

FINAL PROJECT REPORT

Project Title: Development of pollen tube growth model for Washington State growers

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Dr. Vincent P. Jones, Washington State University TFREC

Other funding sources: None

Total Project Funding: \$133,500

Budget History:

Item	Year 1:	Year 2:	Year 3:
Salaries	23,900	27,980	29,213
Benefits	11,467	13,424	14,016
Wages			
Benefits			
Equipment			
Supplies	750	750	750
Travel (to Wash. St. orchard sites)	3000	3000	3000
Plot Fees			
Contractual services & repairs	750	750	750
Miscellaneous			
Total	\$39,867	\$45,904	\$47,729

OBJECTIVES:

Our overall goal for 2009-11 was to collaborate with the Washington Tree Fruit Research Commission and Washington State University Tree Fruit Research and Extension Center in the development of a computer generated pollen tube growth modeling program.

The specific objectives were:

- 1) Validate our prior work on pollen tube growth and thinning by conducting field studies at selected cooperating orchard sites in Washington State. Assist, if needed, with field implementation of beta testing of the modeling program with cooperating growers.
- 2) Repeat Washington State “in-orchard” tests conducted in 2008 to accumulate multiple-year data on commercially important cultivars. Try to collect more “normal year” data (as compared to 2008) on Red Delicious, Golden Delicious, Fuji, Gala, Honeycrisp, Jonagold, Pink Lady, Granny Smith, and Braeburn.
- 3) Assimilate data into development of a functional model of pollen tube growth for growers to test on selected specific apple cultivars.
- 4) Continue studies of pollen germination/tube growth under natural field temperature and light conditions compared to 2005-08 laboratory and field experiments, expanding studies to additional commercially important cultivars.
- 5) Further develop reliable laboratory techniques for the study of a wide range of constant and variable temperatures on pollen germination and tube growth.
- 6) Developing model parameters for Red Delicious and Honeycrisp (2011 – 1st year).
- 7) Continued collaborative effort to develop computer model program and incorporate into DAS or AgWeather.net.
- 8) Provide continued training to recognize desirable amount of king bloom open to "start the clock".
- 9) Expand beta field testing of models for Gala, Fuji, and Golden Delicious (3rd year) to include Cripps Pink (Pink Lady).

SIGNIFICANT FINDINGS 2009 - 2011:

- Added to database of temperature effect on pollen tube growth (high temperature range).
- Refined metrics for the actual time required for fertilization.
- Implemented different calculations in the model based upon cultivar differences in time required for fertilization.
- Refined “triggering method” for start of bloom thinning applications.
- Established style length data base for various apple cultivars and also noted the need for developing a real-time style measurement protocol.
- Developed preliminary pollen tube growth model for beta testing on Cripps Pink (Pink Lady).
- Expanded testing of pollen tube growth modeling program in Washington St. sites.
- Added plantings of Jonagold, Granny Smith, and Cameo for future testing.
- Continued growth chamber studies of pollen germination/tube growth.

RESULTS AND DISCUSSION:

Applying our research findings from past three years and results from previous research projects funded by the Washington Tree Fruit Research Commission (2002-08) we were able to expand on the accumulation of data needed to advance the preliminary models used for predicting pollen tube growth and its relation to applying bloom thinners at the proper time. In doing so we are now ready to proceed with validation and implementation of models for beta-testing on the AgWeatherNet site. We (Va Tech and AgWeatherNet) are presenting a new 3-year research proposal to the Washington Tree Fruit Research Commission to validate the Golden Delicious, Gala, Fuji and Cripps Pink models which have been used for beta-testing at selected Washington sites. Initial validation of our experimental pollen tube model during the past 3-year project was undertaken by the following grower cooperators: Tom Butler (Washington Fruit & Produce Co.), Kevin Larson (Roche Fruit), Harold Ostenson (Stemilt Fruit), Darin Case (Dovex), Tory Schmidt (Washington Tree Fruit Research Commission), Dena Ybarra (Columbia Basin Nursery), Paul Carter (Stemilt Fruit), and Gary Snyder (C&O Nurseries).

Washington Field Testing – 2009-11

The below figures (Figures 1, 3 & 4) show projected pollen tube growth and bloom thinning application dates with spray timings generated using the models for bloom thinning tests conducted at several Washington sites over the past three years (2009-11).

