Sustainable control of grapevine powdery mildew (*Uncinula necator* Schweinitz Burrill) in vineyards in South Australia

Peter Crisp
B. Ag. Sc. (Hons), The University of Adelaide

Thesis submitted for the degree of
Doctor of Philosophy
in
The University of Adelaide
February 2004

Plant and Pest Science
School of Agriculture and Wine
Faculty of Sciences

Table of Contents

Abstract

Grapevine powdery mildew, caused by the fungus *Uncinula necator* Schweinitz Burrill, is a major disease affecting grape yield and quality worldwide. In conventional vineyards, the disease is controlled mainly by regular applications of sulphur and synthetic fungicides, such as demethylation inhibiting fungicides (DMIs), and in organic agriculture by sulphur and canola-based oils. The impending restrictions on the use of sulphur in organic viticulture, the development of resistance to DMIs in Australia and elsewhere, and the demand for residue-free grapes create a need for effective alternatives to sulphur and synthetic chemicals. This research has identified potential replacements for synthetic fungicides and sulphur in the control of powdery mildew, such as milk, whey, bicarbonates and canola oil-based sprays.

A series of greenhouse experiments was conducted to evaluate 34 potential novel materials and biological agents for efficacy in controlling powdery mildew. The most effective treatments applied were *Bacillus subtilis* (which reduced disease by 94% compared to the untreated control), Synertrol Horti-Oil® (a canola oil-based product, 92%), milk (70%), whey (64%) and Ecocarb® (potassium bicarbonate, 58%). Milk and whey provided increased control of powdery mildew as the concentration increased. The efficacy of milk tended to decrease as the fat content of the milk was reduced.

The materials that were most promising in the greenhouse were then assessed in field trials in commercial vineyards. Applications of milk, whey and mixtures of a canola oil-based product and potassium bicarbonate, applied at rates of 300 L/ha to 1000 L/ha depending on canopy development, reduced the severity of powdery mildew. The severity of powdery mildew on vines sprayed with a 1:10 dilution of

milk, 45 g/L whey powder and mixed programs was not significantly different from that on vines sprayed with sulphur (wettable powder, 3 g/L). However, the relative control of powdery mildew by the test materials in field trials was highly dependent on the degree of coverage of the plant surface achieved. In vineyards where coverage was compromised, the degree of control of powdery mildew was reduced, often to commercially unacceptable levels.

Electron spin resonance (ESR) and scanning electron microscopy (SEM) were used to investigate the possible mode or modes of action of milk and whey in the control of powdery mildew. The ESR experiments showed that production of oxygen radicals by various components of milk in natural light was associated with reduced severity of powdery mildew. SEM images showed that milk and whey caused the hyphae of *U. necator* to collapse and damaged conidia within 24 h of treatment. Hydrogen peroxide, applied as a source of free radicals, also caused collapse of the hyphae of *U. necator* within 24 h but did not damage conidia, and appeared to stimulate germination. Lactoferrin (an antimicrobial component of milk) ruptured conidia, but damage to hyphae was not evident in lactoferrin-treated samples until 48 h after treatment. The results suggested that fats, free radical production along with the action of lactoferrin, and possibly other proteins, are associated with the control of powdery mildew by milk.

Novel soft fungicides, such as milk and oil plus bicarbonate mixtures, were effective alternatives to sulphur and synthetic fungicides in certain South Australian conditions. Biological agents (including *B. subtilis*, which was highly effective in greenhouse experiments) did not provide acceptable control of powdery mildew in the vineyard.