A POLLEN TUBE GROWTH MODEL FOR APPLE BLOOM THINNING: BACKGROUND & BETA TESTING

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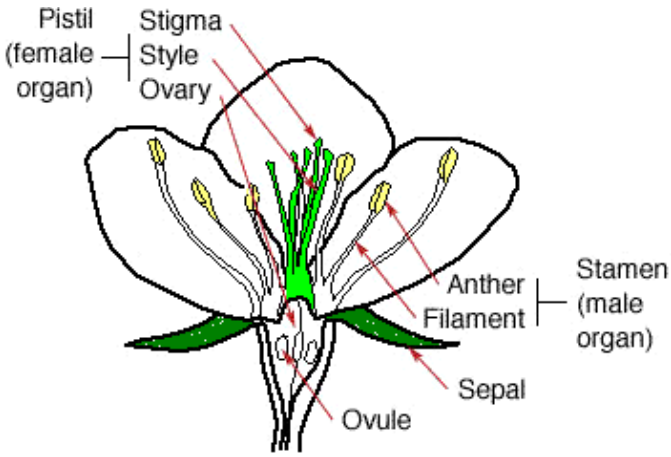
A Pollen Tube Growth Model

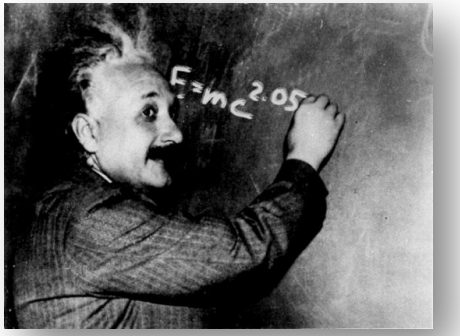
- In apple production, crop thinning during bloom produces the largest fruit, the greatest return bloom in the following year, and reduces biennial bearing

