Downy Mildew

Questions and Answers

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INNOVATORS NETWORK



Australian Government

Grape and Wine Research and Development Corporation

GRAPE AND WINE RESEARCH AND DEVELOPMENT CORPORATION

Identifying the disease

Q 1.: How do I know if the spots I see in my vineyard are downy mildew oilspots?

Downy mildew produces golden-yellow, oily spots on leaves, which are best seen on the top side of the leaves. When young (less than say 4–5 days old), the spots are often surrounded by a chocolate halo, which fades as the oilspot ages. The youngest spots first appear as circular spots 8–10mm in diameter. In susceptible young leaves they grow rapidly bigger, reaching 20–30 mm in diameter in 10–14 days. (For more detail on distinguishing downy from other symptoms, go to the Disease Diagnosis module at www.GrowCare.com.au).

Q 2.: What is the white down of downy mildew?

It is the sporangia (spores) of the disease. They are produced only on the undersides of oilspots and on infected green tissue but then only when the conditions are right – during a warm, humid night. These spores can spread downy at very rapid rates.

Q 3.: I get downy and powdery mildew confused. Is there a test to tell if an oilspot is downy mildew and if it is active?

Yes, do the 'bag test'. Lightly moisten a sealable plastic bag by adding a little water then shaking the bag vigorously to spread the water evenly around the inside of the bag. Then up-end the bag to drain out any excess water. Place the leaves with suspect oilspots or infected bunch material (it is best to take the sample in the afternoon) in the bag. Make sure that the undersides of the leaves are facing upwards and are not wet. Seal the bag and incubate it at 20–25^{0}C in the dark - a kitchen cupboard is a good spot. In the morning, active downy mildew tissue will show fresh white down on the undersides of the oilspots, on the surface of bunch stems and on berries smaller than pea-size (5–7 mm diameter).



Oilspots are circular and light yellow when young



Active viable downy mildew oilspots will show the characteristic fresh white down in the morning after the bag test.
(Photo: Richard Hamilton)

The disease

Q 4.: What is the difference between downy primary and secondary infections?

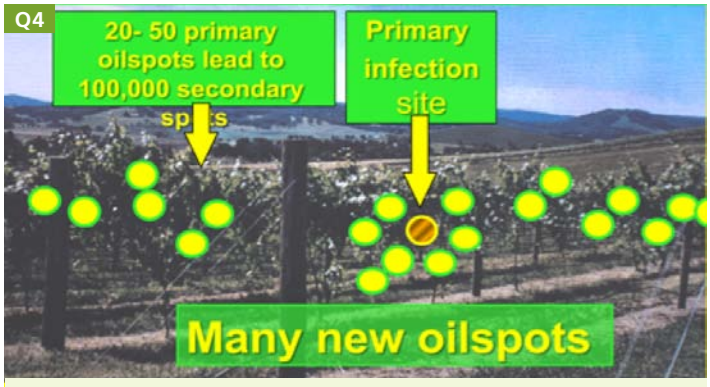
A primary infection occurs when the downy spores move from the soil to the vine. It produces a few oilspots in the foliage – usually about 1–3 oilspots in every 50 metres of canopy row.

Secondary infection occurs when downy spreads from oilspots in the canopy. Spores move from leaf to leaf or leaf to bunch and, because each oilspot can produce many 1,000s of spores, this can lead to an explosive increase in disease levels causing many more new generation oilspots and bunch infections.

Q 5.: I know downy is driven by wet weather but can you summarise the conditions needed for each step?

A primary infection requires the soil to be wet for 16 hours at temperatures at or near 10^{0}C for overwintering spores (called oospores) to release zoospores in the soil. These swimming zoospores then need rainfall to splash them up to the vine foliage and the leaves need to be wet for a further 2–3 hours for infection to occur. Because these conditions are quite specific, primary infections usually only occur a few times a season. After the primary infection, the downy mildew pathogen will incubate for five or more days before oilspots appear in the canopy.

Once these spots have appeared, spores can be produced on their under-surfaces as part of the secondary infection process. This requires a warm, humid night and the leaves need to be wet in the morning for infection to occur. This event may occur many times in a season. A second incubation period is then needed before a new generation of oilspots will appear (for more detail on the life cycle of downy mildew, go to the GWRDC website http://www.gwrdc.com.au/webdata/resources/files/DownyMildewFactShee.pdf or www.GrowCare.com.au)



Secondary infection can be explosive, producing many 1000s of new generation infection sites overnight. Early season, when the bunches are very susceptible, this phase of the disease can be rapidly destructive.

