

Control of the main foliar diseases of container-grown roses

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Foliar diseases are common and widespread on container-grown roses, the most important being black spot, downy mildew, powdery mildew and rust. When severe, any one of these fungal diseases may cause premature defoliation and reduced growth and their unsightliness reduces marketability.

This factsheet provides guidance on how to minimise losses by good nursery hygiene, avoiding environmental conditions favourable for disease development and by appropriate fungicide treatment.

Action points

- Minimise disease carry-over from one season to another by thoroughly collecting and safely disposing of prunings and leaf litter.
- Take similar action when beds are empty and treat the bare floor with disinfectant.
- As much as possible, maintain growing conditions that prevent the atmosphere being very humid and leaf surfaces staying wet.
- When devising a fungicide spray programme, try to minimise the development of fungicide resistance, environmental impact, and possible disruption to integrated pest management programmes.
- Start the spray programme before disease has become established.
- Monitor crops so that the spray interval can be adjusted according to disease pressure.
- Maintain good disease control on field-grown maiden crops for as long as possible before lifting, to maximise plant vigour and reduce establishment failures following containerisation.
- When diseases develop, ensure that they are correctly diagnosed,

otherwise control measures may be implemented that are inappropriate.

- If contemplating applying a mixture of fungicide products, or products

which are only permissible through Off-Label Long Term Arrangements for Extension of Use, check for risk of phytotoxicity by first test treating a few plants.



1 Black spot – purplish black spots up to 1.5 cm in diameter develop on the upper surface of leaves

Symptoms

Many of the symptoms caused by the different diseases on rose are distinctive. However, in all instances, the outcome of a severe attack is premature defoliation, significant reduction in vigour and reduced market quality. Smaller spots caused by the black spot fungus and spots caused by downy mildew, and occasionally powdery mildew, are similar in colour and appearance. Where there is doubt about the cause of such symptoms, expert diagnosis is strongly advised. Failure to do so could lead to selection and use of fungicides that are ineffective for the purpose. Key features to aid diagnosis are summarised in Table 1.

Black spot (*Diplocarpon rosae*)

Purplish-black spots up to 1.5 cm in diameter, sometimes with a fringed margin, develop on the upper surface of leaves. The area immediately surrounding each spot becomes

yellowed and when the disease is severe, entire leaves are affected. Leaves become necrotic and fall prematurely. On rose varieties with resistance to the disease, symptoms may show as just tiny black flecks.

Raised purple-red irregular blotches caused by the fungus can develop on unripe stems. These spots later become blackened and blistered but remain small and are rarely lethal.

The fungus may also be present as small black spots on petioles, peduncles, fruits and sepals. Plants severely affected by black spot lose their leaves early, are consequently weakened, and flowering is reduced the following year.

Downy mildew (*Peronospora sparsa*)

The fungus produces irregular or angular-shaped reddish-brown to purplish (occasionally yellow-green) spots (variable in size, from 3 to 15–20 mm in diameter) on the upper side of leaves. Affected leaves may become necrotic and fall prematurely.

Sporulation is sparse but sometimes visible as a whitish-grey, downy growth on the lower surface.

Occasionally, the calyx, petals and stems are affected which sometimes results in flowers and flower buds being malformed. Black or brown dead areas form on the petals. Young shoots can become so heavily diseased that they die back.

Symptoms of downy mildew are less obvious than those of the other foliar diseases described here. An attack may only be noticed when defoliation occurs, usually following wet or humid weather.

Powdery mildew (*Sphaerotheca pannosa*)

The disease affects leaves, stems, buds and flowers. Initially, it develops as small white powdery blotches with strands of the fungus visibly radiating from the centre. These blotches may expand rapidly and coalesce if left unchecked, until sometimes entire surfaces are covered.

