



Fig. 1. Downy mildew symptoms. Oil spots (a) and white “down” (sporangiophores) formed beneath oil spots (b); Symptoms on inflorescence (c) and berries at fruit set stage (d); Sporangium with sterigmata (typically in threes) and sporangia (e-f). Photo credits: Tijana Petrovic (a-d) and Jessamy Bennett (e-f).

Disease: Downy mildew

Classification: K: Chromista, D: Oomycota, C: Oomycetes, O: Peronosporales, F: Peronosporaceae.

Downy mildew (DM) is a ubiquitous disease of grapevines causing direct yield loss by damaging inflorescences, clusters and shoots, and indirect loss by prematurely defoliating the vines, exposing bunches to sunburn and reducing sugar content. Severe defoliation may cause yield loss in the following season due to the reduced ability of the vines to store reserves. In warm, wet growing seasons in the absence of effective control near flowering, DM can cause 50-75% fruit loss. It is estimated to cost the Australian grape and wine sector \$63 million per annum.

The Pathogen: *Plasmopara viticola* originated in North America, where it coevolved with wild *Vitis* species. The pathogen was reported in the eastern states of Australia in 1917 and in WA in 1997. *P. viticola* is an obligate parasite and grows in all green parts of the vine then forms overwintering structures (oospores) in necrotic leaves, shoots and berries.

Host Range: Several American and Asian *Vitis* species and wild genera in the *Vitaceae*. The European grape (*V. vinifera*) is highly susceptible to *P. viticola*.

Biology and ecology: *P. viticola* overwinters as oospores (sexual stage) in leaf litter and soil for 7-10 years. Primary infections occur when weather conditions are favourable for germination of oospores to form primary sporangia, which release zoospores, i.e. ≥ 10 mm rainfall when temperature is $\geq 10^{\circ}\text{C}$ over a 24h period. The pathogen is splashed onto foliage and the zoospores swim to and infect via stomata on the underside of the wet leaves. Growth of *P. viticola* begins near the end of the 24h infection period if conditions remain favourable. Hyphae grow inside the leaf tissue, forming oil spots (Fig. 1a) 4-21 days after infection has occurred. These oil

spots produce sporangiophores in relative humidity $\geq 98\%$, $\geq 13^{\circ}\text{C}$, leaf wetness 2-3h predawn and when these conditions persist for at least 4h of darkness. Sporangia containing zoospores (asexual stage) are usually spread by wind and rain-splash to cause secondary infections.

Symptoms: Disease appears on all green parts of the vine (Fig. 1a-d). Infected parts of young bunches turn brown, wither and die rapidly (Fig. 1d). Berries become resistant to infection within 2-4 weeks after bloom. Sporangia bearing sporangia appear as white “down” on the underside of the leaf oil spots and other infected plant parts (Fig. 1e-f).

Disease management: Monitor during favourable weather conditions for primary/secondary infection and disease progress. Avoid distribution of infected soil/plant material and maintain an open canopy. Apply pre-infection fungicides as per label recommendations as close as possible prior to predicted infection periods. Protection at flowering is critical. Post-infection fungicides can be applied between infection and symptom expression, but the risk of fungicide resistance is high. Always follow resistance management guidelines.

Further Reading: Gessler et al. (2011) *Phytopathologia Mediterranea* 50:3-44; Rouxel et al. (2014) *Phytopathology* 104:692-701; Scholefield and Morison (2010) <http://www.gwrdc.com.au/wp-content/uploads/2012/09/GWR-08-04.pdf>.

Key Contact: Tijana Petrovic, University of Adelaide; e-mail: tijana.petrovic@adelaide.edu.au, Lee Bartlett, South Australian Research and Development Institute; e-mail: lee.bartlett@sa.gov.au; Jessamy Bennett, jessamy.bennett@student.adelaide.edu.au; Eileen Scott, University of Adelaide; e-mail: eileen.scott@adelaide.edu.au