Grape Compass
Enabling quality grapes
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Grape Compass: Frequently asked questions

Grape Compass is a smartphone-based Climate Smart technology for farmers. In this document, we present an overview of the application as well as explore some of the detail of the technology behind it and its use through a set of Frequently Asked Questions.

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1 An introduction to the fundamentals

1.1 What is Grape Compass?

Grape Compass is a smartphone application providing a five-day forecast of the risk of a fungal disease outbreak. "Forewarned is forearmed" – these predictions provide farmers with accurate insights into future climatic conditions (and the likelihood of disease outbreaks) - enabling them to better plan their fungicide spraying programs to both avoid unnecessary sprays and optimally protect their crop. Grape Compass combines state-of-the-art weather forecast models and scientifically validated fungal disease models for each fungal disease to make its disease pressure predictions.

1.2 How does Grape Compass work?

Grape Compass utilizes an ensemble of weather forecasts - multiple weather forecast models each providing slightly different predictions of future weather that can be expected in the coming days. The Grape Compass algorithm considers all the scenarios in the ensemble in light of disease models for each fungal disease type and determines whether conditions could result in disease pressure or not. The Grape Compass algorithm is very conservative and alerts for disease risk even when only a small number of the weather models predict conditions suitable for disease outbreaks. Grape Compass is thus inherently risk averse and "errs on the side of caution".

See section 3 on the use of the application for more information.

1.3 What are the scientifically validated fungal disease models used in Grape Compass?

The following disease models are integrated within the Grape Compass algorithms:

Botrytis

Broome, J. C., English, J. T. Marois, J. J., Latorre, B. A. and Aviles, J. C. (1995). Development of an Infection Model for Botrytis Bunch Rot of Grapes Based on Wetness Duration and Temperature. Phytopathology. Vol. 85. Pp. 97-102. (See article here).

Downy Mildew (both Primary and Secondary)

Haasbroek, P.D. (2006). Refinement and Improvement of a Downy Mildew Early Warning Disease Model for the Western Cape. M.Sc. Agric. Thesis in Agrometeorology. University of the Free State: Bloemfontein. (See thesis here).

Powdery Mildew

Thomas, C. S., Gubler, W. D. and Leavitt, G. (1994). Field Testing of a Powdery Mildew Disease Forecast Model on Grapes in California. Phytopathology 84: Pp. 1070 (abstr.). (See the model and clear explanation here).

See section 2.1 and section 2.2 for more information on what the basis of fungal disease prediction is.

1.4 What weather factors are taken into consideration by Grape Compass to predict the disease infection risks?

The weather parameters differ for each disease and the specific fungal disease model but include:

- Temperature

- Precipitation

- Relative humidity

- Leaf wetness duration

1.5 What is the source of Grape Compass's weather data and how is it representative of local weather conditions?

Grape Compass is one of many smart-IT applications hosted in the HydroNET portal, which works with advanced weather forecast information from the European Centre for Medium-Range Weather Forecasts (ECMWF). ECMWF is a highly technical and advanced network of systems that calculates weather forecasts for every parameter separately (e.g., precipitation, temperature, wind speed) in 50 scenarios, every 3 hours, for pixels that are 4000 m x 4000 m in size. For Grape Compass, a 3-hourly forecast up to 5 days in advance is used. Prior to the calculation of fungal disease risk situations, the 90th percentile of every parameter is selected to provide a so-called 'worst case scenario' for every 3 hours up to 5 days in advance. Next, Grape Compass uses these values to calculate disease model input (e.g., hourly leaf wetness duration, relative humidity, and hourly average temperature) and displays corresponding risk indices for the fungal diseases. The 90th percentile run accommodates a large range of uncertainty and is chosen deliberately to generate a forecast scenario that is more conservative than the mean values (control run) in order not to miss a disease event. Grape Compass is the first and only application that makes use of weather forecast ensembles from ECMWF as input for fungal disease models to predict risk levels in vineyards. A 99% overlap between Grape Compass predictions and the local conditions measured in the same location has been found (see section 1.6).

