Precision Thinning using the Pollen Tube Growth Model

Greg Peck, Ph.D.

Collaborators:
Virginia Tech: Keith Yoder, Leon Combs, and Candace DeLong
Cornell: Peter Herzeelle, Dan Olmstead, Art DeGaetano, Mike Basedow, Dan Donahue, Poliana Francescatto, Craig Kahlke, Mario Miranda Sazo
Apple flower anatomy
How was the model developed?

- Dwarfed root-bagged trees are forced to bloom in a greenhouse
- Trees are held dormant in cold room to accumulate chill units
- Pollen from selected pollinizers (Snowdrift) is harvested and stored
- Flowers are emasculated at full balloon stage, hand-pollinated, and tree is placed in growth chamber under predetermined climatic conditions
How does the model work?
Measuring Style Length

ANTHERS AND PETALS REMOVED FOR EASIER MEASURING OF STYLES

MEASURE STYLES AS SHOWN FOR FLOWER STYLES MEASURED WITHOUT REMOVING FROM TREE
Starting the model “clock”

- Sufficient king bloom open to provide desired crop load
  - Count the number of flowers per branch cross-sectional area
  - Can be estimated based on experience
- The model starts when the last flower that you need to achieve the desired crop load has been pollinated
- First thinning spray is applied when the pollen tube growth has been modeled to grow beyond the longest style
  - In other words, the flower has been fertilized
- Additional thinning sprays prevent additional fertilization
- Other considerations
  - Warm temperatures (>10°C) for bee flight
  - Within tree and within orchard variability
Fuji Pollen Tube Growth Model

R² = 0.9966

Pollen Tube Growth (mm/hr)

Temperature (ºF)
Where is the PTGM being used?

• Models have been developed for:
  • Golden Delicious
  • Gala
  • Fuji
  • Cripps Pink (Pink Lady)
  • Honeycrisp
  • Granny Smith
  • Red Delicious

• 2012-2014, worked with over 200 beta-test sites in Washington State

• 2014 model available through WSU’s AgWeatherNet website

• 2011-2015 bloom thinning tests in Virginia; 2017 in New York

• 2018 beta testing through NEWA
Model limitations

- Assumes optimal bee activity and pollen availability/viability
- No models for secondary or niche varieties
- Mode of action for many bloom thinners is still open for debate
- Developing bloom thinning programs for Eastern US and organic apple growers
- Understanding the paternal (pollen) effects on pollen tube growth rates
# Flower thinning materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid lime sulfur (LLS)</td>
<td>Most commonly used product in WA; organic approval; 2-5% (lower rates with oil is recommended for NY)</td>
</tr>
<tr>
<td>Ammonium thiosulfate (ATS)</td>
<td>Commonly used in NY</td>
</tr>
<tr>
<td>Regalia (knotweed extract)</td>
<td>Organic approval; cedar apple rust control; fire blight control</td>
</tr>
<tr>
<td>6-Benyladenine, 6-BA (MaxCel)</td>
<td>Minimal thinning</td>
</tr>
<tr>
<td>1-naphthaleneacetic acid, NAA (Pomaxa, Fruitone-N, Fruitone-L)</td>
<td>Minimal thinning</td>
</tr>
<tr>
<td>Naphthaleneacetamide, NAD (Amid-Thin)</td>
<td>Positive results found in VA, but not in PA</td>
</tr>
<tr>
<td>Potassium carbonate and sodium chloride</td>
<td>Inconsistent results</td>
</tr>
</tbody>
</table>
Online version is ready for open access in 2019!!!

http://ptgm.newa.cornell.edu/

- Temporary URL for 2019
- Local memory storage
- 2020 version will be part of NEWA 2.0 redesign that will have individual log-in access
The Network for Environment and Weather Applications

Apple Pollen Tube Growth Model (PTGM) for Blossom Thinning

Model Developer
Gregory Peck, Ph.D., Assistant Professor
School of Integrative Plant Science | Horticulture Section
Cornell University | Ithaca, NY
gmp32@cornell.edu

NEWA Coordinator
Dan Olmstead, Extension Associate
New York State IPM Program
Cornell Agritech | Geneva, NY
dlo6@cornell.edu
How to access the PTGM

• From the NEWA home page
• http://newa.cornell.edu
  Nav --> Crop Management -->
  Apple Pollen Tube Growth