Table 1
Summary of key symptoms of rose black spot, downy mildew, powdery mildew and rust

Disease	Leaves	Stems	Flower stalks and flowers
Black spot	Purplish-black spots, sometimes with an irregular edge, on the upper surface of leaves. These contain minute black spore-bearing structures.	Raised purple-red irregular blotches on unripe stems, later becoming blackened and blistered.	Small black spots on peduncles, fruits and sepals.
Downy mildew	Irregular, rounded, purplish or yellow-green spots on the upper side of leaves. Sporulation often sparse but when visible is whitish-grey, and has a down-like appearance.	Similar symptoms to leaf infection but only occasional. Sporulation usually sparse. Heavily diseased shoots die-back.	Similar symptoms to leaf infection, affecting calyx and petals and may cause flower and flower bud malformation. Occurs only occasionally.
Powdery mildew	Small white powdery blotches with fungal strands radiating from their centres. Blotches coalesce until entire surfaces are covered. Mainly on the upper leaf surface.	White powdery blotches on shoots and thorns. Affected shoots become brittle and may be killed by severe infection.	Diseased buds fail to develop further or produce distorted blooms.
Rust	Brightly-coloured pustules develop during the summer, affected leaves may be distorted.	Young stems can become girdled by groups of pustules to such an extent that shoots are killed.	Unaffected.

The fungus is usually more prevalent on the upper leaf surface than the lower. It is more common on young foliage, which can become curled and twisted. Tissues surrounding an affected area develop a pink tinge and may become distorted. Severely affected leaves become necrotic and may fall prematurely.

Affected shoots become brittle and diseased buds may fail to develop or produce distorted blooms, especially when petals are affected. Heavy infection resulting in premature leaf loss will severely check growth.

Rust (principally *Phragmidium mucronatum* and *P. tuberculatum*)

Although several species of rust have been identified on rose, in the UK only *P. mucronatum* and *P. tuberculatum* are common and of significant economic importance. These two fungi cause similar symptoms.

P. mucronatum attacks various groups of roses, including the rootstock *Rosa laxa*. *P. tuberculatum*, the more common of the two, affects Hybrid Tea and Floribunda roses.

During the summer, the disease first appears as pustules on the lower leaf surface. These are about 5 mm in diameter and when mature they break open releasing a mass of minute, bright orange-coloured spores. Affected leaves, especially immature ones, may be distorted.

As the disease becomes more severe, yellow spots develop on the top surface of the leaf and defoliation may occur. Stems may also be affected, developing long narrow lesions. Young stems can become girdled by groups of pustules and shoot death may ensue.

Later in the season, a different type of pustule, which is orange to rusty brown in colour and 2-3 mm in diameter, develops on the underside of leaves. These pustules initially produce orange-coloured spores but, as autumn progresses, an increasing proportion of black-coloured spores are produced. The latter are the resting spores of the fungus and are important for enabling the fungus to survive from one season to the next.

Although an attack of rust on the susceptible rootstock *Rosa laxa* does not appear to affect bud take, it can seriously affect the quality of maiden bushes.



2 Black spot – note the feathery edges typical of this disease



3 Powdery mildew is usually obvious as white fungal growth; leaves often have a pinkish tinge



4 Purplish leaf spots and angular blotches are a common symptom of downy mildew



5 Rose rust – bright orange and, later, black spore masses develop on the lower leaf surface

Disease sources and spread

Black spot

The fungus survives from one season to the next in a dormant state on old and fallen leaves and within stem lesions. As temperatures rise during the spring, the fungus becomes active and produces spores which are spread by water-splash. Spores landing on the new foliage infect if the leaf surface remains wet for at least 7 hours.

Spread of black spot is generally more localised and slower than that of the wind-dispersed powdery and downy mildew fungi. However, current practice when uprooting roses prior to root pruning and potting on for sale, is to stack them 2-3 metres high in trolleys and trickle water over them to prevent desiccation. If the black spot fungus is present in stems, thorns or any remaining leaves, this practice will also serve to disseminate its spores down through the stack.

Downy mildew

The fungus survives between seasons as dormant fungal strands within the wood of rooted plants and within the tissues of cuttings. The fungus also produces resilient resting spores in affected plant tissues but their



6 Widespread black spot on cv. 'Silver Wedding'

significance for survival and spread is not understood.

Air-borne spores produced from infections on the underside of leaves are the most important means of spread during the growing season. These spores are transient, surviving no more than a few days. When conditions are moist, spore germination is rapid and is quickly followed by infection.

Powdery mildew

The fungus mainly survives between seasons as dormant infections visible on stems and thorns. It has also been found on rudimentary leaves of buds and on inner bud scales.