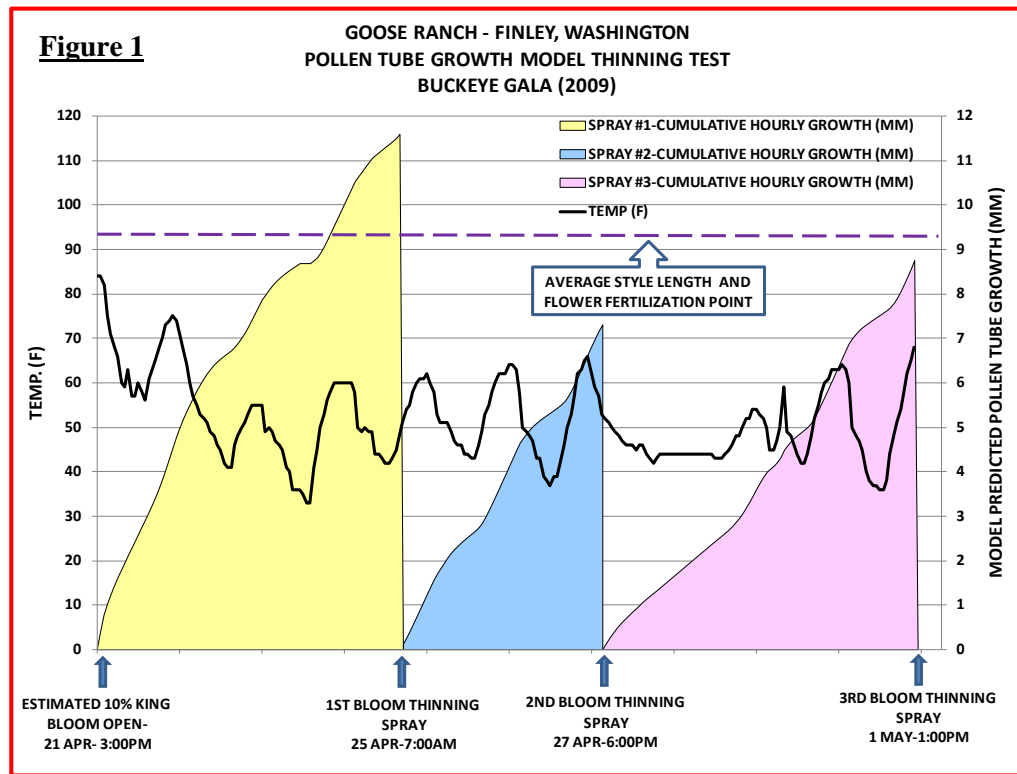
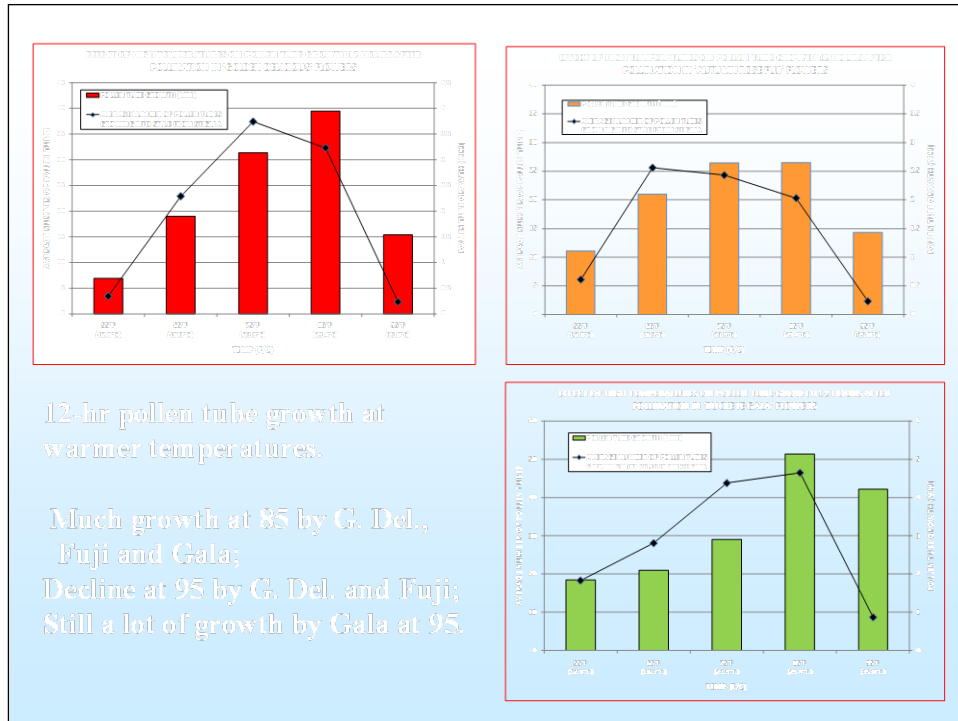


