USE OF A MATHEMATICAL MODEL WITH HOURLY WEATHER DATA FOR EARLY WARNING OF DOWNY MILDEW IN VINEYARDS

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Introduction
Downy Mildew (Plasmopara Viticola) is known as one of the most important vineyard diseases in the Western Cape, because it has the capability to develop and spread very quickly (Emmett et al., 1992), and so cause large crop losses in certain years according to the weather conditions. Farmers must make decisions as whether or not to spray for downy mildew (Magarey et al., 1994) and also how frequently to spray and which agrochemicals to use. Obviously they want to limit the number of times they spray to reduce costs and environmental pollution, but they also want to minimize the risk of crop failure due to infection by downy mildew disease. In 1992 an Austrian researcher developed the Metos automatic weather station and associated software, to predict the occurrence of primary and secondary infection of downy mildew. The overseas model was however not sensitive enough to accurately calculate infections in South Africa, and furthermore it only gave a “Yes/No” warning of possible primary and/or secondary infections. The Metos software model (Pessl, 2000) was adapted for South African conditions in 1995 and 2006 to make it more accurate and user-friendly and named Donsige Skimmel Vroeg-Waarskuwingsmodel (DSVW) (Afrikaans for “Downy Mildew Early Warning Model”) (Haasbroek, 2006). The DSVW model output now provides a graphical representation of the past weather variables (up to 3 weeks), and an indication (3 different colours - high, medium and low chance) of possible favourable periods for both primary and secondary infection occurrence.

Methodology
Automatic weather stations collect hourly data of different weather elements in downy mildew disease prone areas. At 5 am modems in a central operation room download hourly as well as daily data from each weather station. Operators then check what data is downloaded and thus available for the disease reports. The raw data (no correction of errors) is then stored in both hourly and daily databanks. The DSVW model is then run to generate primary and secondary downy mildew disease reports from the hourly raw databank for each of the stations in the grape growing areas of the South Western Cape Province of South Africa. Software is being developed to do quality control on the data. This will increase the reliability and accuracy of the disease reports.

Results
About a third of the users have a weather station on their own farm (less than 5 km from the vineyards) while others use weather data from a neighbour’s farm or from one of the ARC-IS CW automatic weather stations. The DSVW model uses the hourly rainfall, temperature and relative humidity measurements to make the decisions about favourable weather conditions for infection by the downy mildew disease. Leaf wetness is now calculated from relative humidity and air temperature as leaf wetness sensors proved to be unreliable. For the primary infections period, the most critical conditions include receiving a 24-h cumulated rainfall of more than 10 mm and having leaves wet for 3 hours when the 24-h average air temperature was >10°C. For secondary infection to be predicted, conditions must have included 4 continuous hours when relative humidity was > 92% with at least 2 or more having wet leaves as well as a mean air
temperature $\geq 13^\circ C$ during these hours. These favourable conditions are then marked on a diagram together with a graph of the weather conditions over the last 3 weeks. The DSVW model also gives 4 risk classes (0%; 1-34%; 35-74% & >75%) for both primary and secondary infection by downy mildew disease. Some producers would prefer a simpler report layout, while others understand and want weather data graphs.

Each morning the infection reports, as predicted by the DSVW model for the each weather station, are sent via e-mail or fax directly to vineyard producers in the Western Cape. They pay a fixed amount per station per year and some receive it as a group. Internet and SMS messages are being investigated for future distribution of the predicted disease results. 70% of producers have been receiving these outputs for 5-10 years. Producers use the information about the periods of favourable weather conditions for downy mildew infections given by DSVW to better manage their preventive spray programs and to minimize crop damage. About 50% of them stated in a survey, that they normally work on a regular repetitive spray programme spraying each part of the vineyard every two weeks. Each of these spray actions cost them about US$60 per hectare although it does vary according to the chemicals used and with time through the season. The DSVW output helps 38% of them to make a decision about whether to spray with systemic or contact chemicals and which chemicals to use. Another 19% use the DSVW output to decide on an additional spray when the DSVW model indicates that weather conditions have been highly favourable for infection with downy mildew. Producers ask for a prediction of infection in a forecast period, so this is being developed.

**Conclusions**

The producers and their advisors have therefore been using the output from the DSVW model to make decisions about when to spray to combat downy mildew on the grapes for the last 10 years. In the near future GPRS technology will be introduced to receive data much quicker than currently and then have more time available to do better data quality control, before sending out the disease reports to the producers.

**References**


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