Managing the disease

Q 6.: I have not found any oil spots in my vineyard. Does that mean that I am safe?

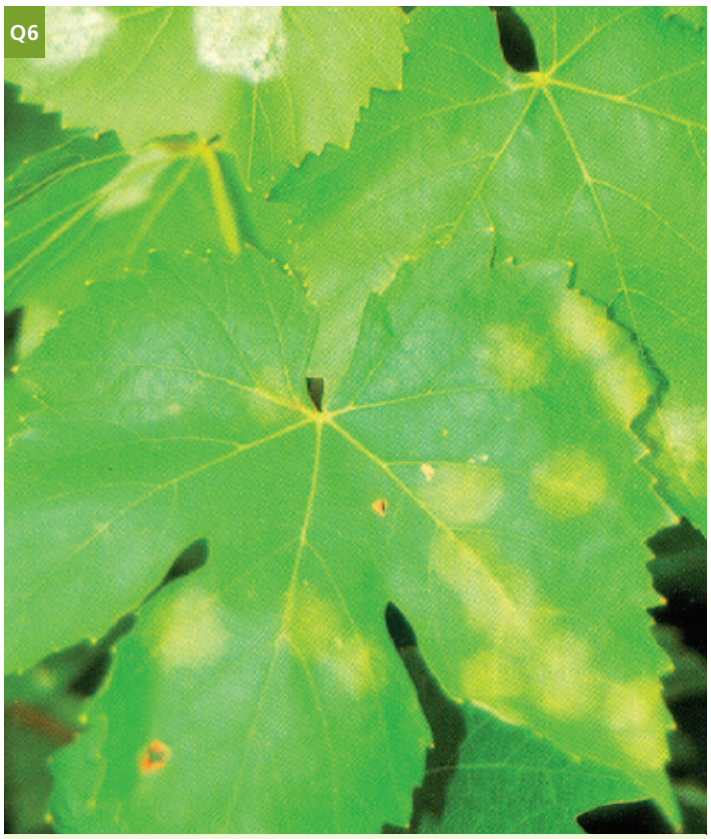
Have you looked? Have you really looked inside the canopy? Effective monitoring requires time, effort and experience. Follow the three Ts of good monitoring: Target, Timing and Technique. Know the symptoms you are looking for (target); when to look for them (timing) and how to monitor (technique). For instance, be sure to look inside the canopy for bunch infection and when looking for oilspots, assess up to 200 vines.

Primary infections are easy to miss and can go untreated. It is possible for infection to go 'straight to bunches' but this is rare. A secondary infection is more noticeable and shows up as small clusters of oilspots on leaves.

Often the primary oilspot will be found as an aged spot in the middle of this new cluster. Infected bunches will usually be the result of secondary infection (see Q15).

Q 7.: In on-going wet conditions that cause repeat infection events, what must I do?

Be sure to look closely in your vine canopy. Search for oilspots in the foliage and especially look within the canopy for infected bunches (See Q1.) It is important to know what level of disease is present in your vineyard and to know what stage the epidemic is up to (Q4 and 5. See www.GrowCare.com.au for further details). This allows good decisions to be made when considering which fungicides to apply.



Older oilspots are dark yellow with or without the white down on the undersides

Q8



Downy mildew rapidly kills highly susceptible young bunches (left), but berries are immune well before pea-size (E-L 31) (right). Downy is best controlled at or before primary infection because in suitably warm, humid weather the disease spreads rapidly in secondary infection.

Q 8.: What is the difference between a pre- and post-infection fungicide?

A pre-infection fungicide is a product that defends against downy. It must be applied as close as possible before infection begins to ensure that new growth is well covered. These products include the copper-based products mancozeb (e.g. Dithane™) and captan. They are otherwise known as protectants or cover sprays.

A post-infection fungicide has the capacity to kill off downy while it is developing, after infection has occurred. They are best applied as soon as possible after an infection event has occurred. These products include metalaxyl (Ridomil™, Axiom™ and Medley™) and phosphorous acid (phos acid). The strobilurins Cabrio™ and Amistar™ have some effect also. These products are otherwise referred to as eradicants or systemics.