Infections become active and start producing spores as temperatures rise during the spring. Spores are dispersed in air currents and initiate infections on the new season's



7a and 7b Powdery mildew can also affect flowers and stems

growth. Further spread will then increasingly develop from infections which have developed on leaves and stem growth produced during the current season. In glasshouse crops, fungal growth may slowly continue throughout the winter and infection cycles continue albeit at a much slower pace, unless the grower intervenes with fungicide treatment.

Late in the summer, the fungus may produce dark, nearly spherical, spore-bearing cases about 2-3 mm in diameter embedded in the surface mat of fungal strands on leaves and

stems. The significance of these structures for the survival of the powdery mildew fungus between growing seasons is not known.

Rust

The fungi survive between seasons as black-coloured spores in the pustules produced on leaves and stems in the autumn. As temperatures rise in the spring, these pustules release spores which are disseminated by water-splash and in air currents.

Where spores alight on leaves or stems, infection takes place provided

conditions are moist for at least 2-4 hours. *P. mucronatum* also survives as a dormant infection in plant tissue which can give rise to new pustules of spores in swollen buds in the spring.

Conditions favouring disease development

Black spot

Surface wetness is essential for spores to germinate and cause infection. The duration of wetness required for completion of these processes is temperature dependent. For example, at 22-26°C, with continuous surface wetness, spore germination takes place within 9-18 hours. The ability of the fungus to infect declines rapidly below 18°C. Development of symptoms following

infection takes 3-16 days and is again dependent on temperature, with 18-21°C being most favourable. The disease can increase rapidly after warm, wet weather.

Downy mildew

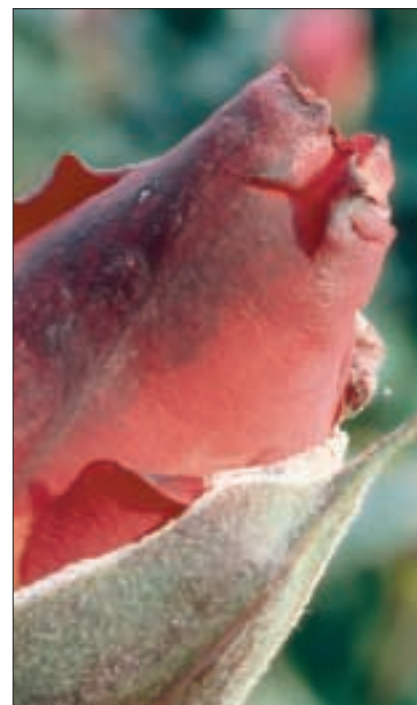
P. sparsa is like the black spot fungus in that surface wetness is essential for spores to germinate and cause infection. The duration of wetness required for completion of these processes is again temperature dependent. The optimum temperature range for germination and infection is 15-20°C, with just 4 hours continuous surface wetness being required for the

process to reliably take place, whereas at 10°C the duration needs to be at least 8 hours.

Given the dependence of *P. sparsa* on moisture, it explains why downy mildew is most commonly found where roses are grown at a high density, with frequent overhead irrigation and in glasshouse crops over winter. The period between infection and appearance of symptoms is also temperature dependent, being as short as 4 days at 20-25°C and up to 7 days at temperatures in the 10-20°C range.



8a Rose downy mildew (*Peronospora sparsa*) results in purplish spots on the upperside of leaves that may be mistaken for black spot (*Diplocarpon rosae*)



8b Downy mildew may cause purplish marking on the stem, calyx and petals (above), as well as spotting on leaves

Powdery mildew

In contrast to the black spot, downy mildew and rust fungi, spore germination and infection of powdery mildew is inhibited when the plant surface is wet. However, for these processes to take place successfully there is an initial requirement for relative humidity (RH) to remain very high (optimum 97-99%) for several hours. Subsequent development is better favoured by drier conditions.

This partly explains why the disease is usually more troublesome when the weather is warm and settled, with the high humidity requirement for spore germination and infection being satisfied during cool, damp nights. In the field, optimum conditions for epidemic development are a repeated night-day cycle with a night temperature of 15°C and 90-99% RH and a day temperature around 26°C and 40-70% RH.