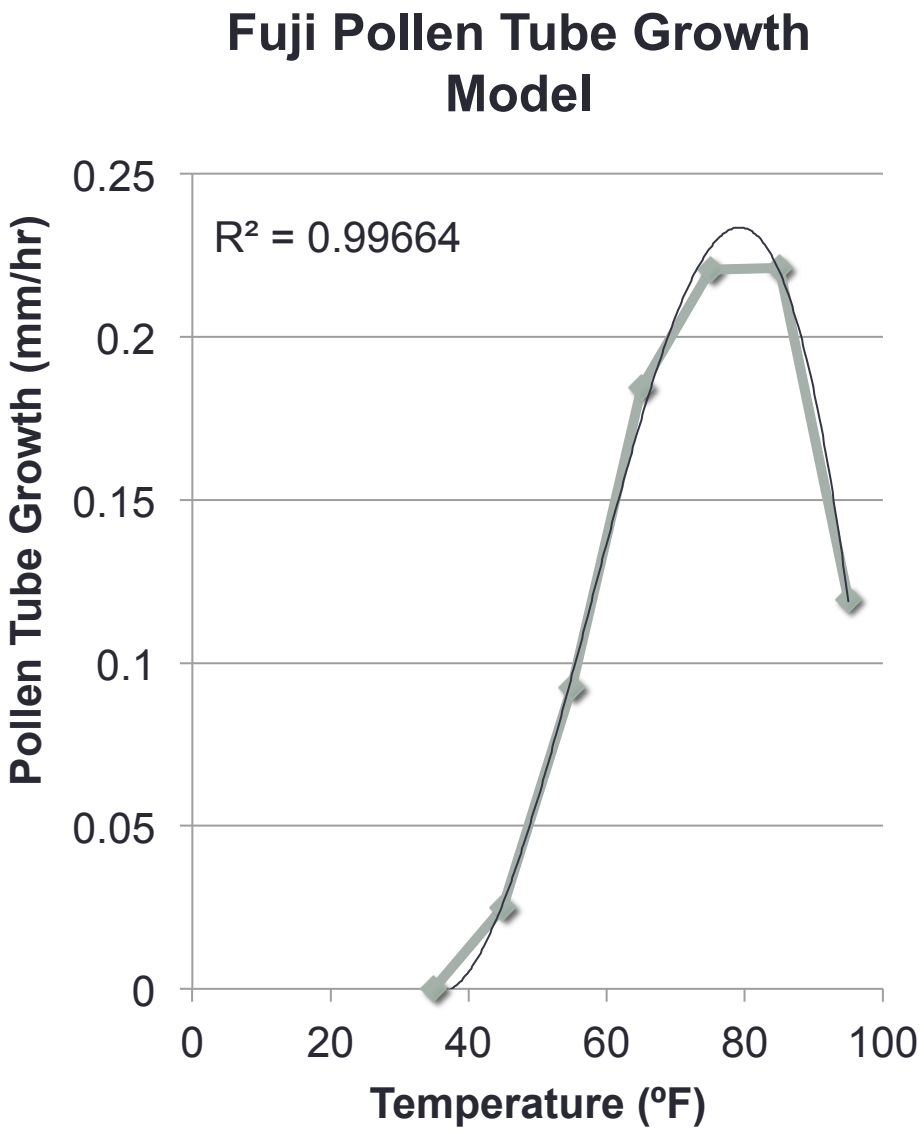


- However, the application timing for bloom spray has been subjective, and is usually based on the percent of full bloom that is open (e.g., an application at 20% and 80% full bloom)
- A more precise application timing can be achieved through modeling
- The pollen tube growth model can help reduce risk of under- or over-thinning

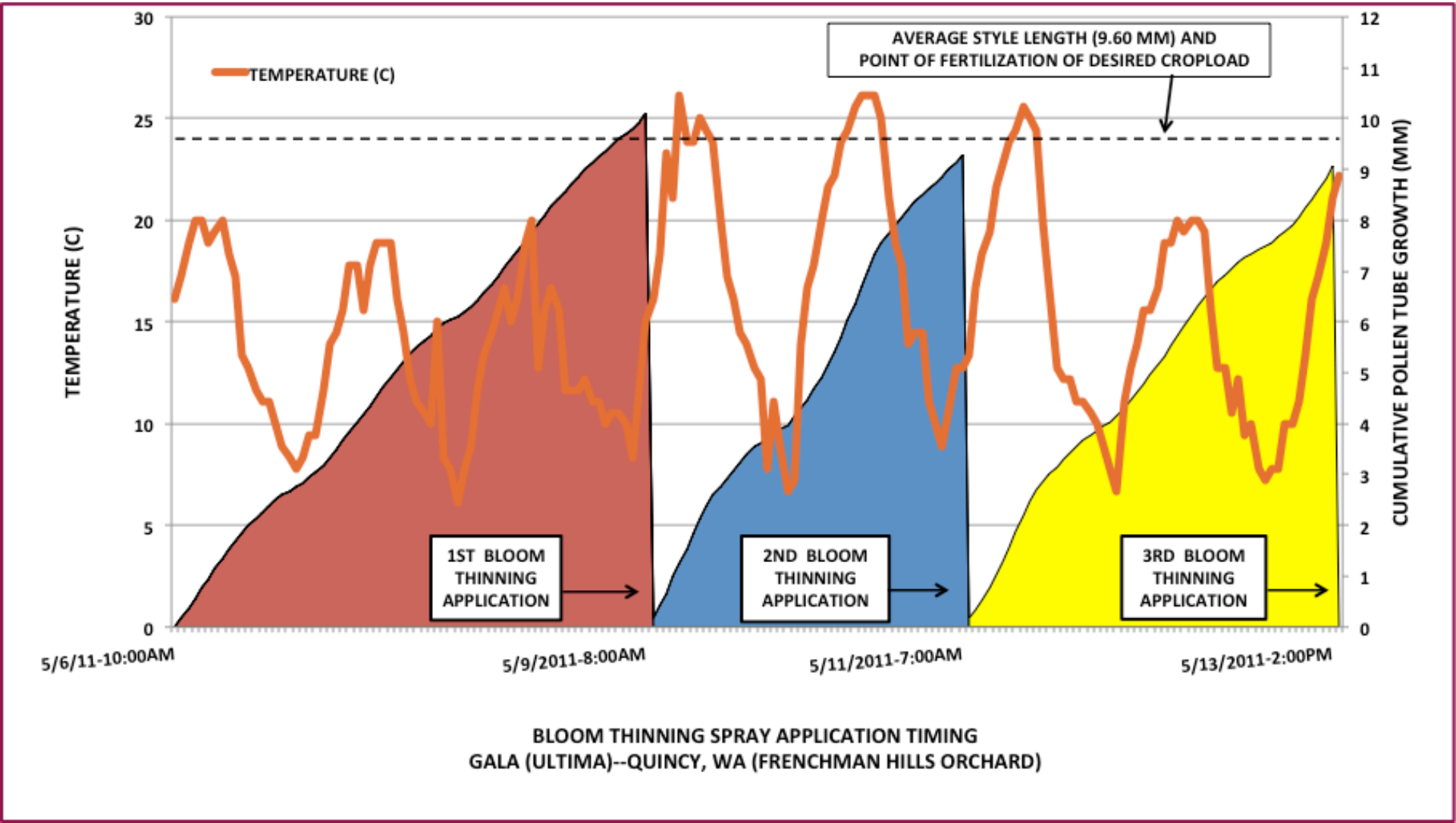
Why use models?