Q 9.: Are the different pre-infection (protectant) fungicides different in their control of downy?

All the pre-infection sprays will do a good job if they are sprayed correctly (Q12). This includes the different copper formulations, mancozeb and the like. Generally, if it is registered, it will work!

Q 10.: I sprayed with copper last week before the recent rains. How much copper did the rain wash off?

Understandably, the rain washes some chemical off the sprayed foliage, but most pre-infection sprays stick quite well. The chief factor in a spray failing to endure is not so much the amount of rain but more the rate of growth of new vine tissue. Leaves and shoots expand and critically, at the time of flowering, the bunches grow rapidly. Because the pre-infection sprays act on the surface of the vine tissue, they need to be present in sufficient coverage and dose before a spore lands on that surface so that the fungus makes contact with the chemical and is killed. As the vine grows, it expands. This spreads out the layer of fungicide like dots spread on a balloon when it is blown up. With expanding tissue, the downy spores have a much better chance of landing in a gap in the spray cover and growing into and infecting the vine.

When the vine is rapidly growing at, or near, flowering, a protective spray cover remains effective for as few as 3–5 days (see Q15). Later, as vine growth slows, a spray cover might last 10–14 days.

Q 11.: How can I measure vine growth?

A simple way is to tie a bread bag twist-tie at the tip of 2–3 shoots at the time you spray. Come back a few days later and you will see how much the shoots have grown. This gives you a measure of how much new and therefore unsprayed vine surface is present before the next infection event.

Q 12.: I'm told that the pre-infection sprays are very effective against downy. How come I sprayed just before the last rain and still found a new generation of downy oilspots on my vines?

Your spray **T**iming seemed good but good spray application is essential for good control. This means getting the chemical **T**ype and **T**reatment right. Good treatment often means using the highest label rate of product and matching the amount (volume) of water and chemical applied to the canopy size (volume) at the time of spraying. This also means spraying at suitable speeds with best sprayer set-up to maximise coverage of the young bunches and the lower leaf surfaces where the downy infects the leaves. These are the places where it is most difficult to achieve good coverage, so canopy management such as trimming is often essential if sprays are needed after flowering in dense canopies.

Q 13.: I want to make sure I also control powdery when I am focussing on downy. Can I tank mix several products when I spray?

This is a good idea. It is easy to focus on downy and forget powdery mildew, botrytis and other bunch rots. The latter two disease groups spread abundantly in conditions that favour downy. Tank mixes are OK for most of the products used for the three disease groups but it is a good idea not to mix more than three products in the one tank.

Q 14.: Do I need to add a wetter or sticker to my sprays?

Generally, no. Most fungicides are formulated with these already incorporated into the product you buy. They are formulated to spread and stick well. Follow the manufacturer's advice on the label. Too much wetter can lead to the spray spreading too much and running off the vine. This reduces the effective dose that remains to prevent infection and can lead to infection occurring even though you sprayed.

Q 15.: I sprayed my vines at the right time and with good coverage but after the rains, I found downy on my bunches and hardly any on the leaves. What is going on?

This has been showing up in a number of vineyards. Nearly all of these have been sprayed just before an infection at the time of flowering. The sprays covered the foliage and the young bunches but in the 3 or 4 days before the rain, lots of bunch flower caps fell off, leaving the developing flowers exposed to infection. After the incubation period of downy inside the vines, infection showed up wherever the coverage was incomplete (Q12). This means that the very susceptible young bunches that were exposed were diseased despite the spraying.

Q 16.: What can I do if downy mildew infection has occurred? Can I stop it?

The post-infection sprays, such as metalaxyl and phos acid, are very effective in controlling downy after an infection event. There are some excellent examples of infection developing, then a post-infection fungicide being applied and the disease being effectively stopped in its tracks.

There are several factors involved in the capacity of downy to multiply in the vineyard. The number, size and age of oilspots determines the capacity of the disease to produce spores in a secondary infection event. The suitability of the conditions is another factor. On a warm, humid night suitable for secondary infection (see Q5), downy produces thousands of spores from each oilspot. If the temperature is around 20^{0}C, an oilspot will produce many more spores than if the temperature is near the lower limit of 13^{0}C. Once the spores are produced, temperature and leaf wetness are critical factors in determining how much new infection will occur. The post-infection fungicides are active against most of these factors preventing oilspots being produced and reducing sporangial production and viability.

