

Rose

Project No. HNS 135 and HNS 150

Control of rose downy mildew

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Downy mildew of rose is a widespread, sporadic and serious disease affecting both outdoor and protected crops. It generally causes unsightliness, poor growth and reduced marketability while severe attacks result in rapid defoliation. The disease can be difficult to identify and control. This factsheet summarises current information on the biology of rose downy mildew and provides guidance on how to minimise losses by good nursery hygiene, avoidance of environmental conditions favourable for disease development and by the use of fungicides and nutritional products.

Background

Downy mildew of rose caused by the fungus *Peronospora sparsa* is found in many countries where roses are grown. The disease, first described in England in 1862, has now been reported throughout Europe and the USA and is known to occur in Canada, China, New Zealand and South Africa.

In the UK it is most commonly seen on glasshouse-grown roses and in overhead irrigated container-grown crops but in recent years some very damaging attacks have occurred in field-crops during prolonged wet weather. Consultation with the industry indicates the farm gate value of bare-root and container roses amounts to £19.2 million. Assuming just 1% of

crop is unmarketable due to downy mildew, this equates to a loss of £192,000 per annum. Additional losses are incurred on garden centres where fungicide options are limited and overhead irrigation is near-universal. Disfigurement caused by downy mildew and the other common foliar diseases of rose (see Factsheet 12/04) can deter sales.

Disease recognition and biology

Symptoms and damage

Downy mildew can infect leaves, stems, flower stalks and flowers. Leaf symptoms are the most common and are mainly found on young growth. Infected leaves develop purplish-red to dark-brown irregularly-shaped spots and blotches seen most clearly on the upper surface. The lesions usually have clearly-defined edges, in contrast to the feathery edges found with black spot caused by *Diplocarpon rosae*. Downy mildew leaf lesions are often angular in appearance as a result of them rarely spreading across major leaf veins. However, downy mildew lesions can sometimes have less well-defined margins; microscopic examination of lesions for the fungal structures typical of downy mildew and black



1 Severe defoliation caused by rose downy mildew

spot should be undertaken if there is doubt about the cause of spotting.

Affected leaves may turn yellow and the disease can result in a rapid and severe defoliation of plants. Even apparently healthy leaves may fall prematurely. Although black spot can also result in leaf drop, usually this is less severe than that caused by downy mildew. Sporulation of downy mildew occurs on the under surface of leaves but can be difficult to see; it appears as a sparse, white to light grey downy growth. More abundant sporulation is observed under prolonged humid conditions. During the later stages of infection, leaves may become necrotic.

Infection of the flower bud or flower results in retarded and distorted growth. Black or brown dead areas form on the petals. The calyx can also be affected. Infection of the flower stalks or stems results in reddish-brown elongate lesions. Occasionally, young shoots become so heavily infected that they die back.

Life-cycle

The life-cycle of rose downy mildew is shown on the opposite page. Evidence for some of the stages is incomplete and is inferred from other downy mildew diseases. The fungus is an obligate parasite and cannot grow without living host tissue. The period between infection and appearance of symptoms can be as short as 4 days at 20–25°C and up to 7 days at 10–20°C. Because of this short life-cycle and the production of air-dispersed spores, the disease can soon become epidemic.

Disease sources and spread

Rose downy mildew is spread between plants by air-borne and water-splashed spores known as conidia. These are produced on structures that emerge through the stomata on the lower surface of infected leaves. The spores are transient, surviving no more than a few days. When conditions are moist, spore germination is rapid and occurs over a wide temperature range up to 26°C. While temperature has relatively little effect on infection

of rose leaves between 9–18°C, leaf wetness duration has a large effect. At least 4 h of continuous leaf wetness is required for spores to germinate and infect leaves at 15–20°C. The incidence of disease was found to increase gradually with increased duration of leaf wetness up to 4 days and then very sharply above 4 days. The dependence of *P. sparsa* on moisture explains why downy mildew is most commonly found when roses

are grown at a high density, with frequent overhead irrigation and in glasshouses over winter.