Figure 1 shows predicted rapid pollen tube growth and fertilization of Buckeye Gala king bloom with relatively warm temperatures at Finley in 2009. The first bloom thinning application was intentionally delayed by the grower to allow more set of later bloom in the top half of the trees, knowing that this would result in heavier set of earlier bloom in the bottom.



In 2009, following warm temperatures (85°F) and rapid petal fall at Finley (Figure 1), we conducted a controlled 12-hr incubation test in the growth chamber (Figure 2), to assess the effects of higher temperatures (75-95°F) on pollen tube growth. Our results showed significantly greater pollen tube growth at 85°F by Golden Del. (above, upper left), Fuji (upper right) and Gala (bottom right); There was a decline at 95°F by Golden Delicious and Fuji; but still significant growth by Gala at 95°F with the apparent optimum at 85°.

Although 2009 was warm as flowers started to open, resulting in fertilization in 55 hr (Figure 3), if bloom had also occurred on April 21 in 2005, the flowers would have been fertilized in only 52 hr.

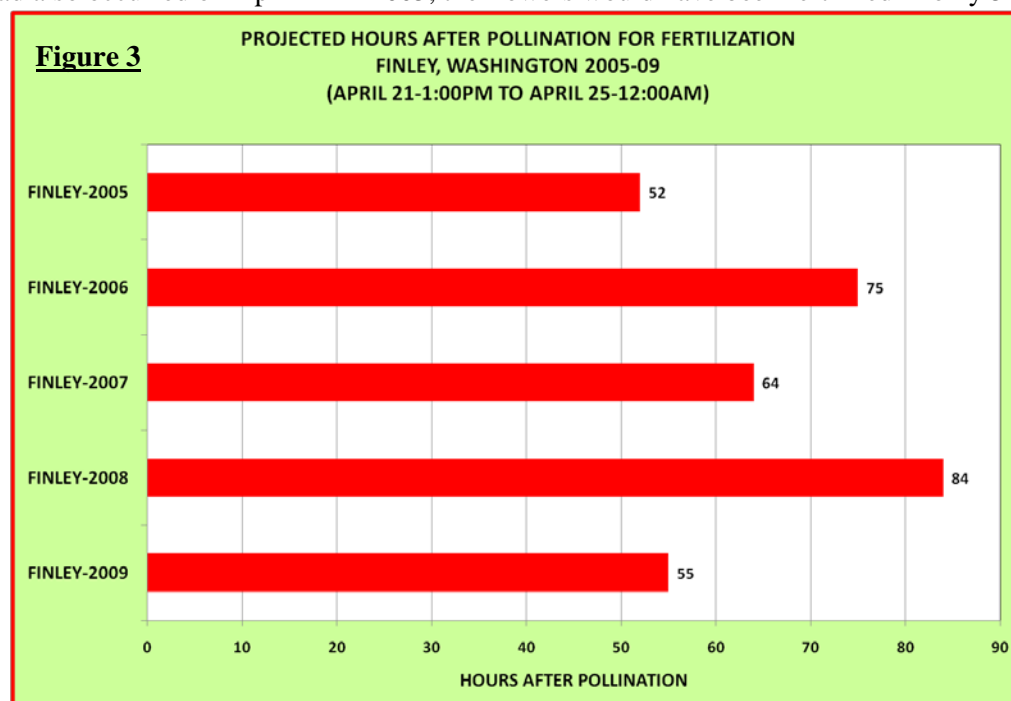
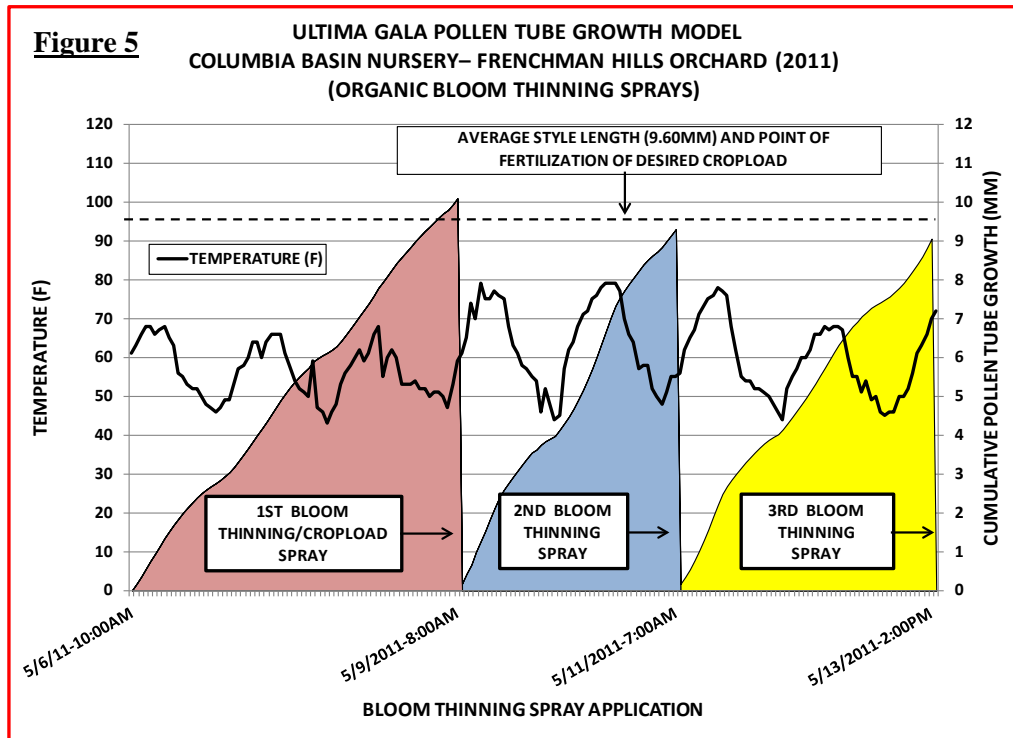
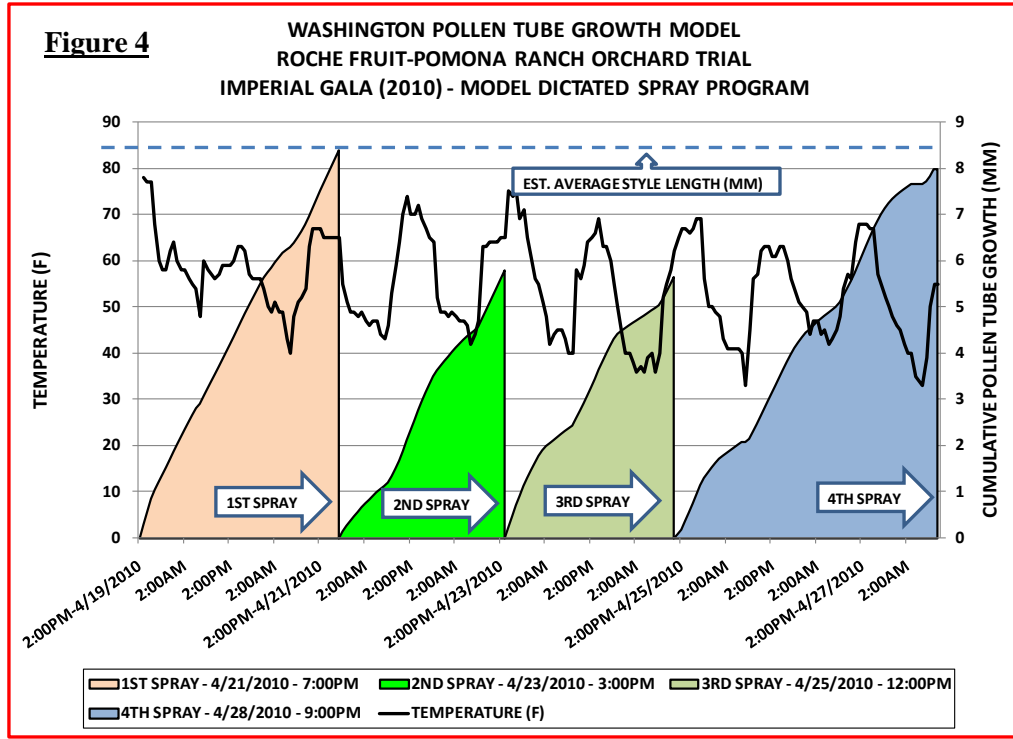
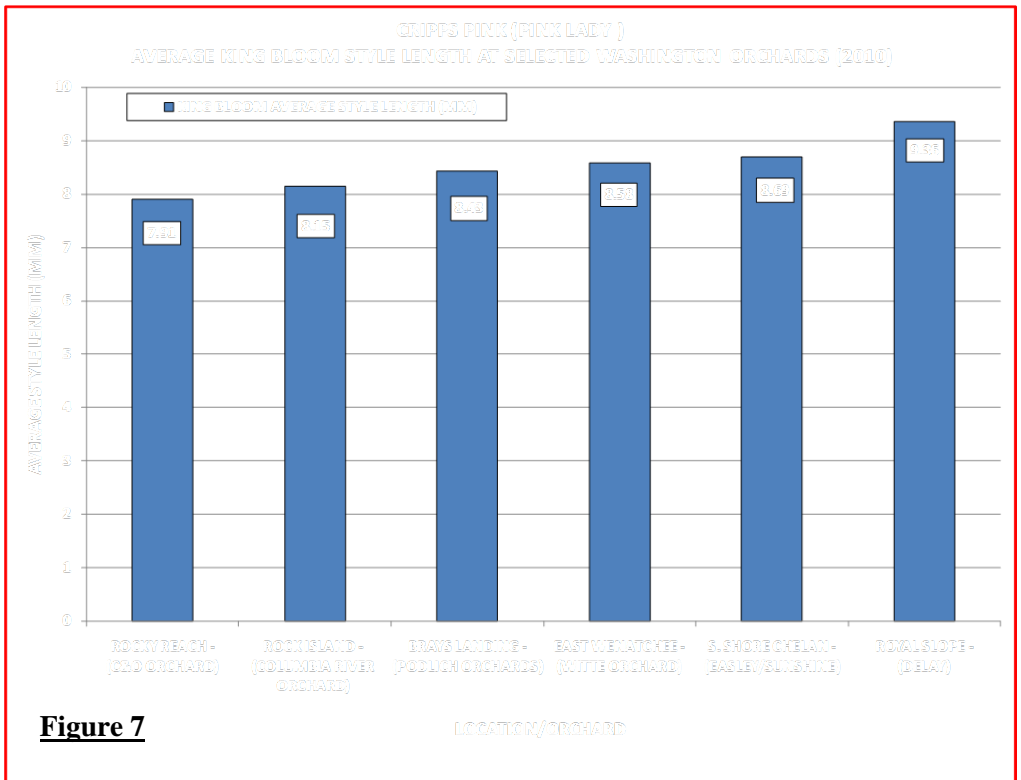
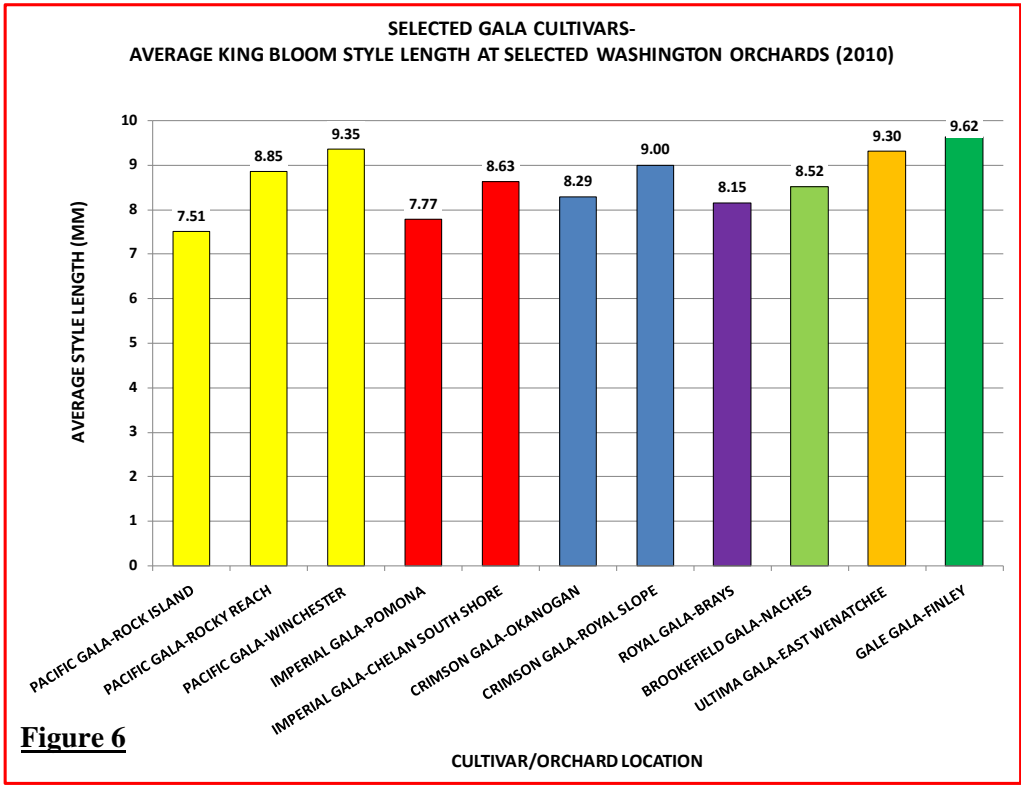