These fungicides are best applied as soon as possible after infection to prevent oilspots developing. If they are applied just after oilspots appear (not recommended!), they sometimes have the capacity to kill out that oilspot or, if the spot persists, the post-infection fungicide has capacity to reduce the number of spores produced and/or it may reduce the viability of any spores that do develop. This multifaceted activity of the post-infection fungicides are the reason why they are so effective, especially if applied within the first 4–5 days after an infection event.

Q15



Good timing of spray applications in relation to infection events, especially primary infection, is a major factor in effective spraying for downy mildew. Young bunches are highly susceptible so good control of primary infection will prevent the risk of secondary infection and reduce the need for more sprays.

Q16



Post-infection fungicides like metalaxyl can kill out oilspots if timed correctly. The brown oilspot (left) has died and the yellow oilspot (right) did not produce new spores despite favourable weather conditions – it can no longer spread the disease.



Automatic weather stations (AWS) monitor the vine canopy for leafwetness, rainfall, relative humidity (RH) and temperature, critical to the life cycle of downy mildew. Some AWS, like this Model T MetStation®, signal infection events and help refine optimum spray timing.

Q 17.: How can I tell when to spray, especially in wet weather?

In wet conditions, there are two approaches. One is to spray regularly and often with a pre-infection (protective) fungicide. The effectiveness of control will depend on achieving a good spray cover before an infection event occurs (see Q10). The spray interval is best determined by assessing vine growth (see Q11) and, by monitoring the weather forecasts for the conditions that favour infection. For some regions, the Bureau of Meteorology works in liaison with regional industry bodies to provide a Downy Mildew Alert, warning growers of impending conditions favourable to infection (see www.GrowCare.com.au).

The second approach is to apply a few cover sprays at critical times early in the season (before the canopy closes over and makes spray penetration more difficult), then following up with post-infection sprays if and when needed, as soon as possible after an infection period (see Q16).

For the maximum effectiveness of both approaches, spray timing will rely more on 'flying by instruments' than by observing oilspots in the vineyard. The pre-infection strategy is best guided by forecasts of wet weather. This means spraying before you can see the downy infection. The post-infection strategy is best guided by use of a weather station to provide weather data for a site near you. This permits analysis of the data to determine the 'just triggered' risk of disease from a recent weather event though the resultant disease outcome is still unseen in the vineyard (see examples of this approach in www.GrowCare.com.au).

Q 18.: What if my vines were at or just past flowering and unprotected when the conditions favoured downy in my vineyard?

As the words of the Downy Rap song say, at this critical time, 'Give it no room'. Because young bunches are so susceptible to downy (Q15), it is essential to gain and maintain good control. Apply a post-infection fungicide as soon as possible and ensure good spray coverage by using well-calibrated equipment and optimising a high water rate for thorough coverage (Q12). (Note: For those interested in the novelty disease management story The Downy Rap, the song is available from www.GrowCare.com.au).

Q 19.: I have had a downy mildew infection, the disease is spreading and I can't purchase any new metalaxyl ... but I have some 5-year old Ridomil™ in the shed. Can I use it?

Many companies only guarantee products with metalaxyl and copper for five years and metalaxyl and mancozeb products for three years. As long as it is kept dry, and preferably cool, the metalaxyl is more stable than the pre-infection actives copper and mancozeb, which are added to reduce the risk of resistance. Also note that some industry quality assurance programs prevent the use of out-dated chemicals in the vineyard. Please consult your winery for more specific advice about chemical use.

Q 20.: Just recently, some formulations of metalaxyl used in pineapples and other crops have been approved by the APVMA for use in vineyards. They are not formulated with a pre-infection fungicide such as copper or mancozeb. Is this safe to use?

Yes but, used alone, metalaxyl will only provide limited protection to the vines. It will work well as a post-infection fungicide but to provide a high level of protectant (pre-infection) activity and to prevent resistance developing to the metalaxyl, make sure you tank mix a pre-infection fungicide with the metalaxyl.

