Botrytis Management in Cut Roses

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CLEMSON UNIVERSITY

American Floral Endowment
Funding Generations of Progress Through Research and Scholarships
Ph.D. Horticulture

- Floriculture Physiology
- Effects of environmental and cultural factors on the production of ornamental greenhouse crops
- *Botrytis* found on pansy flowers at a Florida nursery that was resistant to all of the main fungicides used to control *Botrytis*

Ph.D. Plant pathology

- Integrated management of diseases
- *Botrytis* control in strawberries and blackberries
- Fungicide resistance mechanisms
- Decision-support models and smart-phone apps to reduce and better time pesticide applications
The problem

• *Botrytis cinerea*:
  ✓ Ubiquitous
  ✓ 200 species plant hosts
  ✓ Necrotrophic

• **Roses**:
  ✓ Reduction in the postharvest quality, leading to substantial economic loss by growers and wholesalers
The problem

- Leaf wetness
- 93% Relative humidity
- 15-25°C Optimum. 0°C to 35.5°C
Disease triangle

Susceptible host

Conducive environment

Virulent pathogen
To evaluate weather conditions in commercial greenhouses and their relationship with *Botrytis* occurrence
• **SAS - Strawberry Advisory System:** is a web site, and smarth-phone app that provides an easy way for strawberry growers in Florida to track and forecast risk levels for Botrytis and anthracnose fruit rot diseases. It also provides fungicide application recommendations and allows growers to receive alerts for selected weather stations via push notifications.
Installation of weather stations

- Solar radiation (W/m²)
- Leaf wetness (min)
- Air temperature (°C)
- Relative humidity (%)
- Dew point (°C)
- Leaf temperature (°C)
- Soil temperature (°C)
- Electrical conductivity (mS/cm)
- Water content of soil media (%)
- Wind speed (m/s)
- Wind direction
Typical daily weather pattern

- Solar radiation (W/m²)
- Air temperature (°C)
- Relative humidity (%)
- Leaf wetness (min/h)
BOTRYTIS RISK MODEL DEVELOPMENT
<table>
<thead>
<tr>
<th>Month</th>
<th>Date</th>
<th>Leaf wetness (h)</th>
<th>Temperature (°C)</th>
<th>Infection risk (%)</th>
<th>Risk</th>
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<tbody>
<tr>
<td>Feb</td>
<td>2/20/17</td>
<td>7.5</td>
<td>11.4</td>
<td>6.3</td>
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<tr>
<td>Feb</td>
<td>2/21/17</td>
<td>0.0</td>
<td>16.9</td>
<td>1.4</td>
<td>No</td>
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<tr>
<td>March</td>
<td>3/17/17</td>
<td>12.5</td>
<td>11.6</td>
<td>16.9</td>
<td>No</td>
</tr>
<tr>
<td>April</td>
<td>4/15/17</td>
<td>12.5</td>
<td>11.3</td>
<td>15.9</td>
<td>No</td>
</tr>
<tr>
<td>April</td>
<td>4/17/17</td>
<td>24.0</td>
<td>14.3</td>
<td>88.1</td>
<td>High</td>
</tr>
<tr>
<td>May</td>
<td>5/29/17</td>
<td>11.5</td>
<td>11.6</td>
<td>14.2</td>
<td>No</td>
</tr>
<tr>
<td>May</td>
<td>5/30/17</td>
<td>10.6</td>
<td>11.9</td>
<td>12.5</td>
<td>No</td>
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<tr>
<td>Jun</td>
<td>6/9/17</td>
<td>19</td>
<td>14.3</td>
<td>67.7</td>
<td>Mid</td>
</tr>
<tr>
<td>Jun</td>
<td>6/14/17</td>
<td>15.3</td>
<td>13.2</td>
<td>36.9</td>
<td>Low</td>
</tr>
<tr>
<td>Jun</td>
<td>6/15/17</td>
<td>8.0</td>
<td>12.8</td>
<td>8.5</td>
<td>No</td>
</tr>
<tr>
<td>Jun</td>
<td>6/16/17</td>
<td>24.0</td>
<td>15.4</td>
<td>91.5</td>
<td>High</td>
</tr>
<tr>
<td>Jun</td>
<td>6/29/17</td>
<td>13.5</td>
<td>11.1</td>
<td>17.9</td>
<td>No</td>
</tr>
<tr>
<td>Jun</td>
<td>6/30/17</td>
<td>17.8</td>
<td>13.2</td>
<td>51.8</td>
<td>Mid</td>
</tr>
<tr>
<td>July</td>
<td>7/1/17</td>
<td>20.1</td>
<td>15.0</td>
<td>76.6</td>
<td>High</td>
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<tr>
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<td>11.7</td>
<td>24.5</td>
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<tr>
<td>July</td>
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<td>11.9</td>
<td>29</td>
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<td>August</td>
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<tr>
<td>Sept</td>
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<td>11.7</td>
<td>25.6</td>
<td>No</td>
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<tr>
<td>Sept</td>
<td>9/03/17</td>
<td>24</td>
<td>12.2</td>
<td>76</td>
<td>High</td>
</tr>
</tbody>
</table>
Predicted vs. real Botrytis incidence values

