Role of treatments during flowering in the management of Botrytis bunch rot in vineyards

Elisa González-Domínguez and Vittorio Rossi

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Botrytis bunch rot

One of the most important and challenging problems of vine grapes
Botrytis bunch rot

The pathogen produces a **large number** of **conidia** on **multiple inoculum sources**

Grapevines are **susceptible at multiple growth stages**

**Spring**
- Penetration
- Invasion
- Sporulation

**Winter**
- Conidiophore
- Conidia
- Asciopore
- Spores
- Apothecia
- Sclerotia

**Autumn**
- Mummified berries
- Sclerotia formation
- Mycelium infection

**Summer**
- Flower infection
- Florid debris infestation
- Berry latent infection
- Infection in ripening berries
Nine different infection pathways exist:

I: Conidial infection of the **style** and **ovules**

IIa: Conidial infection of the **stamens** and/or **petals**

IIb: Fruit infection via the fruit **pedicel**

I: Conidial infection of the **style** and **ovules**

IIa: Conidial infection of the **stamens** and/or **petals**

IIb: Fruit infection via the fruit **pedicel**

III: Conidial infection and extensive colonization of **floral debris** in **Veraison**

IV: Conidial accumulation within the developing **bunch**

Va: Conidial infection of **ripening fruit**

Vb: Mycelial infection of **ripening fruit**

VI: Conidial accumulation on fruit and dispersal to **picking wounds**

*Modified from Elmer and Michailides, 2007*
Botrytis bunch rot rot
Control

Routine application of fungicides

A  End of flowering
B  Pre-bunch closure
C  Veraison
D  Before harvest
Environmental Conditions Affect *Botrytis cinerea* Infection of Mature Grape Berries More Than the Strain or Transposon Genotype

Nicola Ciliberti, Marc Fermaud, Jean Roudet, and Vittorio Rossi

First and fourth authors: Istituto di Entomologia e Patologia Vegetale, Università Cattolica del Sacro Cuore, Via E. Parmense 84, Piacenza, I-29122, Italy; second and third authors: INRA, UMR 1065 SAVIE “Santé et Agroécologie du Vignoble”, ISVV, Université de Bordeaux, CS 26032, 33882 Villenave d’Ornon Cedex, France. Accepted for publication 2 March 2015.

**ABSTRACT**

Ciliberti, N., Fermaud, M., Roudet, J., and Rossi, V. 2015. Environmental conditions affect *Botrytis cinerea* infection of mature grape berries more than the strain or transposon genotype. Physiological 105:1090-1096.

In favorable conditions (100% RH or 36 h of WDI) and unfavorable conditions (40% RH or 3 h of WDI), berry wounding did not significantly affect disease incidence; under moderately favorable conditions (80% RH or 6 to 12 h of WDI), disease incidence was approximately 1.5 to 5 times higher in wounded berries compared to uninjured berries.

Influence of Fungal Strain, Temperature, and Wetness Duration on Infection of Grapevine Inflorescences and Young Berry Clusters by *Botrytis cinerea*

Nicola Ciliberti, Marc Fermaud, Luca Languasco, and Vittorio Rossi

First, third, and fourth authors: Istituto di Entomologia e Patologia Vegetale, Università Cattolica del Sacro Cuore, Via E. Parmense 84, Piacenza, I-29122, Italy; second author: INRA, UMR 1065 SAVIE “Santé et Agroécologie du Vignoble”, ISVV, 71 Ave. E. Bourseau, CS 20032, 33882 Villenave d’Ornon Cedex, France. Accepted for publication 25 September 2014.

**ABSTRACT**


Influence of fungal strain, temperature, and wetness duration on infection of grapevine inflorescences and young berry clusters by *Botrytis cinerea* was a strain rather than a transposon genotype attribute. Across all strains, infection incidence was lower when inflorescences were clearly visible or fully developed, highest at blossoming (from beginning to end of flowering), and intermediate at the postblossoming fruit stages (fruit swelling and

Ciliberti N, Fermaud M, Roudet J, Languasco L, Rossi V. Environmental effects on the production of *Botrytis cinerea* conidia on different media, grape bunch trash, and mature berries. Australian Journal of Grape and Wine Research. Accepted
The model considers 2 infection periods and 3 pathways:

- **Infection by conidia on inflorescences and young berries (SEV1)**
- **Infection by conidia on mature berries (SEV2)**
- **Berry-to-berry infection (SEV3)**
Weather data