- To simplify complex phenomena
- To be able to ask questions about future events
- and make reliable predictions



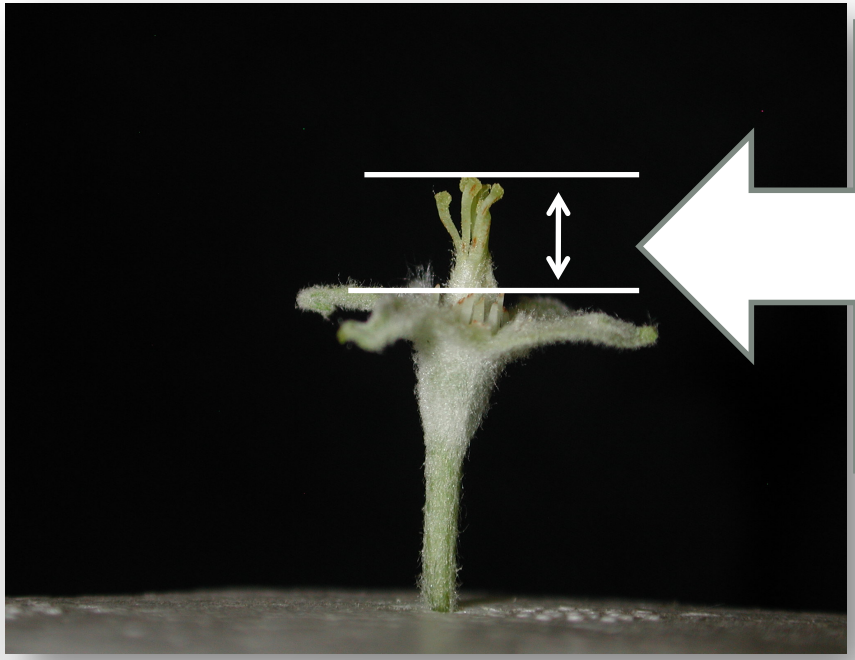


How does the model work?



Measuring Style Length

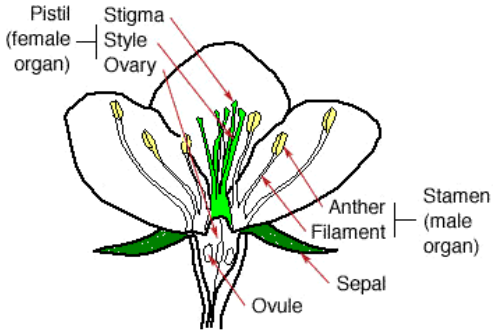
ANTHERS AND PETALS REMOVED FOR EASIER MEASURING OF STYLES



MEASURE STYLES AS SHOWN FOR FLOWER STYLES MEASURED WITHOUT REMOVING FROM TREE

Starting the model “clock”