Rust

A period of surface wetness is required for spores to germinate and infect. At the optimal temperature range for development of the disease (18-21°C), the infection process requires the continuous presence of moisture for 2 to 4 hours. At a temperature of 27°C or above, development of the disease is markedly slower.



9 Severe powdery mildew on cv. 'Margaret Merril'

Control strategy

Successful control of the major foliar diseases of roses needs an integrated strategy involving a combination of varietal selection, good cultural management and selective fungicide use, as detailed below.

Observations indicate a clear link between severe foliar disease on crops in the field and poor establishment after potting, often referred to as spring-dieback. Maintaining good control of foliar diseases on field-grown maiden crops, for as long as possible before lifting, will help to maintain plant vigour and reduce establishment failure following containerisation.

Varietal resistance

Much of the information about varietal resistance is anecdotal and with black spot and powdery mildew is

complicated by the existence of different races of the fungi. The geographic distribution of these races, and their impact on varietal resistance, is not well understood. It is possible that a variety resistant in one locality could prove highly susceptible in another. Claims made about the resistance of specific varieties therefore need treating with some caution. Rootstocks resistant to black spot are not known to influence the susceptibility of the scion.

Black spot: The susceptibility of rose varieties to black spot varies and most can still be damaged when conditions favourable for the fungus. New introductions seldom retain their initial resistance for long, probably due to increasing exposure to a greater diversity of races of the fungus. Tetraploid roses such as Hybrid Tea and Floribunda are reported to be particularly susceptible

whereas other species are more resistant.

Downy mildew: All rose varieties are susceptible to a greater or lesser extent, 'Silver Jubilee', for example, being particularly susceptible.

Powdery mildew: Nearly all species and cultivars are susceptible in conditions favourable to the disease. Some varieties, for example 'Arthur De Sansal', 'Blairii Number Two', 'Yellow Belinda', 'Blue Moon' and 'Zephirine Drouhin' are highly susceptible, whereas 'Elina', 'Evergold', 'Korresia', 'Sweet Dream' and 'Warm Wishes' are much less so.

Rust: The popular rootstock, *Rosa laxa*, normally used for bud grafting Floribunda and Hybrid Tea roses, is very susceptible to rust. Susceptible flowering cultivars include 'Silver Wedding', 'Amber Queen' and 'Gingernut', to name a few.

Crop management

Minimising periods of leaf wetness and avoiding prolonged periods of high humidity will have a very significant effect in helping to prevent black spot, downy mildew and rust (but not powdery mildew). The following measures will help to achieve this:

- Avoid watering from overhead late in the day or during the evening.
- 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.
- 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.
- Ensure plants do not suffer drought or root damage, as this is believed to make them more susceptible to powdery mildew.

- Where bare-root plants are stacked and stored before potting, be aware that, if black spot is present, regular damping down to reduce desiccation risks spreading the black spot fungus.

Nursery hygiene

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 or Panacide M.

Fungicide use – some key factors

Fungicide use against the main foliar diseases is likely to be most effective when used as part of an integrated strategy incorporating cultural measures and varietal resistance.

- Start the spray programme before the target disease, or diseases, becomes established.
- Use fungicides in a manner which minimises the risk of a resistance problem.

- Adjust the spray intervals according to disease pressure and environmental conditions.
- Ensure that spray application achieves uniform and thorough coverage throughout the crop canopy, by correct nozzle selection, correct spraying pressure and using a sufficient spray volume.

Fungicide use – crop safety

When a fungicide product without label approval for use on rose is used for the first time, it is strongly advised that it be applied beforehand to a small number of plants to check for crop safety, and to proceed only if the outcome of this check indicates that phytotoxicity is unlikely.

Grower experience suggests spray damage is most likely to occur:

- On young plants.
- On soft growth of younger plants.
- When several pesticides are used on a crop within a short period of time.
- When several pesticides are used in a mixture, or additional wetter/spreader is added.
- During very hot or bright weather.