There is uncertainty regarding the primary inoculum of rose downy mildew. Although it has been speculated that rose downy mildew may overwinter as fungal strands on or in woody tissue, as happens with some other downy mildew diseases, this was not supported by recent studies on rose. Rose plants affected

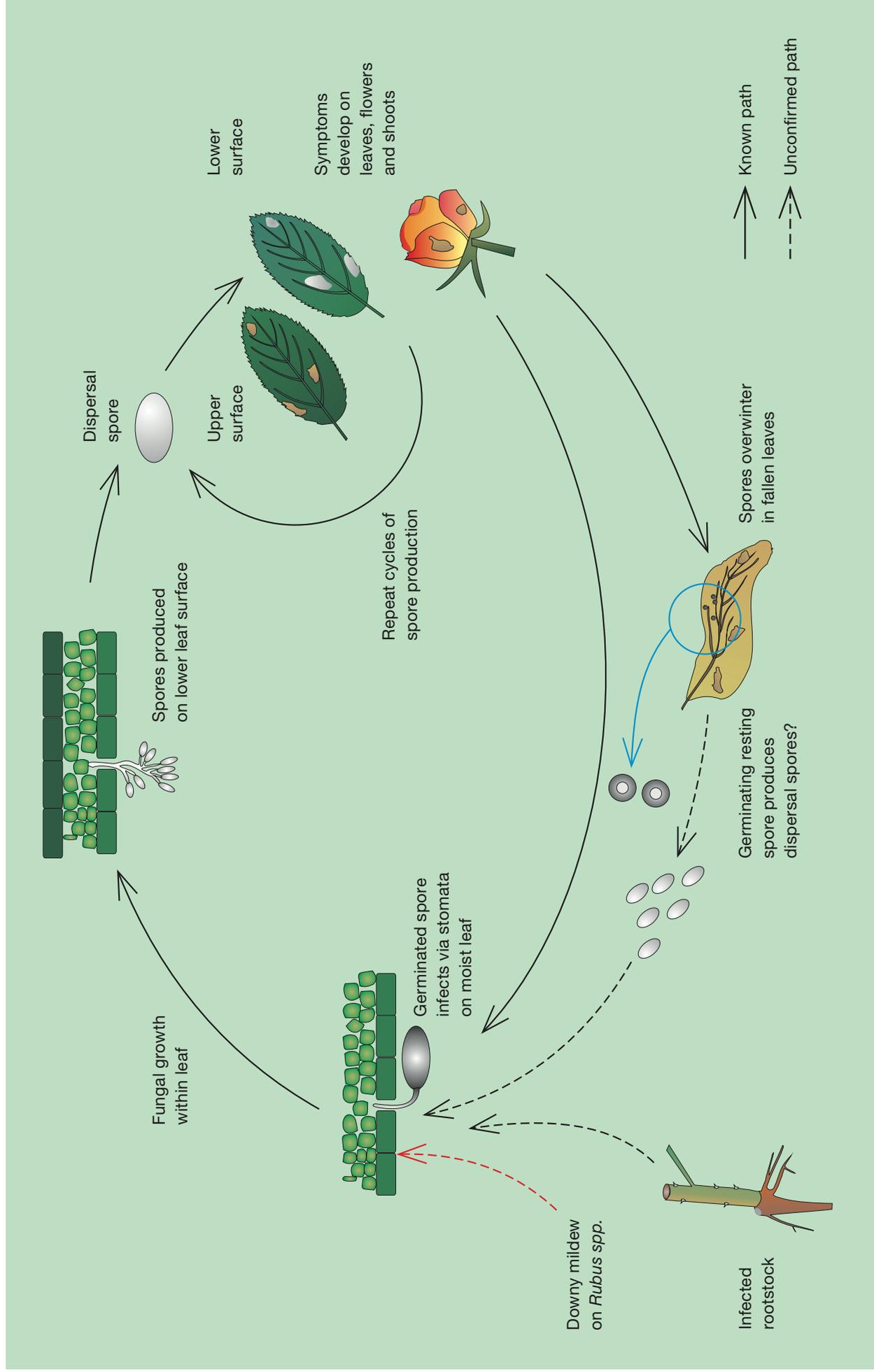


2 Purplish leaf spots and angular blotches are a common symptom of down mildew on leaves. Unlike black spot, the margins of spots caused by downy mildew are not feathery



3 Petal discoloration on a flower bud caused by downy mildew

Diagram 1 Life-cycle of rose downy mildew



by downy mildew one season did not develop the disease the following season when all dropped leaves were disposed of and the plants were grown in an enclosed chamber with frequent misting to encourage downy mildew.