• Direct access
• http://ptgm.newa.cornell.edu
PTGM features

• Saved user settings
  • Information is kept unless local browser cache is cleared.
• Multiple management blocks or orchards
• Multiple thinning spray logs
• Pollen tube development graphs
• Pollen tube summary tables
Steps for using PTGM

- Create a new management block
- Select a start date
- Select an end date
- Enter blossom stylet length(s)
- Enter the 1st thinning spray date
- Enter the 2nd thinning spray date
- Enter the 3rd thinning spray date (if needed)
Before you begin

• Making changes to your block information
• Click the icon **after** a block is created.
  • Located to the right side of a block header bar next to the trash can.
• Edit any field this interface.
• Thinning spray dates must be updated sequentially
Create a new management block

- Click + Block
- Choose a name.
- Select an apple variety from the dropdown menu.
- Choose a US state.
- Choose a weather station.
Select a start date and time

• Click

• Choose a date of interest to start the model.

• Click ‘Select time’ from the lower right corner.

• Choose an hour of interest using the 24-hour scale provided.

• Click ‘Ok.’
Select an end date

- Click the icon
  - Located to the right side of a block header bar next to the trash can.
- Choose an end date and time.
- Click ‘Update Block.’
Enter blossom stylet length(s)

- Click

- Choose an option for providing average style length
  - ‘Insert average style length’ provides a single entry field for a pre-calculated value.
  - ‘Calculate average style length’ provides multiple entry fields for individual measurement entries.

- Click ‘Ok’ when finished.
PTGM model output

- The model displays a graph of pollen tube growth
- Apple variety and style length are used for this calculation.
- Click to view a table summary.
Set 1\textsuperscript{st} thinning spray date

- Click \(\text{Set 1st Spray}\) to set the first thinning spray date.
- This should be done at 95% growth for 1\textsuperscript{st} thinning.
Enter additional thinning spray dates

• Click **Set 2nd Spray** to set the first thinning spray date.
• This should be done around 65% growth for 2\textsuperscript{nd} thinning.
• A 3\textsuperscript{rd} thinning spray can be entered, if needed.
## 2018 Beta-Test Locations

<table>
<thead>
<tr>
<th>Location</th>
<th>Personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Ontario Region</td>
<td>Craig Kahlke, Poliana Francescatto, Peter Herzeelle, and Mario Miranda Sazo</td>
</tr>
<tr>
<td>Eastern NY</td>
<td>Mike Basedow and Dan Donahue</td>
</tr>
<tr>
<td>Michigan</td>
<td>Phil Schwallier</td>
</tr>
<tr>
<td>North Carolina</td>
<td>Tom Kon</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>Jim Schupp</td>
</tr>
<tr>
<td>Virginia</td>
<td>Sherif Sherif and Keith Yoder</td>
</tr>
</tbody>
</table>
Concluding remarks

• Bloom thinning can be and is increasingly being practiced in the Eastern US

• Bloom thin varieties where fruit size is essential for profitability, e.g. ‘Gala’

• Bloom thin biennial bearing varieties during the “on year”, e.g. ‘Fuji’, ‘Honeycrisp’

• Focus on later blooming varieties, e.g. ‘Honeycrisp’

• Bloom thinning may reduce the need for 1-2 fungicide sprays

• Bloom thinning with liquid lime sulfur may increase russet

• Avoid varieties that are prone to russet (e.g., ‘Golden Delicious’ & ‘Ginger Gold’)

• Alternative bloom thinning materials are available (e.g., Regalia & Amid-Thin)
Acknowledgments

• Virginia Dept. of Agriculture and Consumer Services, Specialty Crop Block Grant

• Washington Tree Fruit Research Commission, particularly Tory Schmidt

• New York State Apple Research Development Program

• Stemilt Growers, Washington Fruit & Produce Co., Roche Fruit, C & O Nursery, Columbia Basin Nursery, & Dovex Fruit

• JMS Flower Farms, Marrone Bio Innovations, Miller Chemical & Fertilizer Corp., Crocker's Fish Oil, Valent BioSciences

• Many hours of assistance from technicians and students
And, if you’re Morris...

Unfortunately, Morris is an accountant at the Botany Institute; not a biologist.

Greg Peck
gmp32@cornell.edu