Q21.Can I use phos acid on my vines? I have nothing else I can use to stop the downy spreading.

Although phos acid is extremely effective in reducing the vineyard disease potential from infected vines, its use will almost certainly result in a detectable residue in wine. Because some international markets have no MRL (Maximum Residue Level) for phos acid, ask your winery for their policy prior to using phos acid.

An alternative, when all else fails, is to maintain a frequent spray program using pre-infection (protectant) fungicides. Trim vines to make for easier penetration of sprays. The Group Y fungicides (e.g. copper, mancozeb etc) are very effective and cheaper than the Group K strobilurins (e.g. Amistar™ and Cabrio™), but the latter also give control of powdery mildew. Keep a look out for powdery in your canopies too because now is a good time to make sure it is under control!

Q 22.: Can I use products that are not registered for grapevines?

No! Chemical applicators should only apply agrochemical products that are currently registered for use on grapes or have a current off-label permit. An expired permit does not constitute permission to use a product. Refer to the AWRI's Dog Book (http://www.awri.com.au/industry_support/viticulture/agrochemicals/agrochemical_booklet/booklet.pdf) or contact the APVMA, AWRI or your grape purchaser if in any doubt.

Q 23.: When do berries gain resistance and what about the berry stalks?

The berries gain resistance to downy mildew as they cease functioning as green tissue and begin to function as a berry. The stomates are where downy enters to cause infection and the stomates on the berry close up permanently sometime before berries reach pea size (5–7mm diameter). Note though, that the berry stalks and bunch stalks (rachis) continue to remain susceptible.



Berries gain resistance to downy mildew when near pea-size but stalks remain susceptible. Note the fresh white down on the infected stalks (Photo: Andrew Weeks)

Managing the disease

Q 24.: How long do oilspots remain active in my vineyard?

About 90 days. Though the centre of the spots may die out when the oilspot sporulates and produces the characteristic fresh white down, untreated oilspots will continue to grow from an outer ring of yellowed (infected) tissue. This maintains the active downy mildew and gives the disease the potential to spread in suitable conditions for much of the rest of the season.

Q 25.: Will skirting and trimming the vines stop downy infection?

No, but it will help airflow to dry out the canopy more quickly and it will assist the penetration of fungicide sprays. Both skirting and trimming will assist in controlling downy (and powdery) mildew and bunch rots. Desuckering will remove susceptible leaf material from near the soil where the disease overwinters – shoots low to the ground often show the disease first.

Q 26.: Sometimes post-infection fungicides like metalaxyl seem to kill off established oilspots. How can I tell if the spots are dead?

Post-infection fungicides like metalaxyl and phos acid both have capacity to kill existing oilspots if applied soon after the spots appear (Q16). The bag test (Q3) is one way of checking if the oilspots are dead. Another is to check the spots after a warm, humid night and look for fresh white down in the morning. If unsprayed oilspots produce the down and the treated spots do not, then you can assume the post-infection spray has been very effective.

This season has again shown some clear examples of this success story when a full epidemic has been effectively quelled by well-timed applications of either metalaxyl or phos acid.

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For further information:

1. The Grape and Wine Research and Development Corporation (GWRDC) website www.gwrdc.com.au. Follow the links under 'Resources' and 'Innovator Network Resources' tabs to:
   - The Downy Mildew factsheets
   - The Downy Mildew tech book
   - Other fact sheets
2. The web-site www.GrowCare.com.au, provides information for Australian grapegrowers seeking details on the diagnosis, epidemiology and management of the mildews of grapevine. It hosts written information, interactive disease and weather information, and songs on the mildews and hosts a teaching video on downy mildew.
3. Nicholas, P.R., Magarey, P.A. and Wachtel, M.F. (1994). (Editors). 'Diseases and Pests', Vol. I. Grape Production Series. Winetitles, Adelaide, South Australia. 106 pp. ISBN 1-875130-15-2
4. Magarey, P.A., MacGregor, A.M., Wachtel, M.F. and Kelly, M.C. (1999). (Editors). *The Australian and New Zealand Field Guide to Diseases, Pests and Disorders of Grapes*. A companion to 'Diseases and Pests', Grape Production Series No.1. Winetitles, Adelaide, South Australia. 108 pp. ISBN 1 875130 33 0. (634.82)

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