contact and systemic action. Do not use on chrysanthemum or ornamental *Prunus.*
Imidacloprid	Imidasect 5GR	Neonicotinoid	On label for other pests, may give some reduction in leaf miners.	Compost incorporated	Larvae	Safe to nematodes. Harmful to some biocontrols for up to 6 weeks.	Systemic action container plants only.
Imidacloprid	Intercept 70WG	Neonicotinoid	On label for other pests, may give some reduction in leaf miners.	Compost drench	Larvae	Safe to nematodes. Harmful to some biocontrols for up to 6 weeks.	Systemic action container plants only.
Natural plant extracts	Majestik	Physical pesticide	Exempt from pesticide regulations, may give some control of leaf miner adults.	High volume spray	Adults	Safe to biocontrols once spray deposit dry.	Contact action.

Nicotine	No-FID, Stalwart XL All Insecticide XL All nicotine 95%	Nicotine	On label for leaf miners.	High volume spray	Adults	Harmful to biocontrols for up to 2 days.	Contact action. Most effective above 16°C.
Nicotine	Nicotine 40% shreds	Nicotine	On label for other pests.	Smoke	Adults	Harmful to biocontrols for up to 2 days.	Contact and fumigant action. Most effective above 16°C. Can cause leaf edge yellowing in chrysanthemum.
Oxamyl	Vydate 10G	Carbamate	Specific Off-label approval.	Compost surface application	Larvae	Harmful to nematodes for 14 days and to other biocontrols for up to 12 weeks.	Systemic activity.
Pirimiphos-methyl	Fumite pirimiphos-methyl smoke	Organophosphate	On label for leaf miners.	Smoke	Adults	Harmul to biocontrols for up to 8 weeks.	Contact, fumigant and translaminar action.
Pyrethrins + naturally derived oil	Spruzit	Pyrethrins	On label for biting and sucking pests.	High volume spray	Adults	Harmful to biocontrols for a few days after application.	*L. huidobrensis* can be resistant. Contact action.
Thiacloprid	Calypso	Neonicotinoid	Specific Off-label approval.	High volume spray	Larvae	Harmful to some biocontrols for up to 2 weeks.	Contact, translaminar and systemic action.
Thiacloprid	Exemptor	Neonicotinoid	On label for other pests, may give some reduction in leaf miners.	Compost incorporated	Larvae	Harmful to some biocontrols for at least 2 weeks (persistence against biocontrols not yet known).	Systemic action.
Vegetable oil extracts/ glucose polymer	Eradicoat	Physical pesticide	Exempt from pesticide regulations, may give some control of leaf miner adults.	High volume spray	Adults	Safe to biocontrols once spray deposit dry.	Contact action.

Notes:

- The Long Term Arrangements for Extension of Use (LTAEU) allow extrapolation of use from a label approval or SOLA to use on an ornamental crop *at grower's own risk*. However, use must be in a similar manner and rate as that specitfied on the label or Specific Off-Label instructions; be cautious as some treatments may prove to be phytotoxic.
- Growers must hold a paper or electronic copy of a SOLA before using any product under the SOLA arrangements. Any use of a pesticide with a SOLA is *at grower's own risk*. Relevant SOLAs are sent to HDC members by HDC, or are available from PSD (see opposite) or from consultants.
- Always follow label recommendations, including rate of use, and check the range of ornamentals listed which can be safely treated.
- Contact the **Pesticide Safety Directorate (PSD)** Information Service, Tel. (01904) 640500 or visit **www.pesticides.gov.uk** or seek other professional advice if in doubt about which products are permissible on ornamentals or how to use them correctly.
- **IMPORTANT** – Growers must always check the current approval status of products listed in this factsheet before intended use as this could have changed since it was produced.
- Full details of compatibility with biological control agents are available from biocontrol suppliers or consultants.

Acknowledgements

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April 2008

Design and production: HDR Visual Communication