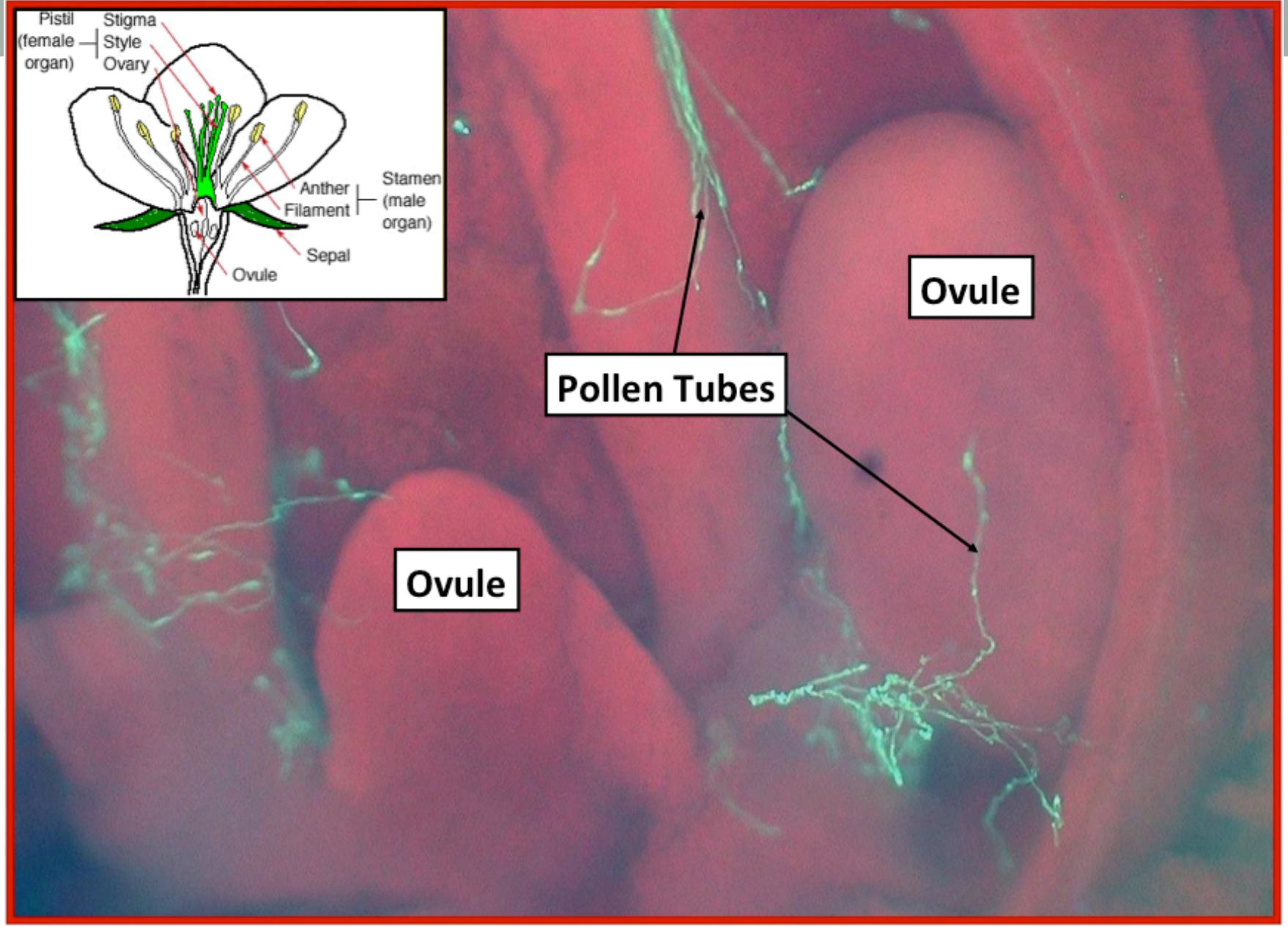
- Sufficient king bloom open to provide desired cropload
  - Count the number of flowers per branch cross-sectional area
  - Can be estimated based on experience
- The model starts when the last flower that you need to achieve the desired crop load has been pollinated
- First thinning spray is applied 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 (>50ºF) for bee flight
  - Within tree and within orchard variability



How was the model developed?

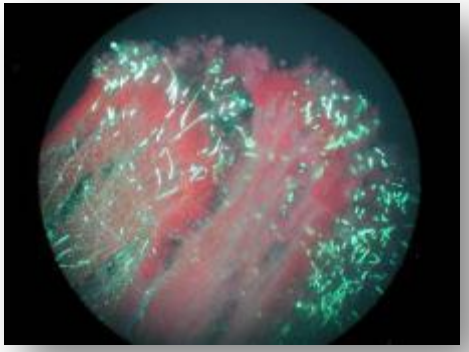
- Dwarfed root-bagged trees are forced to bloom in a greenhouse
- Trees can be held dormant in cold room
- Pollen from selected pollinizers is harvested and stored
- Flowers are emasculated at full balloon stage, hand-pollinated, and tree is placed in growth chamber under predetermined climatic conditions

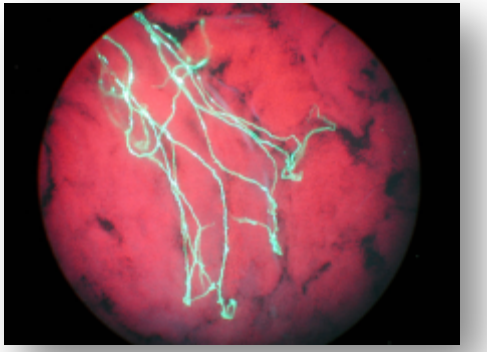
By measuring pollen tube growth rates under controlled environmental conditions in growth chambers, we have developed a model that calculates the time required to fertilize the king bloom after pollination.



Fertilization is determined by evaluating stained pollen tubes using fluorescence microscopy.

- Blossoms collected at planned intervals; pistils and ovules processed and stained to observe pollen tubes in the style.
- Fluorescence microscopy gives a view of germinating pollen grains and progression of pollen tubes down the style.
- This shows tube growth over time at the selected temperature and indicates how soon fertilization would occur, based on style length.
- Fixed blossoms can be held for later analysis.