1.6 How reliable are the Grape Compass disease risk predictions?

The reliability of the Grape Compass disease risk forecasts has been confirmed during testing over four different growing seasons, both in South African and in Spain. Tests were done to determine both the consistency and reliability of risk forecasts:

Consistency of risk forecast

The five-day forecast of Grape Compass is updated every 24 hours. Therefore, the first test looked at the consistency of the forecast, i.e., whether the risk level for a certain day change as the day gets closer? For 97% of the predictions Grape Compass' risk levels remain stable (unchanged at the same risk level) or decrease (indicate lower risk) over time. In other words, only 3% of predictions for 5 days ahead were shown to move to a higher risk level as the day approaches – highlighting the "risk averse" nature of the algorithm. It is also important to highlight that in cases where the risk rating has gone higher after the initial 5-day prediction (i.e., a change between days 1 and 4), the farmer is still dealing with a prediction/forecast that allows time for a proactive response.

Reliability of risk forecast

The reliability has been tested by comparing the forecasted risk of Grape Compass with the calculated risk based on in field weather station readings of actual weather conditions. The Grape Compass predicted risk aligned with the weather station (actual) disease outbreak risk with a 99% accuracy.

Grape Compass is thus shown to be a consistent and reliable predictive tool that arms farmers with an accurate view of future weather conditions and disease pressure, enabling them to plan their operations proactively and with confidence.

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2 Fungal diseases, their management, prediction and Grape Compass's role

2.1 Why is spray program management so critical?

The use of fungicides reduces the chance of a fungal disease outbreak almost completely and is therefore the primary means to control fungal disease risk. The management of fungicide spray programs is critical in two ways: Firstly, missing sprays in periods of high disease pressure can result in significant loss of crop and even total crop failure, severely reducing farm income. Secondly, the application of fungicides comes at a high cost, both financially and environmentally, which means that spraying when there is no disease pressure can be a waste of resources, damage the environment unnecessarily and result in avoidable costs for the farmer. Avoiding situations of missed sprays when there is disease pressure AND unnecessary sprays when there is no disease pressure, protects the farm's income and saves costs, leading to greater profitability and greater financial security over the longer term.

2.2 What is the basis of fungal disease prediction?

Powdery mildew, downy mildew and botrytis bunch rot are considered the major fungal diseases that damage vineyards worldwide. Plant Pathologists have developed fungal disease models to predict possible disease pressure. Fungal disease models are mathematical equations that require weather data parameters as input to give risk estimations as output. A ground rule for all these models is that disease development occurs under the combined conditions of a virulent pathogen, a susceptible host, and a favourable environment (the 'disease triangle'). Most pathogens need water to grow and to penetrate green plant tissue to start infection. Temperature influences the rate of development. The growth stage of the plant also determines its susceptibility to fungal infections. Powdery mildew and downy mildew, on the one hand, are especially a threat at the beginning of the growing season when the leaves are still young, thin and light green. Botrytis bunch rot, on the other hand, is a danger at the time of flowering and closing of the bunches.

2.3 Why is weather station based data inadequate?

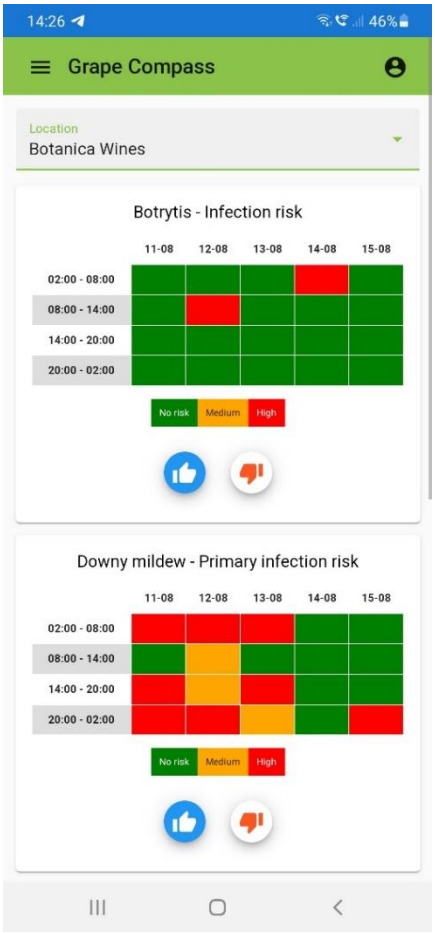
In-field weather stations provide the most accurate measurement of the local temperature and wetness. CURRENT fungal disease outbreak risk levels are, therefore, most accurately determined using in-field weather stations. Unfortunately, the insight weather stations provide is in most cases too late to be used as a guide for the planning of spray programs. Given the lack of lead-time to react to the data derived from the weather station farmers must make "best guesses" of disease pressure and face the double risk of either spraying when there is no disease pressure and/or not spraying when there is disease pressure. In short, while the weather station and other real-time data are the most accurate measure of in-field conditions, the fact that they measure present conditions only makes them of limited to no value as a predictive planning tool.

