FINAL PROJECT REPORT

Project Title: Temperature effect on pollen germination/tube growth in apple pistils

PI:	Dr. Keith Yoder	**Co-PI(2):**	Dr. Rongcai Yuan
Organization:	Va. Tech	**Organization:**	Va. Tech
Telephone/email:	(540)-869-2560, Ext. 21 e-mail: ksyoder@vt.edu	**Telephone/email:**	(540)-869-2560
Address:	595 Laurel Grove Rd.	**Address:**	595 Laurel Grove Rd.
Address 2:	Va. Tech AHS-AREC	**Address 2:**	Va. Tech AHS-AREC
City:	Winchester	**City:**	Winchester
State/Province/Zip:	VA 22602	**State/Province/Zip:**	VA 22602

Cooperators: Leon Combs, Research Specialist, Va. Tech AHS-AREC; Winchester, VA
Dr. Jim McFerson, Washington Tree Fruit Research Commission
Tory Schmidt, Washington Tree Fruit Research Commission

Total Project Request: **Year 1:** $39,868.00

Other funding Sources - none

Total Project Funding: $39,868.00

Budget History:

Item	Year 1: 2008	Year 2:	Year 3:
Salaries	24,564		
Benefits	11,054		
Wages	0		
Benefits	0		
Equipment	0		
Supplies	750		
Travel	2,500		
	0		
Contractual services & repairs	1,000		
Miscellaneous			
Total	39,868		

Objectives: Our overall goal for 2008 was to collaborate with the Washington Tree Fruit Research Commission and Washington State University Tree Fruit Research and Extension Center to develop and validate a computer generated pollen tube growth model. The specific objectives are:

1) Assimilate data into development of a functional model of pollen tube growth in selected apple varieties for growers to use.

2) Expand the validity of our previous work on pollen tube growth by conducting limited field studies involving pollination at full bloom at selected cooperating orchard sites in Washington State.

3) Further develop reliable laboratory techniques to study a wide range of constant and variable temperatures on pollen germination and tube growth.

4) Study pollen germination/tube growth under natural field temperature and light conditions compared to 2005-07 laboratory experiments placing emphasis on commercially important pollen cultivars.

Significant Findings:

- Field studies conducted Apr-May '08 at orchard sites in Wenatchee, WA yielded valuable information on pollen tube growth in various cultivars when pollinization occurs under less than optimum conditions (Figure 1). Data collected on style length showed considerable variation in commercially important cultivars (Figure 2). These data are critical to setting parameters for a modeling program.

- Results from tests conducted at Va Tech AREC on 'Pink Lady' "in orchard" on pollen tube growth 24 hours after pollination showed that actual average growth of pollen tubes into styles after pollination for that period was approximately 2.46 mm. When projecting hourly growth using model parameters for both Golden Delicious and Gala cultivars, results showed Golden Delicious growth model (projected growth approx. 2.40 mm) was more closely aligned with actual pollen tube growth than Gala model which projected growth to be 3.77 mm after 24 hours (Figures 3-4).

- Expanding pollination tests on additional commercially important cultivars (Honeycrisp, Jonagold, Granny Smith) in spring 2008 we have reinforced our findings that all cultivars cannot be evaluated or grouped under one umbrella, as if to say that if it works for one cultivar, it will work for all cultivars.

- We have considered designs of possible computer layouts for modeling program with interface for dissemination of relevant data into computer-generated output programs (Figure 5) (possible layout) to be in collaboration with WTFRC and Dr. Vincent Jones, WSU.

Results & Discussion

Our tests conducted this year at orchards sites in Wenatchee, WA and at Va Tech AREC in Winchester, VA have yielded valuable data in development of a computer generated program for estimating pollen tube growth after pollination (Figure 5). Working with WTFRC and Dr. Vince Jones we are developing parameters and requirements to initiate

the activation of such a model for Washington state growers to use in the near future. As we have observed from pollination studies conducted this spring under less than ideal conditions pollen tube growth varies from cultivar to cultivar under comparable temperatures (Figure 1). Growth in the cultivars Honeycrisp and Jonagold appears to be less affected by cooler temperatures at pollination than are Fuji and Pink Lady. These traits could affect timing of bloom-thinning applications when not applied at the proper time could lead to over thinning or less than desired thinning if applied too late after pollination. Evaluation of fruit set soon after bloom could be enhanced with a better understanding of pollen tube growth in regards to temperature after pollination. Missed or non-optimal timing of bloom thinners is costly for growers and results in increased costs for thinning at other stages after bloom. It may also lead to reduced average croploads and resulting loss of sales. Understanding that all cultivars have different traits is essential to developing a accurate pollen tube growth model. Variables such as cultivar style length (Figure 2) illustrates just one difference that must be incorporated into a model to project the information that a grower can use in bloom-thinning practices. Projecting these growth traits can be combined in some instances to cover multiple cultivars (Figure 3-4) but needs more extensive field and laboratory testing before a modeling program can be released for general public use.