The fungus can also produce resilient spores (oospores) in leaves, stems and flowers but their significance for survival and spread is not understood. It is speculated that oospores in fallen leaves may

germinate in the spring to produce dispersal spores that infect newly emerging leaves.

Peronospora sparsa is also recorded as the cause of downy mildew on blackberry, more commonly on cultivated blackberries and hybrid berries than wild brambles. Cross-infection tests have shown that downy mildew from blackberry can infect rose and vice-versa. However, different strains may exist and the practical

significance of *Rubus* species as a source of primary inoculum to infect rose is unclear.

Disease detection

Detecting downy mildew on growing plants is frequently difficult as the sporulating structures may be absent and infection may occur on stems, petioles and flowers as well as the leaves. Moreover, the disease



4 Avoid watering from overhead or late in the day



5 Leaf spotting and shoot dieback in container roses following persistent wet weather

sometimes appears as less obvious brown or reddish brown areas which may be confused with physical damage. Molecular diagnostics which can detect the presence of *P. sparsa* DNA have recently been developed. These offer a rapid and conclusive method of detecting the fungus, and of investigating potential sources of infection. Early detection can help to target areas for careful hygiene and possible removal of infected plants, or more timely fungicide treatment before the disease becomes well established. Use of the molecular diagnostic experimentally has revealed the presence of downy mildew in a wide variety of tissues (see Table 1).

Significantly, the disease was not detected in budwood samples, from a variety of sources, suggesting this material is unlikely to serve as a means of introducing downy mildew. However, rootstock material was found to be positive, and may act as a source of infection. While the typical symptoms such as angular leaf lesions were always positive with the molecular test, many less typical lesions were also positive.



6 Damage symptoms on petioles and stems can be confused with physical damage

Table 1 Detection of *Peronospora sparsa* by a molecular diagnostic test on various rose tissues with suspected downy mildew symptoms

Tissue type	Number positive	Number negative
Leaf	30	164
Petiole	5	5
Stem	18	69
Budwood	0	78
Rootstock stem	6	8

Control

Varietal control

Differences in the susceptibility of rose varieties to downy mildew have been documented. Complete resistance has been described in some species roses, but in cultivated rose only partial resistance is known

to date. One of the characteristics of partial resistance is that under high disease pressure significant infection can occur. However, when other disease control measures are employed, partial resistance can be a very useful character which helps to minimise the infection level. Varieties which have appeared particularly susceptible in recent

years include Silver Jubilee, Gentle Touch, Lili Marlene, Shocking Blue, Velvet Fragrance, and Silver Anniversary. Varieties which have appeared more resistant include in particular Hot Chocolate, but also Glamis Castle, Rhapsody in Blue and Buxom Beauty. Recent information from breeders has indicated that some higher levels of resistance are

available in the varieties Cantario, Resonanz, Westzeit and Inspiration. Inspiration is available in the UK. These have been specifically bred for downy mildew resistance, and further progress should be possible. However, rose downy mildew may show variation which enables it to overcome varietal resistance, as is the case with many downy mildews of other plant species. Currently, there is no information on the structure of rose downy mildew populations in the UK, and varieties which have shown resistance need careful monitoring over time to determine if resistance is robust.

Cultural control

Infected leaves and prunings left on the ground are important sources of all the major foliar diseases so there needs to be a regime for regularly gathering them up and safely destroying them. Larger prunings are best gathered by raking but smaller prunings and fallen leaves can more thoroughly be picked up by vacuuming. Avoid collecting leaves when wet as this may lead to increased spread of black spot.

Whenever the standing grounds or beds are empty, treat them with a disinfectant eg Jet 5 (see HDC Factsheet 15/05 - Use of chemical disinfectants in protected ornamental production).

Environmental control

Minimising periods of leaf wetness and avoiding prolonged periods of high humidity will have a very significant effect in helping to prevent downy mildew (and rust and black spot). The following measures will help to achieve this:

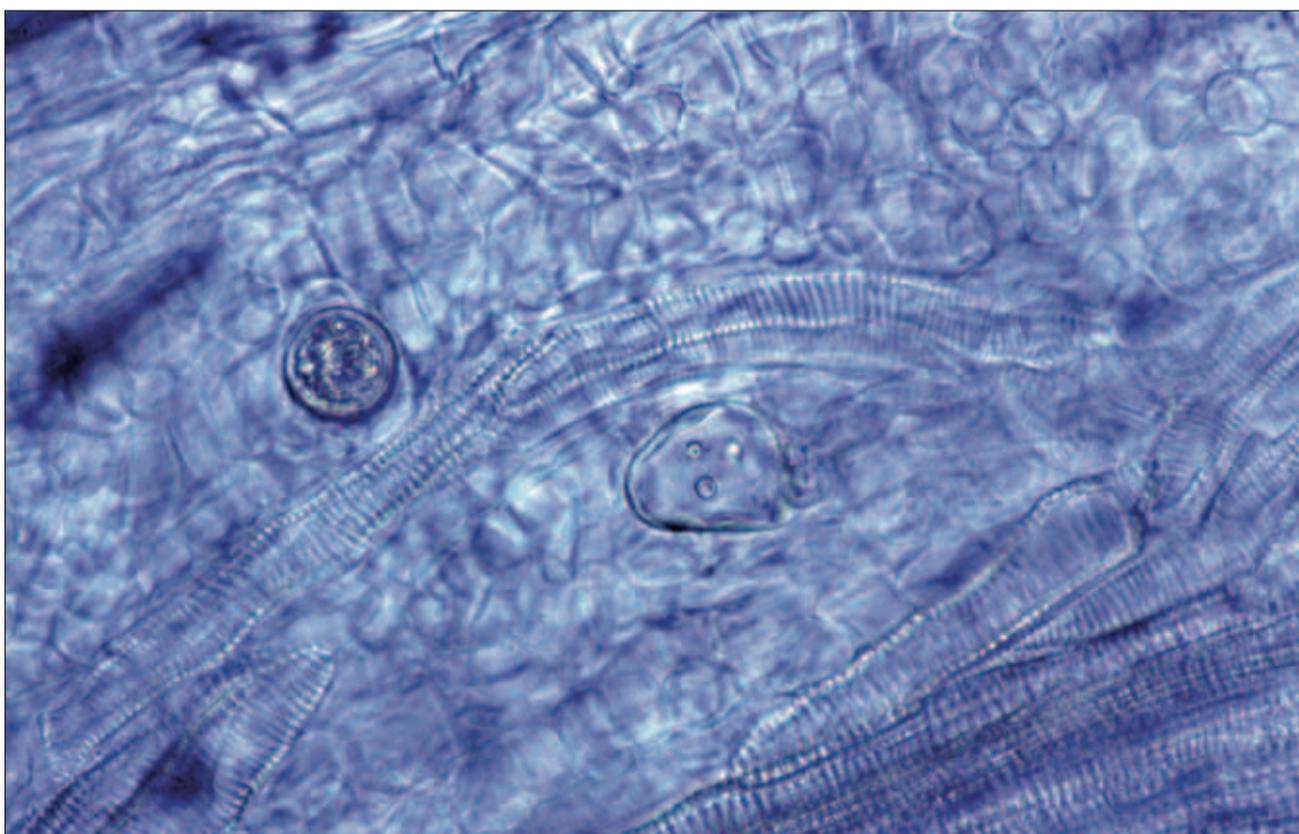
- Avoid watering from overhead late in the day or during the evening or night.
- Wherever possible, employ trickle or sub-irrigation methods (eg capillary action systems) to minimise the need for overhead irrigation. Where there is need to grow very disease susceptible, high-value varieties, it may be essential for this measure to be combined with production under protection to avoid problems resulting from rain splash.

- Wherever possible, do not locate plants in hollows or close to windbreaks.
- Encourage good air circulation around plants by having plant spacing which is as generous as the economics of production will permit and where production is under protection, augment with ventilation and if necessary, the use of fans.
- For the more disease susceptible varieties, avoid heavily-shaded sites that dry slowly in the morning.

Chemical control

Some fungicide products permitted for use on rose with activity against downy mildew are listed in Table 2.

New fungicides evaluated for control of rose downy mildew in HNS 150 varied considerably in efficacy. Valbon (benthiavalicarb-isopropyl + mancozeb) was highly effective compared with SL567A (metalaxyl-M), while Revus (mandipropamid) gave control comparable to SL567A.



7 Resting spore of downy mildew in a leaf (centre left); these structures are likely to survive overwinter in fallen leaves

There is less risk of resistant strains developing to chlorothalonil, thiram and mancozeb than other fungicides, but these chemicals are also generally less active against downy mildew than the other (site-specific) fungicides listed in the table.