2.4 What are weather models and what is their potential value?

Weather models provide a forecast of expected weather conditions, such as temperature, rainfall, wind speed & direction and humidity. Basic weather forecasts are *deterministic*, which means that they provide only one value for future weather conditions. More sophisticated weather models are *stochastic*, which means that they provide not one but a range of forecasted values for future weather conditions. Deterministic weather models forecast the most likely weather conditions, whereas stochastic models provide an ensemble of scenarios, forecasting the range of possible weather conditions that can be expected. We all use weather forecasts such as Yr.no and Windguru to get an idea of what the weather up ahead holds and to plan our activities. Grape Compass is an advanced weather forecast that utilizes an ensemble of fifty weather forecasts to provide farmers with foresight to aid their planning. By specifically integrating fungal disease models Grape Compass equips farmers with the ability to plan with confidence to avoid unnecessary sprays and to not miss needed sprays.

3 Using the application

Figure 1 Screenshot of the application used on a smartphone.



3.1 What do the colours of the blocks mean in Grape Compass?

Botrytis and Downy Mildew (both Primary and Secondary)

Both in the cases of Downy Mildew and Botrytis the colour green indicates zero risk, yellow signals moderate risk and red shows a high risk of fungal disease infection.

Powdery Mildew

The scientific disease model for Powdery Mildew differentiates between low, moderate and high-risk situations once the initial infection occurs. Therefore, the colour green in the Powdery Mildew table signals low, rather than no risk. See the table below in Question 3.2 (Table 1) for more information.

3.2 How should the risk levels be interpreted/ what actions to take?

Botrytis

Green pixels in the table indicate no risk of infection and a treatment can be postponed for that period. In the case of a yellow or red pixel, a fungicide treatment might be applicable depending on the growth cycle and natural airflow in the canopy that can limit its effects.

Downy Mildew (Primary)

Green pixels in the table indicate no risk of infection and a treatment can be postponed for that period. In the case of a yellow or red pixel, a fungicide treatment might be applicable depending on the growth cycle and natural airflow in the canopy that can limit its effects.

Downy Mildew (Secondary)

The pixels in this table show the Downy Mildew Secondary infection risk after the initial infection has taken place in the vineyards. Therefore, this table only applies to situations in which the Primary infection could not be prevented. Fungicide treatments with a curative function can be applied to limit impact.

Powdery Mildew

For Powdery Mildew, the application assumes that the initial infection has taken place and therefore risk levels will vary between low to high and will never be zero throughout the growth cycle. The risk levels for Powdery Mildew in Grape Compass correspond to the UC Davis table below (Table 1) with a corresponding suggested spray schedule.