Sporulation

Infection risk

Botrytis bunch rot
Model output

- Heat map showing temperature and relative humidity trends over time.
- Graph indicating sporulation levels.
- Graph showing infection severity (SEV1 and SEV2+3) with dates and severity levels.
Botrytis bunch rot
Model validation

21 epidemics in Italy and France

Evaluate the ability of the model to predict if the epidemic will be:

- mild
- intermediate
- severe

Table 2. Summary characteristics (location, year, cultivar, and training system) of the vineyards used for validation of the Botrytis cinerea model. Also indicated are the observed incidence and severity of Botrytis bunch at maturity and the classification of the epidemics.

<table>
<thead>
<tr>
<th>Code of epidemics</th>
<th>Vineyard locality (country)</th>
<th>Year</th>
<th>Cultivar</th>
<th>Training system</th>
<th>Observed incidence (%) (^a)</th>
<th>Observed severity (%) (^a)</th>
<th>Observed epidemic group(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAG-09</td>
<td>Bagnacavallo (IT)</td>
<td>2009</td>
<td>Trebbiano Romagnolo</td>
<td>Casarsa</td>
<td>64.5</td>
<td>3.3</td>
<td>Intermediate</td>
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<tr>
<td>BAG-11</td>
<td>Bagnacavallo (IT)</td>
<td>2011</td>
<td>Trebbiano Romagnolo</td>
<td>Casarsa</td>
<td>35.0</td>
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<td>BAG-12</td>
<td>Bagnacavallo (IT)</td>
<td>2012</td>
<td>Trebbiano Romagnolo</td>
<td>Casarsa</td>
<td>78.0</td>
<td>3.3</td>
<td>Severe</td>
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<td>CA-13</td>
<td>Caramona (IT)</td>
<td>2013</td>
<td>Trebbiano Romagnolo</td>
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<tr>
<td>CO-09</td>
<td>Conselice (IT)</td>
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<td>Trebbiano Romagnolo</td>
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<td>Mammolive (IT)</td>
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<td>CD-12</td>
<td>Mammolive (IT)</td>
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<td>Trebbiano Romagnolo</td>
<td>Guyot</td>
<td>94.5</td>
<td>48.0</td>
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<td>Mammolive (IT)</td>
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<td>15.1</td>
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<tr>
<td>SM-12</td>
<td>S. Michelle (IT)</td>
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<td>Pinot Gris</td>
<td>Guyot</td>
<td>2.2</td>
<td>0.2</td>
<td>Mild</td>
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<tr>
<td>SM-13</td>
<td>S. Michelle (IT)</td>
<td>2013</td>
<td>Pinot Gris</td>
<td>Guyot</td>
<td>0.0</td>
<td>0.0</td>
<td>Mild</td>
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<tr>
<td>V-14</td>
<td>Villanova d’Orton (FR)</td>
<td>2014</td>
<td>Merlot</td>
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<td>36.7</td>
<td>1.6</td>
<td>Intermediate</td>
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<td>VI-14</td>
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<td>Trebbiano Romagnolo</td>
<td>Casarsa</td>
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<td>Severe</td>
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<td>Barbera</td>
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<td>Intermediate</td>
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<td>Z-12</td>
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<td>Barbera</td>
<td>Guyot</td>
<td>0.0</td>
<td>0.0</td>
<td>Mild</td>
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</tbody>
</table>

\(^a\) Disease incidence assessed as the percentage of bunches with Botrytis rot at maturity.

\(^b\) Disease severity assessed as the percentage of the bunch surface affected by Botrytis rot at maturity.

\(^b\) Epidemic group: severe (incidence ≥ 75%; severity ≥ 15%), intermediate (4 ≤ incidence ≤ 25%; severity < 15%), mild (incidence < 24%; severity < 5%).
Botrytis bunch rot
Model validation

Discriminant Function Analysis (DFA) correctly classified 81% of epidemics

<table>
<thead>
<tr>
<th>Function</th>
<th>Eigenvalue</th>
<th>% of Variance</th>
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<tbody>
<tr>
<td>$F_1$</td>
<td>0.971</td>
<td>82.2</td>
</tr>
<tr>
<td>$F_2$</td>
<td>0.202</td>
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<tr>
<th>Discriminant variables</th>
<th>Standardized canonical coefficient</th>
<th>Correlation coefficient</th>
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<tr>
<td></td>
<td>$F_1$</td>
<td>$F_2$</td>
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<tr>
<td>SEV1</td>
<td>0.991</td>
<td>0.141</td>
</tr>
<tr>
<td>SEV2 + SEV3</td>
<td>-0.101</td>
<td>0.996</td>
</tr>
</tbody>
</table>
DFA was used to calculate daily the severity of an epidemic at harvest.
Discriminant Function Analysis (DFA) correctly classified 81% of epidemics

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<td>0.996</td>
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*SEV1* had the most influence in separate groups.