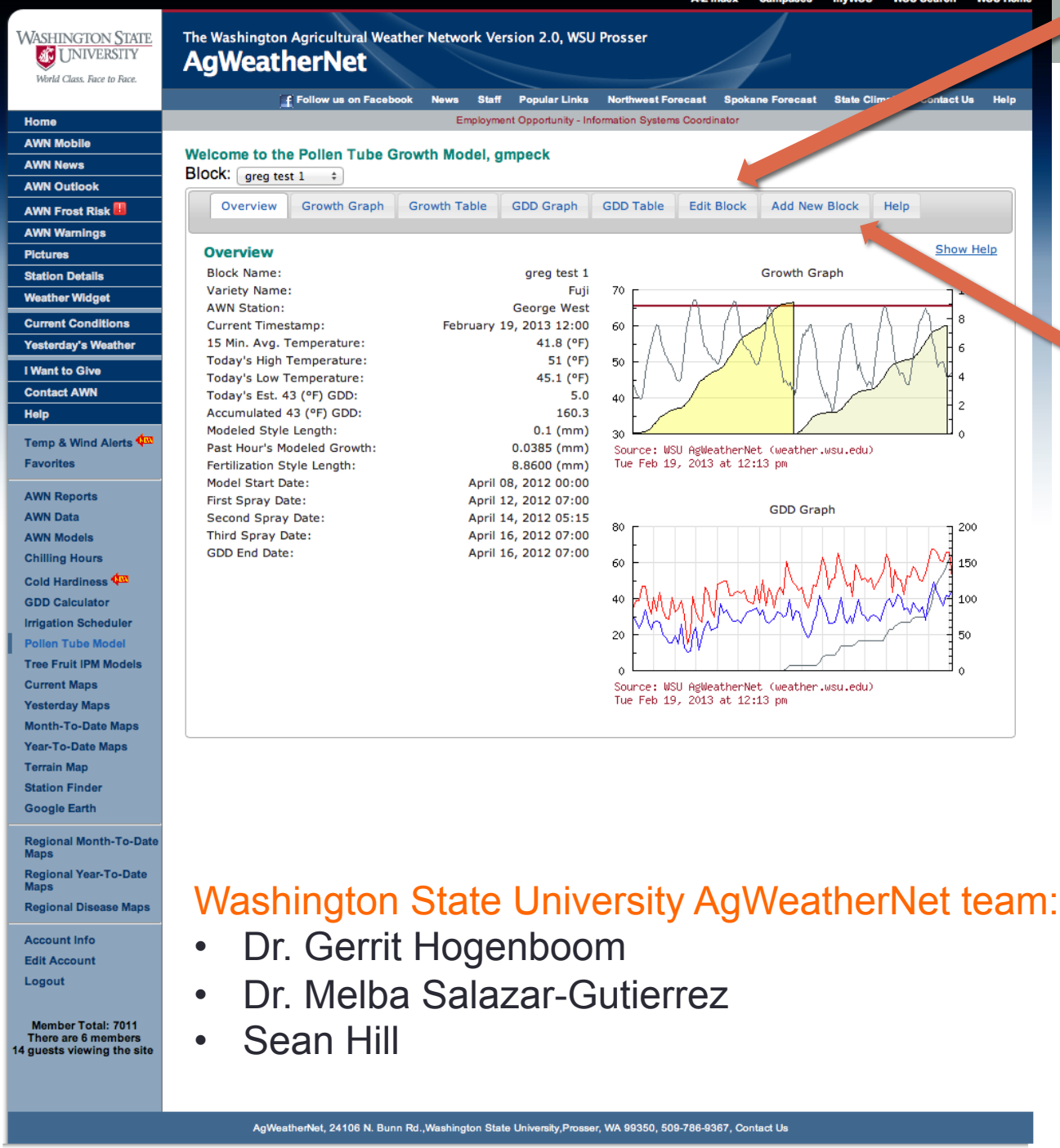




How is it being used?