Many of the fungicides used against downy mildew have little or no activity against rose black spot, powdery mildew or rust. See Factsheet 12/04 for information on control of these diseases.

Always check and follow the product label or SOLA before use. Availability of fungicides for use in ornamental plant production is subject to change.

Fungicide programmes

Programmes for control of downy mildew should follow anti-resistance strategies in order to maintain product effectiveness. Select fungicides from different fungicide groups (see Table 2) for successive sprays. A fungicide programme using Valbon, Aliette 80WG (fosetyl-aluminium) and Amistar (azoxystrobin) or Strobry (kresoxim-methyl), should provide an effective anti-resistance strategy and

good disease control even under high infection pressure. Revus and Valbon have one active ingredient in a common fungicide group (40), so successive treatments should be avoided. Other products (eg Fongarid Gold, metalaxyl-M) could be introduced into the sequence.

In project HNS 135, under severe disease pressure on two highly susceptible varieties grown with overhead irrigation, a programme based on a spray of Fubol Gold (metalaxyl-M + mancozeb), Aliette 80WG or Amistar every 7 days reduced the leaf area affected by downy mildew by around 60%.

Timing of fungicides before symptom appearance is critical. The appropriate interval between successive sprays depends on disease risk. As a general guide, apply sprays at 7 day intervals at high disease risk and at 10–14 day intervals during periods of reduced disease risk.

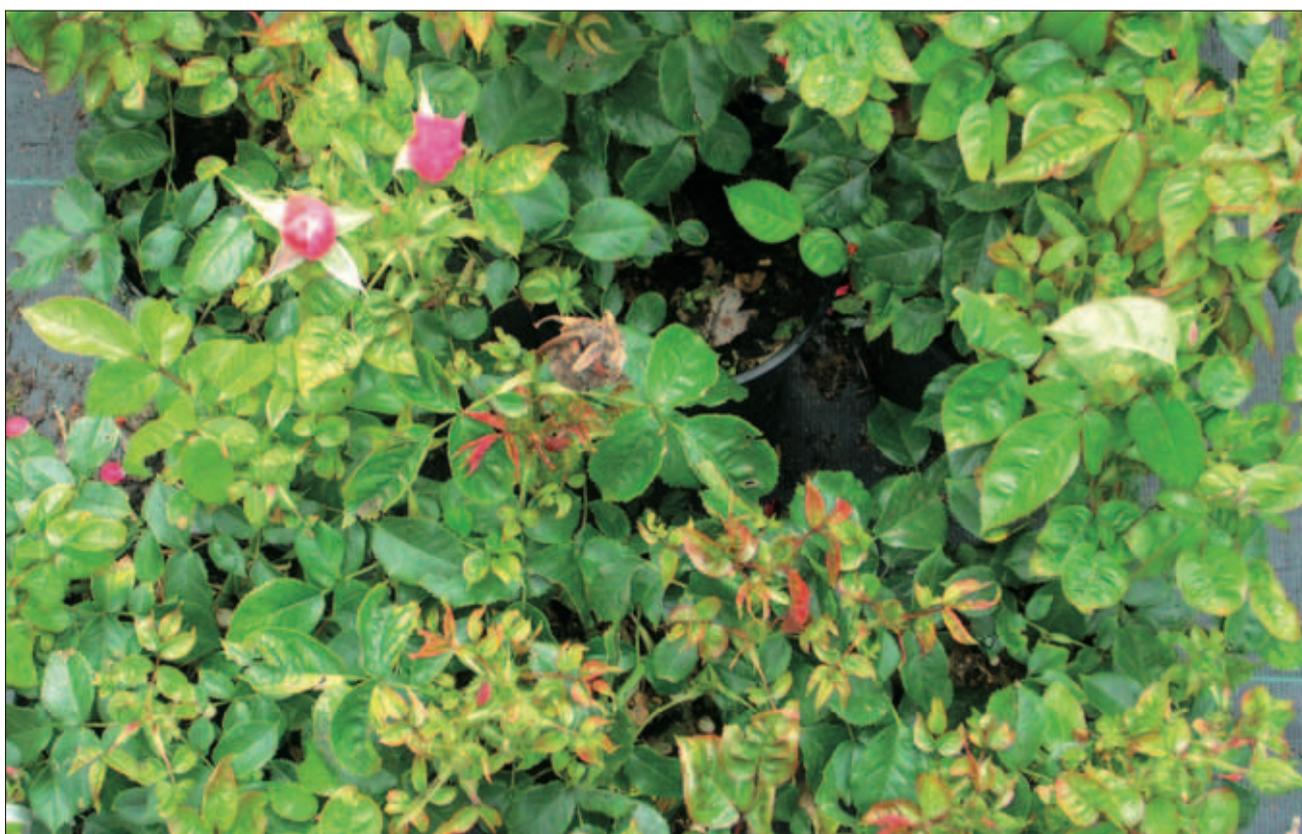
Natural products

Some natural products used for general improvement of crop health were also found to reduce rose downy

