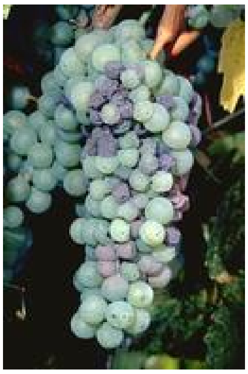
Research and IPM

Models: Diseases

| More disease models | More models | Grape botrytis bunch rot PMG |



Crop: Grape

Disease: Botrytis Bunch Rot

Pathogen: *Botrytis cinerea*

Note: Before using a model that was not field tested or validated for a specific location, a model should be tested for one or more seasons under local conditions to verify that it will work in the desired location. See Model Validation below.

Model 1 of 2

Model developer and citation

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 85: 97-102.

Sensor location

Within canopy.

Input variables

Environmental: Hourly average temperature (in Celsius), leaf wetness duration (hours)
Host: Host maturity affects infection by this pathogen. In grapes, the flowers and post-veraison berries are the most susceptible host stages, unripe berries and young shoots are less susceptible. This information is not included as an input into the model but should be taken into account when using this environmentally driven infection model.
Calculated variables: Average temperature during leaf wetness events.

Model description

This model identifies *Botrytis cinerea* infection periods on grape berries based on leaf wetness duration and the average temperature during the wetness events. The model was developed using mature detached grape berries in controlled humidity chambers that were subjected to 4, 8, 12, 16, or 20 hours of wetness at temperatures between 12 and 30 C. A multiple regression model best described (R^2=0.75) the logit of berry infection as a function of the interaction of wetness duration and temperature:

$$\text{Infection Index} = \ln (Y/1-Y) = -2.647866 - 0.374927W + 0.061601WT - 0.001511WT^2$$

Where: W = leaf wetness duration in hours; T = temperature in Celsius; and ln (Y/1-Y) = the logit of disease incidence where Y = the proportion of infected berries.

Additional model assumptions/implementation considerations:

1. Split wetness periods: If the wetness sensor registers more than 4 hours dry then the model restarts wetness accumulation at next wetness event, otherwise, it combines wetness periods and notes that a split period has occurred.
2. If T < 12 C then run the model as if T = 12 C (minimum temperature tested in experiments)
3. If T > 32 < 40 then run model as if T = 32 C (maximum temperature tested in experiments)
4. If T > 40 C then time interval is not conducive to infection

5. If RH is greater than or equal to 95% then assume a wetness period is occurring due to limitations of wetness sensors.
6. If more than 16 hours of wetness occur, regardless of temperature, then consider wetness event severe.

The disease index is calculated whenever leaf wetness is detected.

Action threshold

The model predicts the following infection risks when the logit value is:

Infection Index Values	Risk Levels
Infection Index < = 0	no risk of infection
0 < Infection Index < 0.50	low risk of infection
0.50 < = Infection Index < 1.00	moderate risk of infection
1.00 > Infection Index	high risk of infection

Fungicide applications should be based on how much risk one wants to accept. Typically, if the disease index value is 0.5 or greater implementors of the model have decided to apply a fungicide. This action threshold can be adjusted up or down depending on the known history of Botrytis bunch rot in a vineyard, the grape variety, and the degree of host susceptibility due to degree of fruit maturity. If more than 16 hours of wetness occur during a wetness event, regardless of the temperature, then consider the event a severe infection event.

For Botrytis bunch rot all tissue is susceptible, shoots, leaves, flowers, and berries but the degree of susceptibility varies with mature berries and grape flowers being the most susceptible, and unripe berries and shoots being much less susceptible.

Model validation

Broome, J. C., English, J. T. Marois, J. J., Latorre, B. A. and Aviles, J. C. 1995. Development of an InfectionModel for Botrytis Bunch Rot of Grapes Based on Wetness Duration and Temperature. *Phytopathology* 85: 97-102.

The model was programmed into an automated weather station (Envirocaster) and validated for two years on Chilean table grapes. Fungicide applications based on the model allowed growers to reduce their use of fungicides by approximately 50% with equivalent disease control.

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Model 2 of 2

Model developer and citation

Nair, N. G. and Allen, R. N. 1993. Infection of Grape Flowers and Berries by *Botrytis Cinerea* as a Function of Time and Temperature. Mycological Research 97(8): 1012-1014.

Sensor location

Not described.

Input variables

Environmental: Temperature (in Celsius) and leaf wetness duration (in hours).
Host: Grape flowers and mature berries.

Model description

A statistical model was developed to describe both flower and berry infection as a function of wetness duration and incubation temperature. The model was developed by placing grape flowers in incubation chambers and exposing them to temperatures of 5, 10, 15, 20, 25, and 30 degrees Celsius and 1, 2, 4, 6, 8, 10, 12, 18, and 24 hours of wetness. Grape bunches were incubated at the same temperatures as above, and subjected to up to 24 hours of wetness at 3 hour intervals.

The statistical model described the data well for both flowers and berries. For flowers, the optimal temperature for infection was 23.7 degrees Celsius, at which point flowers became infected after only 1.3 hours of exposure to wetness. For berries, the optimal temperature for infection was 20.8 degrees Celsius, at which point berries became infected after 13.9 hours of exposure to wetness.

Nonlinear least squares minimization was used to estimate the means of the model constants in the following equation:

$$I = I_{max}[1 - \exp(-(Qt/K_{time})^2)]$$

Where: $Q = \exp[-((T-T_{opt})/K_{temp})^2]$

- I_{max} = maximum percentage infection
- K_{time} = time for infection to reach 63% of I_{max} at T_{opt} when exposed to wetness
- T_{opt} = optimal temperature for infection

- K_{temp} = range of temperatures over which infection occurred
- T = temperature
- t = time

For flowers:

- I_{max} =95.6+/-1.4%
- K_{time} =1.3+/-0.1h
- >T_{opt} =23.7+/-0.5
- K_{temp} =+/-10.5+/-0.3

For berries:

- I_{max} = 100%
- K_{time} = 13.9 +/-0.6h
- T_{opt} = 20.8 +/-0.2
- K_{temp} = +/-8.9 +/-0.4

For both flowers and berries, infection developed over a wide range of temperatures. The results indicate flowers require fewer hours of wetness to become infected than grape berries.

Action threshold

Not yet determined.

Model validation

None was presented in this article.

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