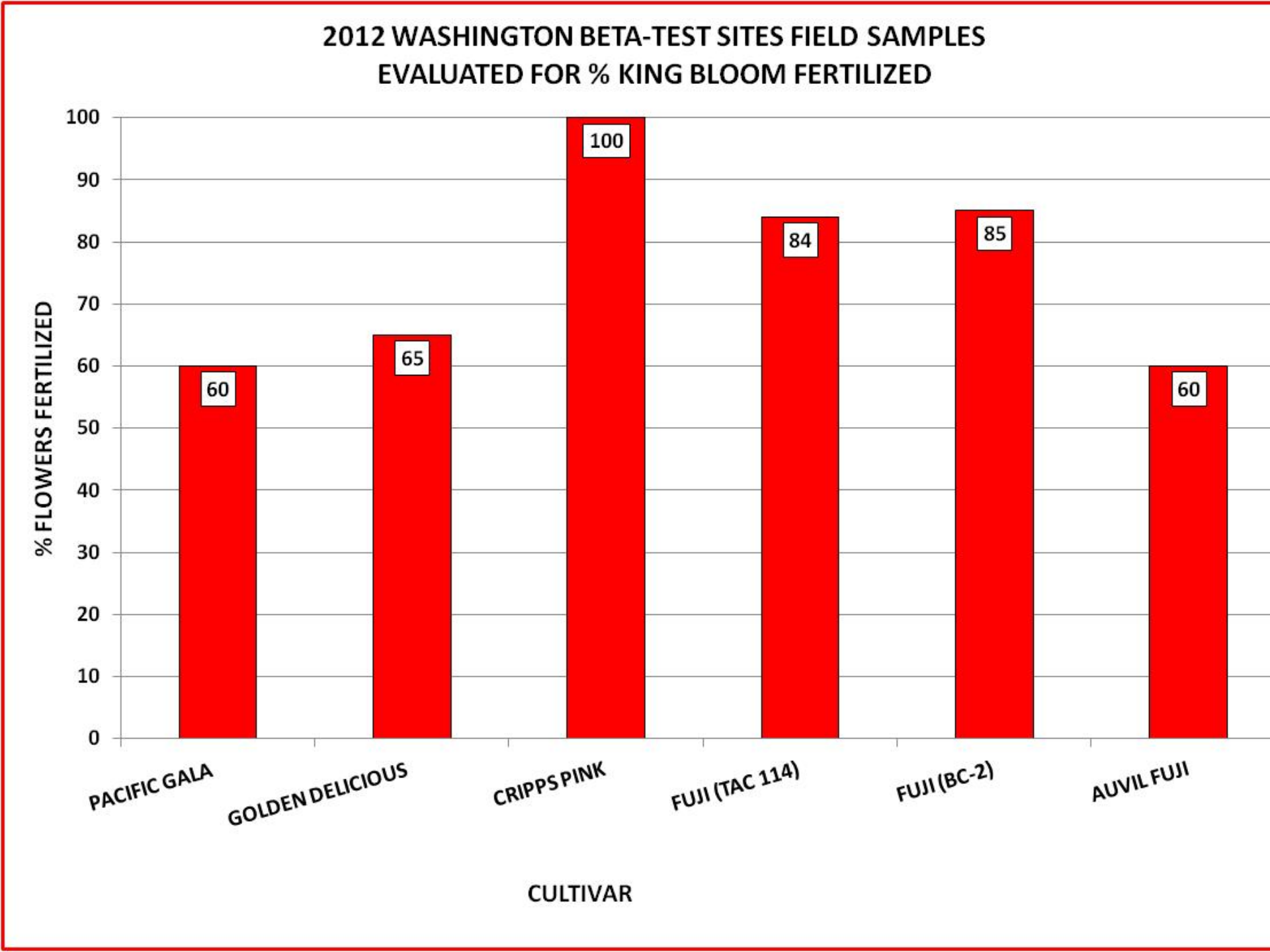
- Models have been developed for:
  - Golden Delicious
  - Gala
  - Fuji
  - Cripps Pink (Pink Lady)
  - Honeycrisp (New for 2013!)
- Model now available through WSU's AgWeatherNet website
- In 2012, worked with over 60 beta-test sites in Washington State
- 2011 & 2012 bloom thinning tests in Virginia

Tom Butler (Washington Fruit & Produce Co.) and Tory Schmidt (WTFRC) pollen model bloom thinning test at Goose Ranch in Finley, WA (2009).