mildew. Natural products that gave some reduction in the development of rose downy mildew in our experiments were:

- Farm-Fos-44, Horti-Phyte, TKO Phosphite and Uncle Tom's Rose Tonic (these are all foliar fertilisers based on potassium phosphite).
- Biosept All Clear (a plant growth stimulant based on plant extracts with grapefruit oil).
- Orophite (a foliar feed containing phosphorus acid, potash and boron).
- EndoRoots (a mycorrhizal rooting stimulant).
- Turf Vigour Special (a foliar feed used as a rooting stimulant on grass; contains urea and the bacterium *Bacillus licheniformis*).

Foliar fertilisers based on potassium phosphite gave the most consistent results. Note that crop damage, visible as leaf yellowing, may occur if potassium phosphite is used above the recommended rate or frequency.



8 Leaf yellowing and distortion following treatment with a potassium phosphite foliar fertiliser at a high rate

Table 2 Some fungicides with activity against rose downy mildew

Product	Active ingredients (and FRAC mode of action Group number)	Approved on:		Approval type	Relative efficacy in HDC trials with application rate used and spray or drench interval (days)			Reference	Maximum rate of use
		Outdoor crops	Protected crops						
Aliette 80WG ^a	Fosetyl-aluminium (33)	✓	✓ ^b	Label	*	2 g/L (drench)	28 d	HNS 53	100 kg/ha (drench)
			✓	Label	*** **	2.5 g/L 2.5 g/L	7 d 14 d	HNS 135 HNS 135	50 kg/ha (spray)
Amistar	Azoxystrobin (11)	✓	✓	SOLA 0443/09	NT				1 L/ha
Bravo 500 ^a	Chlorothalonil (M5)	✓	✓	LTAEU ^c	NT				2.2 mL/L
Fongarid Gold ^a	Metalaxyl-M (4)	✓	✓	Label					1.25 L/ha (outdoor drench) 1.88 L/ha (protected drench)
Previcur N	Propamocarb hydrochloride (28)	✓	✓	Label	**	1.5 mL/L (drench)		HNS 53	150 L/ha (drench) (1.5 mL/L)
Previcur Energy	Fosetyl-aluminium (33) + propamocarb hydrochloride (28)	✓	✓	SOLA 2667/08	*	2.5 L/ha		HNS 150	30 L/ha (drench in propagation)
Revus	Mandipropamid (40)	✓	-	SOLA 2867/08	**	0.6 L/ha		HNS 150	0.6 L/ha
Signum	Boscalid (7) + pyraclostrobin (11)	✓	✓	SOLA 1842/09	***	1.5 L/ha		HNS 150	1.35 L/ha
Stroby WG	Kresoxim-methyl (11)	✓	✓	Label	NT				0.3 kg/ha
Thianosan DGa	Thiram (M3)	✓	✓	Label	NT				4 g/L
Valbon	Benthiavdicarb-isopropyl (40) + mancozeb (M3)	✓	-	SOLA 1513/10	***	1.6 kg/ha		HNS 150	1.6 kg/ha

^aEquivalent products available. ^bProtected pot plants. ^cLong term Arrangements for Extension of Use (LTAEU). NT – not tested. % reduction compared with untreated: * 1–25% ** 26–50%; *** 51–75%; **** 76–100%.

Fubol Gold WG has activity against rose downy and approval for use on ornamentals, under certain product labels (MAPP 10184 for protected crops until 31 July 2011, and MAPP

14605 and 1018 for outdoor crops) under the LTAEU while an application for a SOLA is being considered. Growers must hold a paper or electronic copy of a SOLA before

using any product under SOLA arrangements. Any use of a pesticide under a SOLA is at grower's own risk. For all products, check the current approval status before use.

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