Assessing powdery mildew (*Erysiphe necator*) on grape bunches

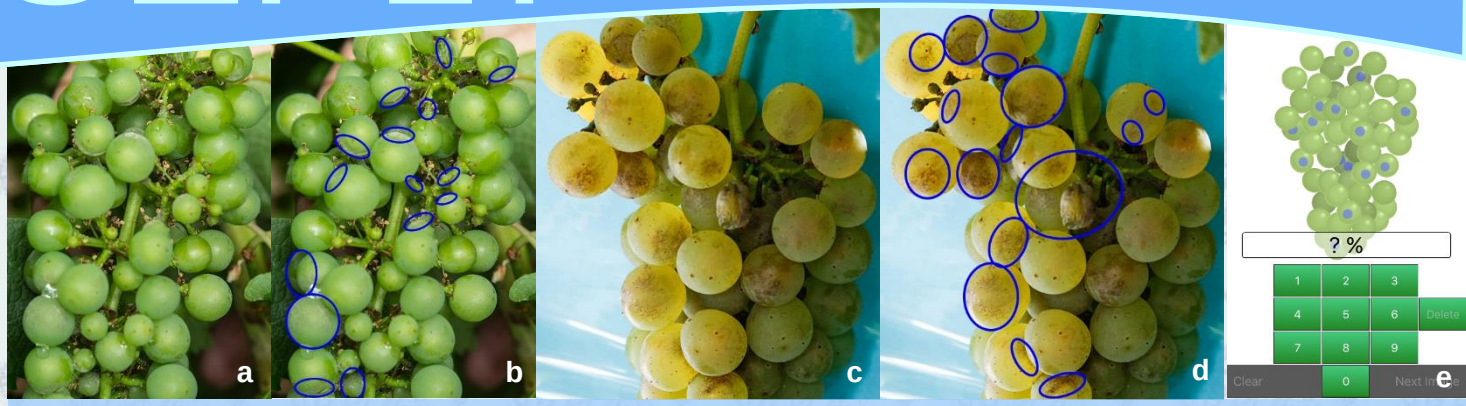

Fig. 1. Powdery mildew on bunches. Recognition of disease at *véraison* (a, b) and harvest (c, d) using powdery mildew on-line resources; Estimating area affected by using computer-generated images banked in the smartphone application, PMapp (e).

Powdery mildew (PM) can reduce the yield and the quality of grapes and wine. Australian wineries typically use a rejection threshold of 3-5% severity on bunches at harvest, based on visual assessment. A smartphone application (PMapp) and supporting resources (www.pmassessment.com.au) were developed to facilitate visual assessment of PM in the vineyard (Fig. 1a-d), and provide training prior to and during the growing season (Fig. 1e), towards promoting consistent assessment of disease. Visual assessment is acknowledged to be subjective, and objective alternatives are required. Objective measures might include fatty acids content, quantitative PCR (qPCR), mid-infrared spectroscopy and hyperspectral imaging.

PMapp: A free application for Apple and Android smart-phones and tablets supports plant pathologists and viticulture consultants to assess severity and incidence of PM on bunches in the vineyard. An assessment includes categories from trace (0.5%) to 100%, with 1% increments from 1-10% and larger increments thereafter. Data collected include date, time, location (with latitude and longitude), the spatial distribution of PM severity across the assessed area and overall incidence. The assessment data can be transferred to a computer as a CSV or XML file for analysis as required. PMapp also contains a bank of computer-generated images of bunches to facilitate assessment of area, a self-calibration tool that allows the user to check his/her accuracy (Fig. 1e) and a diagrammatic key. This tool can also be used to assist with assessing and recording area affected (severity) by other diseases.

Grape PM Assessment Resources: The website offers a stepwise guide to in-field assessment with links to training for disease recognition, area assessment and a diagrammatic key with 2% increments at the low end of the scale (as in PMapp). The disease recognition component comprises high-resolution photographs with areas outlined that might exhibit PM symptoms; the user selects the image in each set of three that shows PM symptoms most correctly (Fig. 1b, d). The area assessment component provides training to estimate surface area affected by PM on the computer-generated images. This tool can be used for training disease assessors before they begin assessments in the vineyard.

Objective measures: Fatty acids are present in the grape skin and flash, and are important for vinification and sensory properties of wine. *E. necator* is rich in saturated fatty acids; they are almost six times more abundant than unsaturated fatty acids. Arachidic acid (C20:0), the most prevalent fatty acid, is proposed as a biomarker for PM on grapes. Its concentration changed significantly amongst visually healthy, partly and fully infected berries. Quantitative PCR with primers developed based on a highly repetitive *E. necator* DNA fragment is sensitive enough to detect as little as 3fg of pure *E. necator* DNA. The qPCR assay quantified traces of *E. necator* on single berries, equivalent to 3 or 7 conidia per berry. Increasing *E. necator* biomass on berries correlated with arachidic acid content. These methods need to be evaluated further.

Further Reading: Knauer et al. (2017) *Plant Methods* 13:47; Petrovic et al. *(*2017*) Australian Journal of Grape and Wine Research* 23: 415-425; Pinar et al. (2016) *Food Chemistry* 207: 251-260; Pinar et al. (2016) Thiessen et al. 2016 *Plant Pathology* 65: 238-249.

Key Contact: Eileen Scott, University of Adelaide; e-mail: eileen.scott@adelaide.edu.au;
Tijana Petrovic, University of Adelaide; e-mail: tijana.petrovic@adelaide.edu.au;
Tim Zanker, University of Adelaide; e-mail: timothy.zanker@adelaide.edu.au