10 Avoid watering from overhead late in the day or during the evening



11 Damage on cv. 'Courage' from a tank mix of Nimrod T + Twist (double rate) 1 week after spraying in spring (sourced from HNS 106a)

Table 2
Fungicide products used in HNS 106a to assess phytotoxicity

Early summer treatments		
3 applications at fortnightly intervals as high volume sprays to run-off with the third spray at double standard rate		
Fungicide products	Standard rate	Damage observed
Untreated	Plain water	None
Nimrod-T + Amistar	3.2 ml/L + 1.0 ml/L	None
Nimrod-T + Twist	3.2 ml/L + 2.0 ml/L	Some distortion and scorch after double rate application and affecting most varieties
Folicur + Aliette	1.0 ml/L + 2.5 g/L	None
Lyric + Aliette	0.625 ml/L + 2.5 g/ml	None
Flamenco + Aliette	1.25 ml/L + 2.5 g/L	Leaf discoloration and distortion on several varieties
F238 + Amistar	2.5 ml/L + 1.0 ml/L	None
F238 + Twist	2.5 ml/L + 2.0 ml/L	Some distortion and scorch after double rate application and affecting most varieties
Late summer treatments		
3 applications as high volume sprays to run-off with second and third sprays at double standard rate		
Fungicide products	Standard rate	Damage observed
Untreated	Plain water	None
Nimrod-T + Folicur	3.2 ml/L + 1.0 ml/L	Slight leaf scorch on a couple of varieties after standard rate application, more severe and affecting all varieties after use at double rate
Nimrod-T + Twist	3.2 ml/L + 2.0 ml/L	Leaf discoloration and scorch on several varieties after standard rate application, more severe scorch after use at double rate
Flamenco	1.25 ml/L	Leaf discoloration and slight scorch and distortion on several varieties
Flamenco + Aliette	1.25 ml/L + 2.5 g/L	Leaf discoloration and slight scorch and distortion on several varieties
Flamenco + Riposte Pepite	1.25 ml/L + 2.5 g/L	Leaf discoloration and slight scorch and distortion on several varieties
F238 + Riposte Pepite	2.5 ml/L + 2.5 g/L	None
F238 + Twist	2.5 ml/L + 2.0 ml/L	Yellowing and slight scorch on young leaves

Recent HDC projects on fungicidal control of foliar diseases on rose (HNS 106 and 106a) investigated the direct effects of a range of fungicides, alone and in mixtures, on a range of varieties (see Table 2 for fungicide product details and effects observed). The overall conclusion was that fungicide tank mixes that do not have a label recommendation are best avoided earlier in the season when there is much more risk that damage would adversely affect marketability, and they should be used only with caution at other times.

Phytotoxicity on container-grown crops in the year they are to be sold can be costly, whereas some transient spray damage to field-grown plants, which will be lifted in the autumn, may be more acceptable if it helps to maintain control throughout the season.

Fungicide use – product efficacy

Table 4 lists products with On-Label Approval for use on container grown rose or hardy ornamentals, or via the Off-Label Long Term Arrangements for Extension of Use. Note that Off-Label use is at growers' own risk (see Table 4 footnote for details). Currently, the products most commonly used commercially against black spot, powdery mildew or rust are Amistar, Nimrod, Rubigan, Stroby WG and Systhane 20EW. Against downy mildew the products most commonly used commercially are Aliette WG, Amistar, Fubol products, Invader and Stroby WG.

HDC projects HNS 106 and 106a also included the evaluation of newer fungicide products against black spot, powdery mildew and rust, in comparison with those commonly used commercially (see Table 3 for rates of use and Table 4 for their spectrum of activity). The outcomes were as follows:

The triazole products, Lyric (flusilazole), Folicur (tebuconazole) and Flamenco (fluquinconazole) and the strobilurin Twist (trifloxystrobin), all gave excellent control of one or more of the target diseases and, in addition, Twist was also effective against downy mildew.

The performance of these products in this work was superior to that of many of the commercially established ones including Systhane 20EW (myclobutanil).

Table 3

Rates of fungicide used for control of black spot, powdery mildew and rust (as tested in HDC project HNS 106a)

Fungicide products	Rate used
Aliette	2.5 g/L
Bavistin DF	0.5 g/L
F238	2.5 ml/L
Folicur	1.0 ml/L
Invader	2.0 g/L
Lyric	0.625 ml/L
Nimrod-T	3.2 ml/L
Ripost Pepite	2.5 g/L
Systhane 20EW	0.3 ml/L
Twist	2.0 ml/L

The spray volume used was that required to achieve good coverage

Fungicide use – spray interval

Recent experience of the disease pressures on a particular nursery will help growers to make informed decisions on an appropriate spray interval. Using the newer and more effective fungicides and adopting sound crop management and hygiene measures, may sometimes allow spray intervals to be extended without compromising effective disease control, particularly if protectant sprays have been applied early in the season.