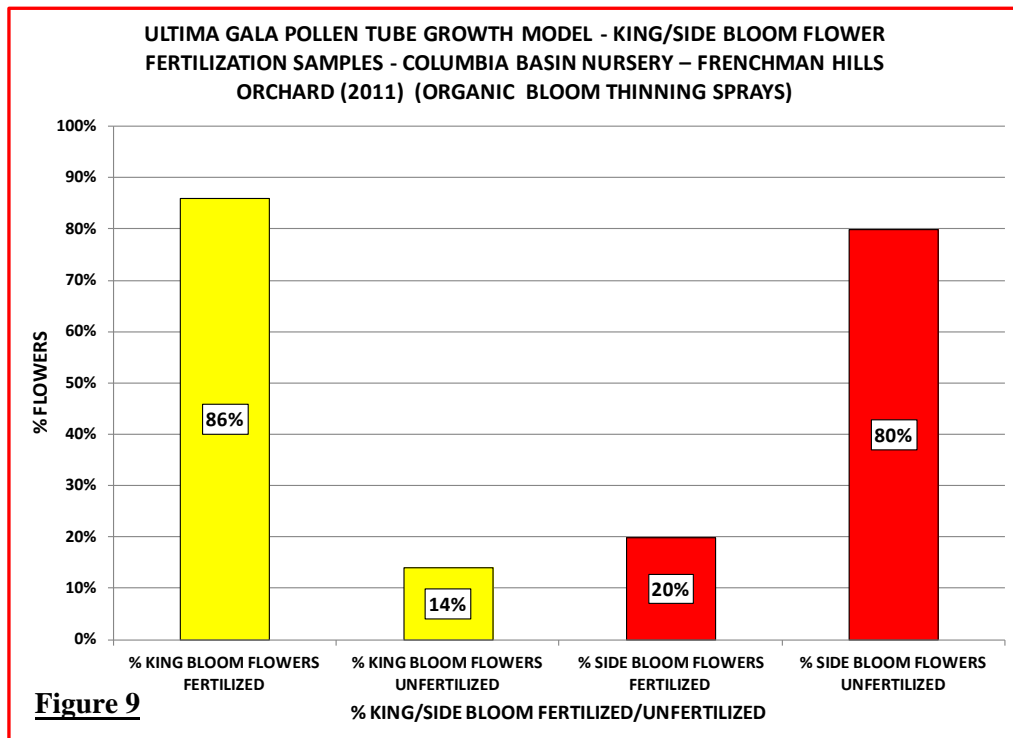
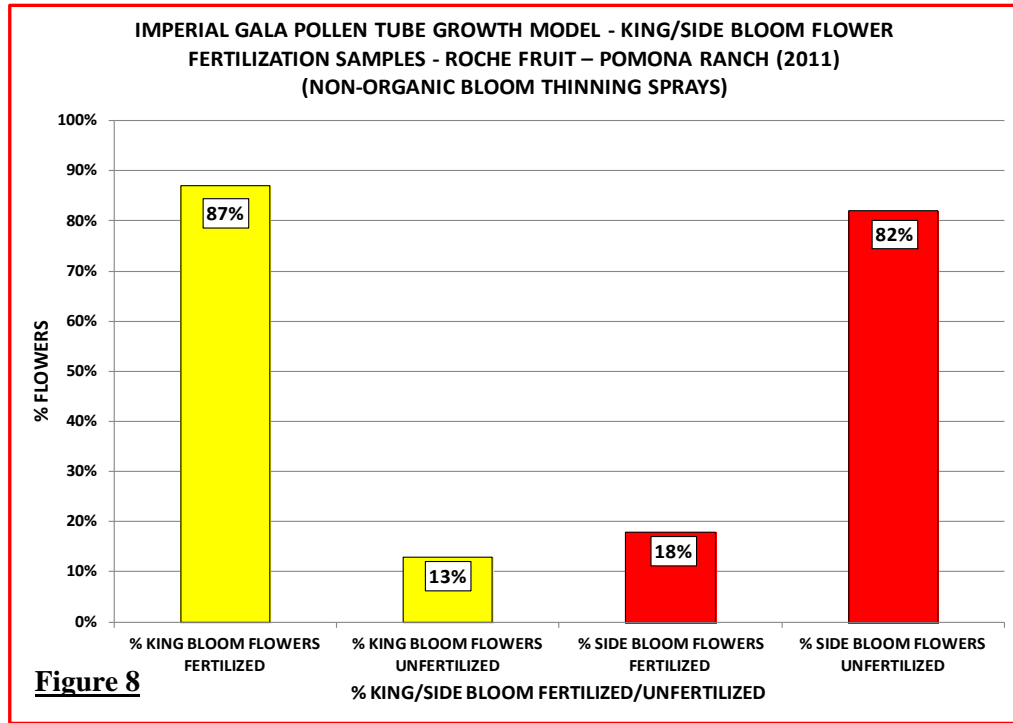
Figure 4 shows the predicted pollen tube growth and timing of bloom thinning sprays April 21-28 at Roche Fruit, Pomona Ranch 2010. The later applications were intentionally timed to prevent set of pollinated blossoms before they were fertilized, thereby reducing the need for hand thinning.