Table 1- Spray intervals by Fungicide groups based on disease pressure using the UC Davis Powdery Mildew Risk Index Model

			Suggested spray schedule			
Index	**Disease pressure**	**Pathogen status**	**Biologicals[1] and SARs[2]**	**Sulfur**	**Demethylation-inhibitors (DMI)[3]**	**Strobilurins and Quinolines[4]**
0-30	Low	Present	7 - to 14-day interval	14- to 21-day interval or label interval	21- day interval or label interval	21- day interval or label interval
40-50	Moderate	Reproduces every 15 days	7 -day interval	10- to 17-day interval	21- day interval	21- day interval
60 or above	High	Reproduces every 5 days	Use not recommended	7-day interval	10-to-14-day interval	14-day interval

[1] *Bacillus pumilis* (Sonata) and *Bacillus subtilis* (Serenade Max)

[2] SAR = Systemic acquired resistance products

[3] Tebuconazole (Elite), triflumizole (Viticure), and myclobutanil (Rally)

[4] Trifloxystrobin (Flint), kresoxim-methyl (Sovran), and pyraclostrobin/boscalid (Pristine)

3.3 What should you do if there are red and green blocks in one day?

Users are advised to base decisions on the highest risk level for each day but to also use the information in conjunction with their own knowledge and experience of each block to be able to make the best-informed decisions.

3.4 Can Grape Compass be used for table grapes?

The fungal disease models used in Grape Compass (see Section 1.3) are applicable to table and wine grape cultivars. However, the research phase of Grape Compass only included practical trials on wine farms. We are currently working together with table grape producers to gain practical experience in the use of Grape Compass on table grapes.

3.5 How best should Grape Compass be adopted?

- The application serves as a predictive decision support tool. Therefore it can be used as an extra layer of information about future conditions to make sure your crop is optimally protected. Integrate Grape Compass within your overall spray management processes along with weather station data, your knowledge of each block, spray recommendations from advisors etc.
- Fungal disease risk identification on scales between no risk, low, moderate, and high risk can help vineyard managers, together with their block-specific knowledge and the phenological stages of the vineyards, to decide when to spray as well as to make the best selections between contact and systemic fungicides and dosage rates.
- Vineyard managers can optimize the fungicide cocktail to prevent powdery mildew, downy mildew and botrytis infection with the help of disease forecast information that considers all disease types.
- For wineries that grow and source grapes from vineyards that lie far apart and face different climatic conditions, location-specific disease pressure forecasting will help with logistical planning, to identify disease pressure differences per region and to prioritize which vineyards to spray.
- For individual farms and wineries, Grape Compass provides insights about future disease pressure and optimal timing for fungicide sprays. Daily use of the application to investigate the necessity to spray or not, will directly impact the spray frequency over the entire growing season, the costs involved and the overall effectiveness of the spray program. Operations with a higher level of flexibility (worker and machinery availability), lower process dependency and shorter reaction lead-times will benefit the most.

4 Basics to know if you are interested in getting started

4.1 What does Grape Compass cost?

Grape Compass is available at a once-off price per season and the price depends on the size of the vineyards (see Table 2 below). The pricing has been calculated to represent a small cost in relation to the total cost of disease management for farms (including agrochemicals, machinery and labour)– avoiding only 1 unnecessary spray will more than offset the annual cost of Grape Compass. The cost is also insignificant in relation to the value of the crop saved in instances where Grape Compass predicts disease pressure that otherwise would have been missed.

In short, Grape Compass provides unprecedented predictive power that can directly save a farm cost and/or protect income, and in so doing, assist in securing financially viable grape production.

Table 2 - Pricing of Grape Compass

Size range of vineyards (ha)	**Price per season (excl. VAT)**
< 36	R4 499
36 – 70	R 8 499
71- 250	R 22 499
> 251	R56 499

4.2 Is there any training and/or support available?

Yes, we can provide online or in-person training and/or support to show you how to use the application.

4.3 Who are the people behind Grape Compass?

Grape Compass was initially developed by Master of Wine Job de Swart (WineJob) who is a self-employed wine marketing consultant and HydroLogic, a Dutch company building award-winning water management applications worldwide. In 2020 the Grape Compass consortium was expanded to include meteorological expertise from the company Weather Impact. In 2021 Grape Compass also teamed with Stellenbosch-based company Blue North Sustainability, which started implementing Grape Compass in South Africa in the spring of 2021.

4.4 Who can I contact to arrange a demo and/or to find out more?

If you would like to know more or have any questions, please contact us at dianca@bluenorth.co.za or 066 212 2211. You can also visit the Grape Compass website at: www.grapecompass.com.