Fungicide use – spray programme

The spray programme needs to be designed and developed around the following:

- A risk assessment which takes account of all the factors (eg varietal resistance, non-chemical control measures, cultural practices, prevailing crop climate, disease monitoring), which could have an important impact on the threat from foliar diseases. This assessment will help determine which fungicides to use and when to apply them.
- The need to minimise the risk of a resistance problem.

- The need for integration with management of insect pests where biological methods are being used for their control.
- The need to minimise environmental impact.

HDC project HNS 106a investigated a fortnightly programme of sprays against black spot, powdery mildew and rust using newer products that had proved very effective in initial experiments. This was compared with a similar programme using three commercially popular products (F238, Nimrod T and Systhane 20EW). Products were used in a sequence designed to minimise the risk of a resistance problem. The programme using the newer products performed very favourably and is illustrated in Table 5, which also includes information about controlling downy mildew. It is a useful basis for developing programmes suited to different cropping situations.

Table 4
Fungicide products with label approval for rose and some other permitted fungicides with useful activity

Fungicide groups	Active ingredient	Product	Use outdoors (O) Use under protection (P)	Range of diseases controlled				Comments
				BS	PM	Rust	DM	
Benzimidazole (MBC)	Carbendazim	Bavistin DF	O and P	(✓)	✓	x	x	SOLA 0009/99 Product unavail- able once existing stocks sold
		Delsene 50 Flo	O and P	(✓)	✓	x	x	SOLA 1004/2004
Carboximide	Oxycarboxin	Plantvax 75	O and P	-	x	✓	x	
DMI (including triazoles)	Fluquinazole	Flamenco	O	✓	✓	✓	x	
	Flusilazole	Lytic	O	✓	✓	✓	x	
	Imazalil	Fungaflor	O and P	-	✓	-	x	
		Fungaflor Smoke	P	-	✓	-	x	
	Myclobutanil	Systhane 20EW	O and P	✓	✓	✓	x	
	Penconazole	Topas	O and P	-	✓	✓	x	
	Prochloraz	Scotts Octave	O and P	✓	✓	(✓)	x	
	Tebuconazole	Folicur	O	✓	✓	✓	x	
Dinitrophenyl	Dinocap	Karathane Liquid	O and P	x	✓	x	x	
Dithiocarbamate	Mancozeb	Karamate Dry Flo Newtec	O and P	✓	x	(✓)	(✓)	
Morpholine	Dodemorph	F238	O and P	x	✓	-	-	
Morpholine and dithiocarbamate	Dimethomorph + mancozeb	Invader	O	✓	-	(✓)	✓	
	Metalaxyl-M + mancozeb	Fubol Gold	O and P	✓	x	✓	✓	Approval for use expires 31 March 2005
		Fubol Gold WG	O and P	✓	x	✓	✓	
Phosphonic acid	Fosetyl aluminium	Aliette WG	O and P	x	x	x	✓	
Phthalimide	Captan	Alpha Captan 50 WP	O and P	✓	x	x	x	
		Alpha Captan 80 WDG	O and P	✓	x	x	x	
		Alpha Captan 83 WP	O and P	✓	x	x	x	
		PP Captan 80 WG	O and P	✓	x	x	x	

Table 4
Continued

Fungicide groups	Active ingredient	Product	Use outdoors (O) Use under protection (P)	Range of diseases controlled				Comments
				BS	PM	Rust	DM	
Phthalonitrile	Chlorothalonil	Various products	O and P	–	(✓)	(✓)	(✓)	
Pyrimidine	Bupirimate	Nimrod	O and P	x	✓	x	x	
	Fenarimol	Rubigan	O and P	x	✓	x	x	
Strobilurin	Azoxystrobin	Amistar	O and P	–	(✓)	✓	✓	
	Kresoxim-methyl	Stroby WG	O and P	–	(✓)	✓	✓	
	Trifloxystrobin	Twist	O	✓	✓	✓	✓	

- ✓ control
- (✓) partial control
- X ineffective
- no information

some growers have noted that Nimrod can damage soft growth early in the season. Do not apply Fungaflor in bright sun, on open flowers, or on variety 'Dr Verhage'.