Week

Incidence (%)
• The disease risk model has value and can become as part of an integrate management program of *Botrytis*

• Weather stations are a tool that may improve timing for fungicide applications
To evaluate *Botrytis* spores density in commercial greenhouses and their relation to cultural practices.
Installation of spore traps
Counting spores process

100 x

400 x
Spores density
Spores density
Spores density
Cultural practices

- Harvesting
- Pinching
- Sweeping floors*
- Blowing (debris removal)*
- Manual debris removal
- Downy mildew removal
- Botrytis removal
- Dead stems pruning
- Dead stems removal
- Weeding
- Drenching
- Fungicide spray application
- Pesticide spray application
- Thermo-fogging
- Supplementary watering of beds
- PGRs application
- Cutting zone cleaning
- Plastic change
- Fertilizer containers change
The number and type of cultural practices have an effect on Botrytis spore density.
To determine *Botrytis* severity in different rose tissues from commercial shipments
Assessing Botrytis Occurrence & Severity on Commercial Rose Shipments

• **South American Study:**
  - One Farm
  - 2 Greenhouses
  - One Susceptible Variety: Orange Crush
  - Six Shipments

• **Geographical Study:**
  - Four Locations: Ecuador, Africa, Colombia; Guatemala or Mexico
  - Four Shipments
Sample Collection and Processing
Botrytis occurrence in different plant tissue: South America Study

Petals are the most susceptible tissue
Botrytis occurrence in different plant tissue: South America Study

A significant portion of the infection occurs in tissues that are not exposed (Mid and inner petals, stamens and ovary)
To assess fungicide resistance profiles in *Botrytis* isolates from commercial cut roses
Context

• **Resistencia**: refers to an acquired, heritable reduction in sensitivity of a fungus to a specific anti-fungal agent (or fungicide).

• **FRAC (Fungicide resistance action committee)**: Group together the fungicides that are in risk of cross resistance development, because have a similar mode of action
Fungicide Resistance Profiles

South America Study
49 Single spore isolates

Geographical Study
58 Single spore isolates

FUNGICIDE RESISTANCE PROFILES: 11 FUNGICIDES THAT BELONG TO 7 CHEMICAL CLASSES (FRAC)

- Control
- FRAC 9: Cyprodinil
- FRAC 12: Fludioxonil
- FRAC 17: Fenhexamid
- FRAC 2: Iprodione
- FRAC 1: Thiophanate-methyl
- FRAC 19: Polyoxin D
- FRAC 7: Boscalid
- FRAC 7: Fluopyram
- FRAC 7: Pentiopyrad
- FRAC 7: Isofetamid
- FRAC 7: Pidiflumetophen
Fungicide Resistant Isolates: 6 Shipments
(South America Study)
Fungicide Resistant Isolates
(South America Study)

Resistant Isolates (%)
0 10 20 30 40 50 60 70 80 90 100

Fungicides applied in the last year
- Fluxapyroxad: FRAC 7
- Pyrimethanil: FRAC 9
- Farnoxadone: FRAC 11
- Azoxyxstrobil: FRAC 11
- Propamocarb: FRAC 28
- Fluopicolide: FRAC 43
- Cymoxanil: FRAC 27
- Tebuconazole: FRAC 3
- Fluazinam: FRAC 29
- Prochloraz: Multisite
- Captan: Multisite
- Iminoctadine: Multisite
- Zinc diethylthiocarbamate: Protectant
Fungicide Resistant Isolates (Geographical Study)

Ecuador n=23

Guatemala n=4

Africa n=26

Colombia n=4

Mexico n=2

Aislamientos resistentes
Aislamientos sensibles
Resistance:

• In some chemical classes, the resistance effect is conserved even when the fungicides are not used in the present but they were used before e.g. FRAC 1
• Resistance to some fungicides can be decreased or disappear if the resistance has an effect on the fitness of the pathogen and no applications of the fungicide are done in a while e.g. FRAC 7- Boscalid on strawberries
Botrytis symptoms
Abiotic symptoms
Pink spots on petals are not *Botrytis* symptoms
**Biotic Symptoms**

- **Alternaria sp.**
- **Aspergillus sp.**
- **Diplodia sp.**
ASSESS THE INITIAL SYMPTOMS FOR BOTRYTIS

Spore suspension

Water

Incubate (high RH)

4 h

8 h

12 h
Symptom Development

Incubation duration:
- 4h
- 8h
- 12h

Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Day 7

Incubate (high RH)

Day 9
Latent Infections

After 4 h of incubation (spores present on wet petals), roses display no symptoms. However, latent infection has occurred and sporulation will occur if the flowers are exposed to the proper conditions (high humidity).

After >8 h of incubation, Botrytis symptoms appear on petals (beige/tan/discolored spots).
Comprehensive approach
Ca and Si content in rose tissue

Calcium content in different rose tissue

Si content in different rose tissue
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Questions?

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