Infections during inflorescence and young berries strongly influence the severity at harvest time.
Infections during **inflorescence and young berries** strongly influence the severity of the epidemic.

Routine application of fungicide

- **A**: End of flowering
- **B**: Pre-bunch closure
- **C**: Veraison
- **D**: Before harvest
What is the contribution of each single treatment?

1. Assessment of previous published studies on control strategies
2. Field experiment: application of single treatments
Previous studies on control strategies

13 experiments

- **2 countries** (Italy and Spain)
- **6 fungicides** (Ronilan, Sumisclex, Vinclosolin, Procymidone, Diclozolinato, Ioprodione)
- **7 varieties** (Barbera, Grignolino, Riesling, Trebbiano, Tocai Friulano, Verdichio, Macabeo)

![Graph showing % severity in control]
## Previous studies on control strategies

### 13 experiments

- **2 countries** (Italy and Spain)
- **6 fungicides** (Ronilan, Sumisclex, Vinclosolin, Procymidone, Diclozolinato, Ioprodione)
- **7 varieties** (Barbera, Grignolino, Riesling, Trebbiano, Tocai Friulano, Verdichio, Macabeo)

### Table: Efficacy Calculation

<table>
<thead>
<tr>
<th>Test</th>
<th>Prodotto</th>
<th>Dosi Kg/hz p.c.</th>
<th>Epoche di Intervento</th>
<th>1ª Prova</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Test</td>
<td>-</td>
<td>79,8 a</td>
<td>-</td>
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<tr>
<td>2</td>
<td>Nonilan</td>
<td>1,5</td>
<td>41 d</td>
<td>41,1</td>
</tr>
<tr>
<td>3</td>
<td>Nonilan</td>
<td>1,5</td>
<td>41,2 cd</td>
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<td>65,4</td>
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<td>6</td>
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<td>3,2 d</td>
<td>3,2</td>
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<td>7</td>
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<td>11</td>
<td>Prodotti</td>
<td>1,5</td>
<td>33,5 bc</td>
<td>33,5</td>
</tr>
</tbody>
</table>

### Contribution of A

\[
\text{Contribution of A} = \frac{\text{Efficacy ABCD - Efficacy BCD}}{\text{EfficacyABCD}} \times 100
\]

- **Efficacy ABCD** = Severity ABCD
- **Severity Control**
Previous studies on control strategies

A: Flowering (61-65 BBCH)
B: Pre-bunch closure (76 BBCH)
C: Veraison (BBCH 82)
D: Before harvest (BBCH 82-89)

\[ R^2 = 0.6242 \quad P < 0.001 \]

\[ R^2 = 0.2197 \quad P = 0.05 \]

\[ R^2 = 0.006 \quad P = 0.77 \]

\[ R^2 = 0.2563 \quad P = 0.093 \]
Five strategy of treatments (test)

A: flowering (BBCH 65)
B: Pre-bunch closure (BBCH 76)
C: Veraison (BBCH 82)
D: 21 days before harvest
Control: no treatment

Protocol:
- 3 localities
- 4 blocks/test; 10 plants/block
- Switch (37.5% cyprodinil + 25% fludioxonil)
- Weather data recovered

Model output

Grey mould in field
Field study: results

Cormons

Ravena

Castell' Arquatto
No grey mould incidence in field → Shelf-life assay

- 50 berries/test and block
- Surface disinfected
- 11 days in humidity chamber (25°C/ 100%RH)

Results:
- Only in Castell’ Arquatto there were not significant differences between each of the treatment and the control (not treatment).
- There was a significant linear relation between SEV1 predicted by the model and the severity observed in shelf-life assay.

Severity = \sum \% affected surface/50
1. Assessment of previous published studies on control strategies:

   A more complete study with other two research groups from France and Spain

1. Field experiment:

   Repeat the experiments next season (expecting more conductive conditions for grey mould development)
Thank you for your attention