However, use must be in a similar manner and rate as that specified on the label or Specific Off-Label instructions and be cautious, as such use is always **at grower's own risk** and some products may prove to be phytotoxic.

- Some products and uses are permitted under the Off-Label Approval Long Term Arrangements for Extension of Use; they are not specified here due to space constraints.
- Some products recently widely used on rose are no longer marketed (eg Nimrod-T, Ripost Pepite, Trustan).
- Some products may cause damage on some varieties and in certain conditions. For example,
- The range of fungicides permitted on rose likely to be effective against one or more of the major foliar diseases, is very much more extensive than that listed in the table above, particularly for production outdoors. This is because the Long Term Arrangements for Extension of Use allow extrapolation of use on edible crops to ornamentals. This means, for example, that fungicides approved for use against potato blight and which may therefore be useful against downy mildew, can also be used on outdoor rose.
- Contact the Pesticide Safety Directorate Information Service (01904 640500 or visit www.pesticides.gov.uk) or seek other professional advice if in doubt about which fungicide products are permissible on container grown rose 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.

Table 5
An example fungicide programme for control of the main foliar diseases of rose

Week number	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
PM, BS, R	Folicur	Twist	Nimrod		Lyric		F238	Twist	Folicur		Nimrod		Lyric	Twist	F238		Folicur
DM				Invader		Aliette				Invader		Aliette				Invader	
Week number	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
PM, BS, R		Nimrod	Twist	Lyric		F238		Folicur	Twist	Nimrod		Lyric		F238	Twist	Folicur	
DM	Aliette				Invader		Aliette			Invader		Aliette				Invader	

- triazole
- morpholine or pyridine
- strobilurin
- other protectant

- PM Powdery Mildew
- BS Black Spot
- R Rust
- DM Downy Mildew

- In addition to Lyric and Folicur, another triazole fungicide, Flamenco has also given promising results.
- Twist has given better results than the other strobilurins Amistar and Stroby WG.
- Fubol Gold WG could be substituted for some sprays of Invader or Aliette WG.
- Use high volume sprays to achieve good foliage cover.

In this example spray programme, Folicur, Nimrod, Lyric and F238 are applied alternately every 14 days for control of powdery mildew, black spot and rust. In the intervening week, Twist, Invader and Aliette are applied alternately for control of downy mildew. The Twist application provides additional protection of powdery mildew, black spot and rust.

Fungicide use – resistance management

If certain fungicides are used intensively, there is risk of selecting out strains of fungal pathogens that are resistant. The effectiveness of such fungicides will then be reduced. The risk of such a problem developing can be minimised by utilising fungicides which differ in their mode of action against a specific disease and carefully programming their use. Table 4 identifies the chemical groups to which some specific fungicides belong. This is the basis for developing

spray regimes that minimise the risk of a resistance problem. Adhere to the following guidelines:

- Use no more than two sequential sprays of the same fungicide or fungicides from the same chemical group.
- For strobilurin fungicides, use no more than 50% of the total sprays of this type of fungicide per crop.
- Comply with product label recommendations, including the recommended dose rate.

- Fully utilise commercially economic non-pesticide measures to minimise the need for intervention with fungicide treatment.

Important note: For further advice on strategies for minimising the risk of a resistance problem, see the FRAG-UK Technical Leaflet: Fungicide Resistance, published in August 2001, which can be downloaded from www.pesticides.gov.uk

Acknowledgements

We are grateful to Chris Burgess, who undertook HDC projects HNS 106 and 106a while at HRI Efford, for helpful

comment and provision of slides 1, 4, 5, 6, 9 and 11, and to Dr Avic Hall, University of Hertfordshire, for providing information about black spot and its control resulting from a

recent Defra-funded research project. Slides 2, 3, 7a, 7b, 8a, 8b and 10 were provided by Tim O'Neill.