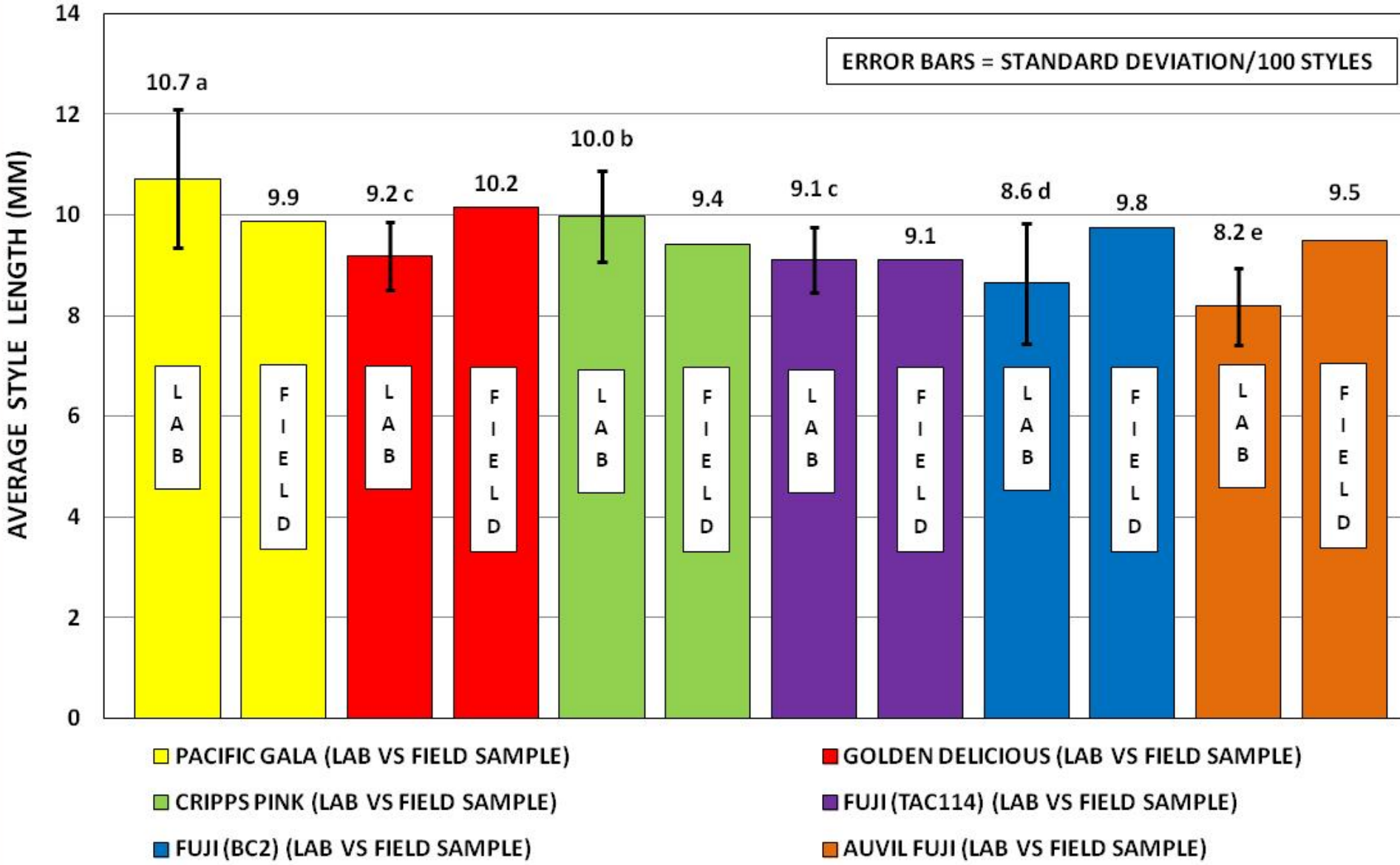


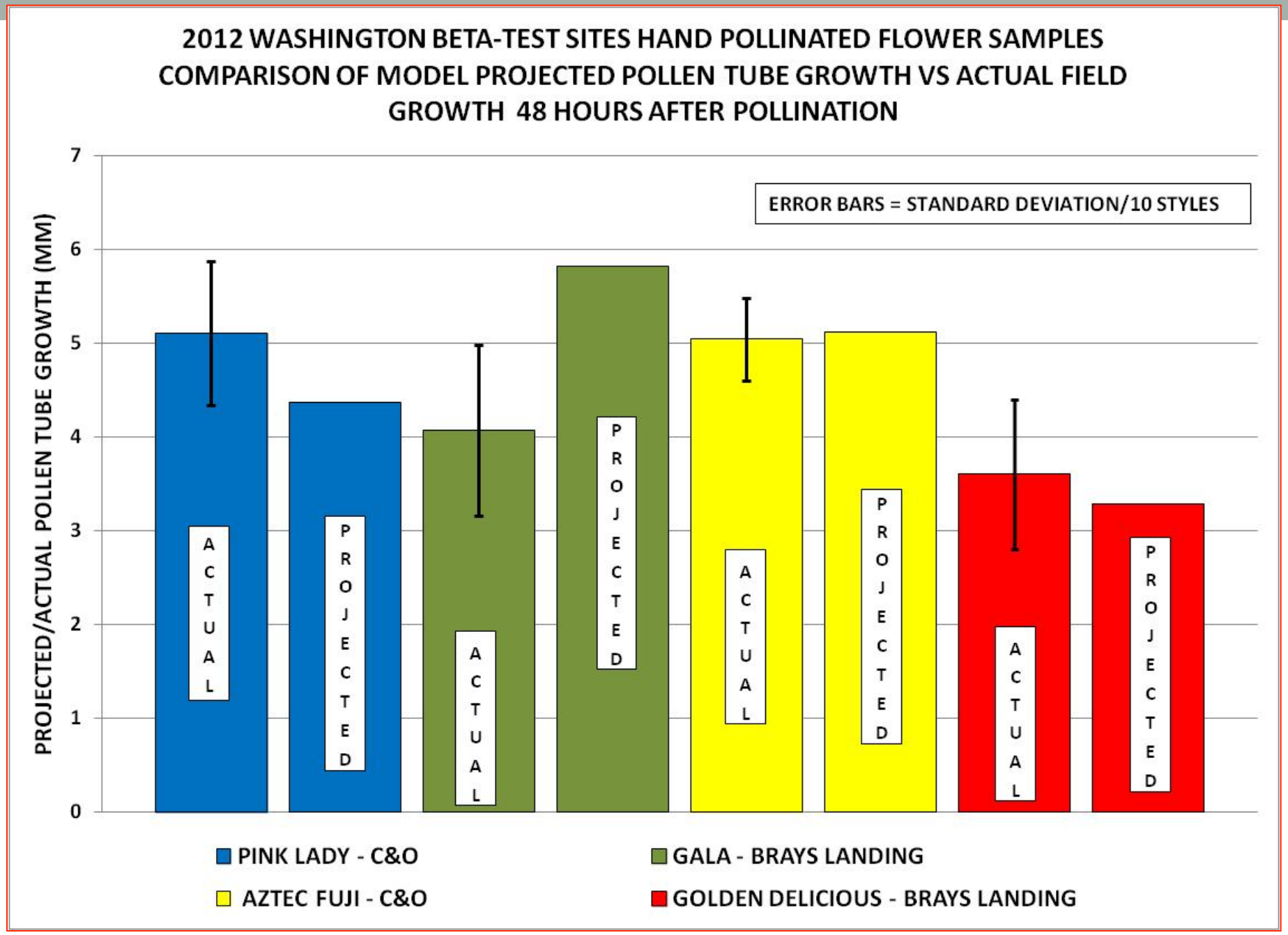
Washington State University AgWeatherNet team:

- Dr. Gerrit Hogenboom
- Dr. Melba Salazar-Gutierrez
- Sean Hill


2012 WASHINGTON BETA-TEST SITES FIELD SAMPLES
EVALUATED FOR % KING BLOOM FERTILIZED
% FLOWERS FERTILIZED
100
90
80
70
60
50
40
30
20
10
0
60
65
100
84
85
60
PACIFIC GALA
GOLDEN DELICIOUS
CRIPPS PINK
FUJI (TAC 114)
FUJI (BC-2)
AUVIL FUJI
CULTIVAR

2012 WASHINGTON BETA-TEST SITES FLOWER SAMPLES COMPARISON FOR AVERAGE STYLE LENGTH: LABORATORY (MICROSCOPE) VS FIELD MEASUREMENTS




2012 WASHINGTON BETA-TEST SITES HAND POLLINATED FLOWER SAMPLES
COMPARISON OF MODEL PROJECTED POLLEN TUBE GROWTH VS ACTUAL FIELD GROWTH 48 HOURS AFTER POLLINATION
PROJECTED/ACTUAL POLLEN TUBE GROWTH (MM)
0
1
2
3
4
5
6
7
ERROR BARS = STANDARD DEVIATION/10 STYLES
ACTUAL
PROJECTED
ACTUAL
PROJECTED
ACTUAL
PROJECTED
ACTUAL
PROJECTED
PINK LADY - C&O
GALA - BRAYS LANDING
AZTEC FUJI - C&O
GOLDEN DELICIOUS - BRAYS LANDING

Cultivar (strain)	Location (orchard name)	Mean style length (mm)	Model predicted pollen tube growth at first application	Number of bloom thinning sprays applied	Grower estimated percent of desired crop load achieved
Golden Delicious	Quincy, WA (Lucky 4 Ranch)	8.6	8.3	2	97%
Golden Delicious	Quincy, WA (Winchester Ranch)	8.1	8.4	3	96%
Gala (Ultra Red)	Quincy, WA (Lucky 4 Ranch)	8.3	7.9	3	98%
Gala (Ultima)	Quincy, WA (Frenchman Hills)	9.6	10.2	3	76%
Gala (Pacific)	Quincy, WA (Winchester Ranch)	9.2	9.7	2	78%
Fuji (TAC 114)	Quincy, WA (Winchester Ranch)	7.5	6.8	2	69%
Cripps Pink	Quincy, WA (Winchester Ranch)	7.1	7.1	3	86%

What's next?

- Additional beta testing and validation
- New models: Honeycrisp (2013) and Red Delicious (2014)
- Understanding the paternal (pollen) effects on pollen tube growth rates
- Integrating mechanical pollination with bloom thinning
- Elucidating the specific modes of action for bloom thinning chemicals
- Understanding flower morphological features that impact bloom thinning, such as style fusion and pollen tube callose plugging
- Integrating bloom thinning with whole-orchard management, including tree nutritional status and disease management
- Developing bloom thinning programs for Eastern US and organic apple growers

And, if you're Morris...

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SELECTED GALA CULTIVARS - AVERAGE KING BLOOM STYLE LENGTH AT SELECTED WASHINGTON ORCHARDS (2010)