Differences in average length of styles among Gala strains (Figure 6) and Pink Lady (Figure 7) demonstrate the importance of field tests with on-site style length measurements at different locations.



Figures 8 and 9 show the percent of sampled king bloom flowers that had been fertilized and later side bloom that were not yet fertilized after timing thinning sprays using the pollen tube growth model in two test blocks in 2011. Non-organic block (Figure 8) and organic block (Figure 9).



EXECUTIVE SUMMARY

The primary goal of the pollen tube growth model for 2009-11 was to continue studies of pollen germination/tube growth under natural field temperature and light conditions in Washington test sites as compared to laboratory and field experiments in 2005-08. With the help of the listed beta-testers we expanded our testing to include many apple producing regions in Washington. Limited testing has also been conducted in Chile. By using commercial growers located in a wide range of growing conditions, we further validated the effectiveness of the model under numerous field conditions. The cooperating growers were able to assess the model in the field and provided useful feedback on the effectiveness and usability of the model.

Our grower cooperators have provided us with the following feedback:

“The big value of using the model may be in taking out the guess work on the application timing. Our current method of timing for Gala is to look for 40% and then 90% open flowers. Your model could take a lot of that guess work out if you were planning to treat 2 times or 3 times. It also is a big stress reliever for the managers”.

Kevin Larson, Roche Fruit.

“We have learned a lot from working with you and have managed to incorporate some of what we’ve learned into our chemical thinning program”.

Dan Plath, Washington Fruit & Produce.

“These Models are great tools; people just have to figure out how to use them”.

Darin Case, Dovex Fruit Company.

“The model work well for us this year”. **Dena Ybarra, Columbia Basin Nursery.**

“Bottom, bottom line is "we are on the right track". I see the future of the model as an important aid to managing crop load and reduction of biennial bearing throughout the industry. I have a strong opinion that the model can, is, and will be an important contributor to increase bloom thinning effectiveness and consistency for our growers”.

Harold Ostenson, Harold Ostenson Consulting.

With the positive feedback from our beta-testers, we are now ready to integrate the model on the AgWeatherNet site, which will integrate weather data into the model software and provide real time model updates. To accomplish this goal, we have submitted a new 3-year collaborating proposal with Dr. Gerrit Hoogenboom, Director of AgWeatherNet (AgWeatherNet). In addition to this goal, we also will continue to add models for more cultivars, such as Honeycrisp, Red Delicious, and Granny Smith. These will be added to the models already in use and being field beta-tested: Gala, Fuji, Golden Delicious, and Cripps Pink (Pink Lady). Additional models can be added over time as deemed relevant by the Washington apple industry.