Figure 1

POLLEN TUBE GROWTH 24 HOURS AFTER "IN-ORCHARD" POLLINATION OF SELECTED CULTIVARS WITH 'SNOWDRIFT' CRABAPPLE POLLEN AT WENATCHEE, WA (2008)

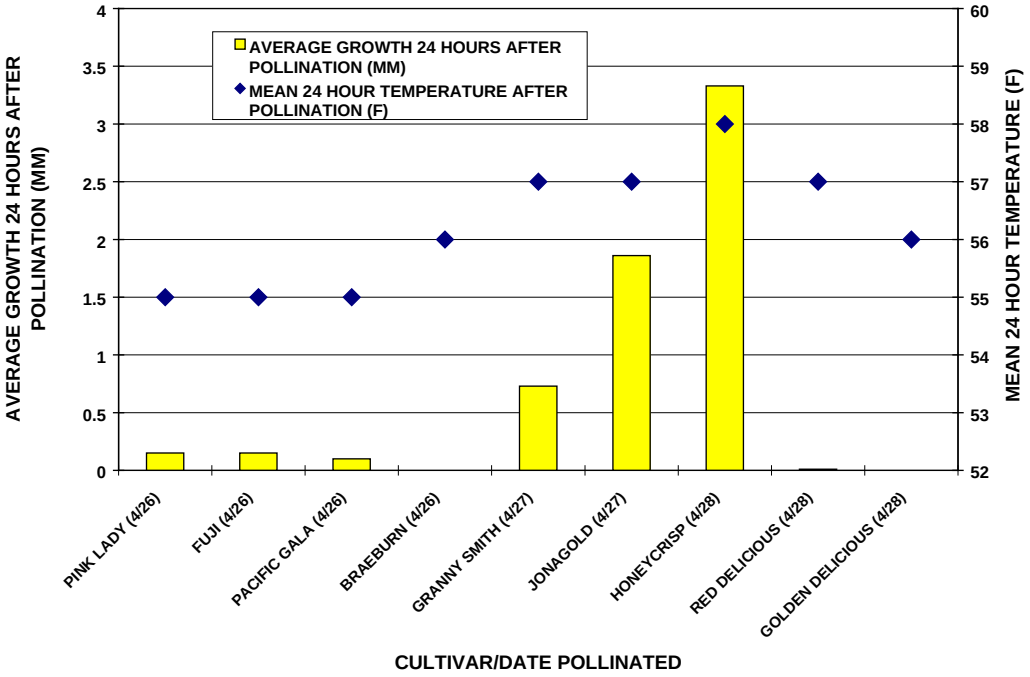


Figure 2

AVERAGE KING BLOOM STYLE LENGTH OF SELECTED WENATCHEE, WASHINGTON APPLE CULTIVARS (2008)

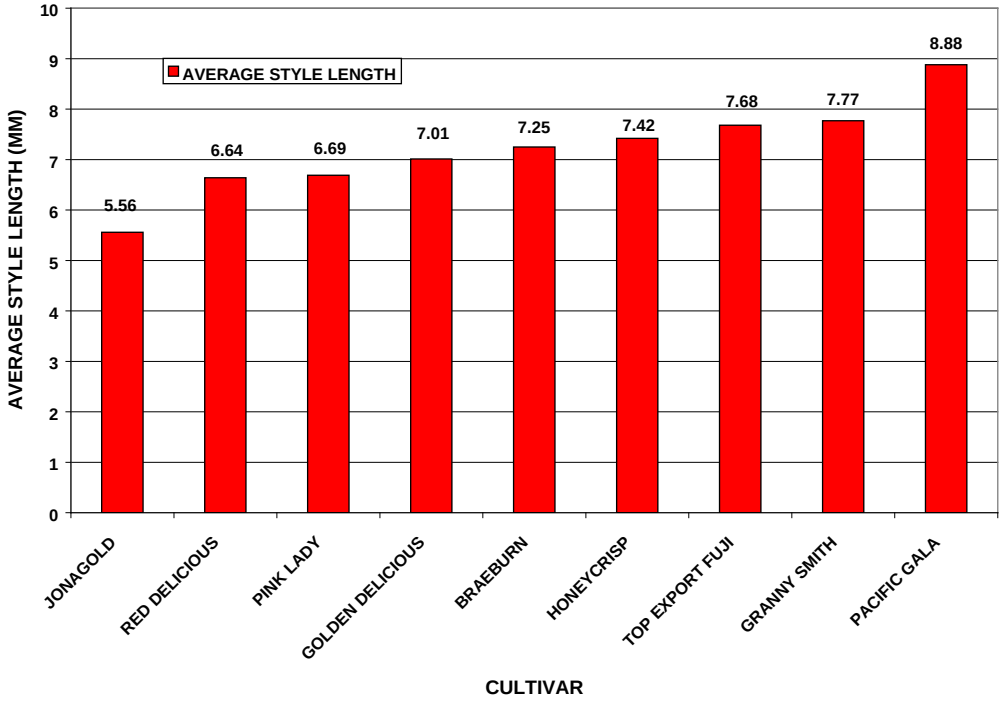


Figure 3

ESTIMATED AND ACTUAL POLLEN TUBE GROWTH IN FIELD ON PINK LADY POLLINATED FLOWERS USING GALA OR GOLDEN DELICIOUS POLLEN TUBE GROWTH MODEL (2008)

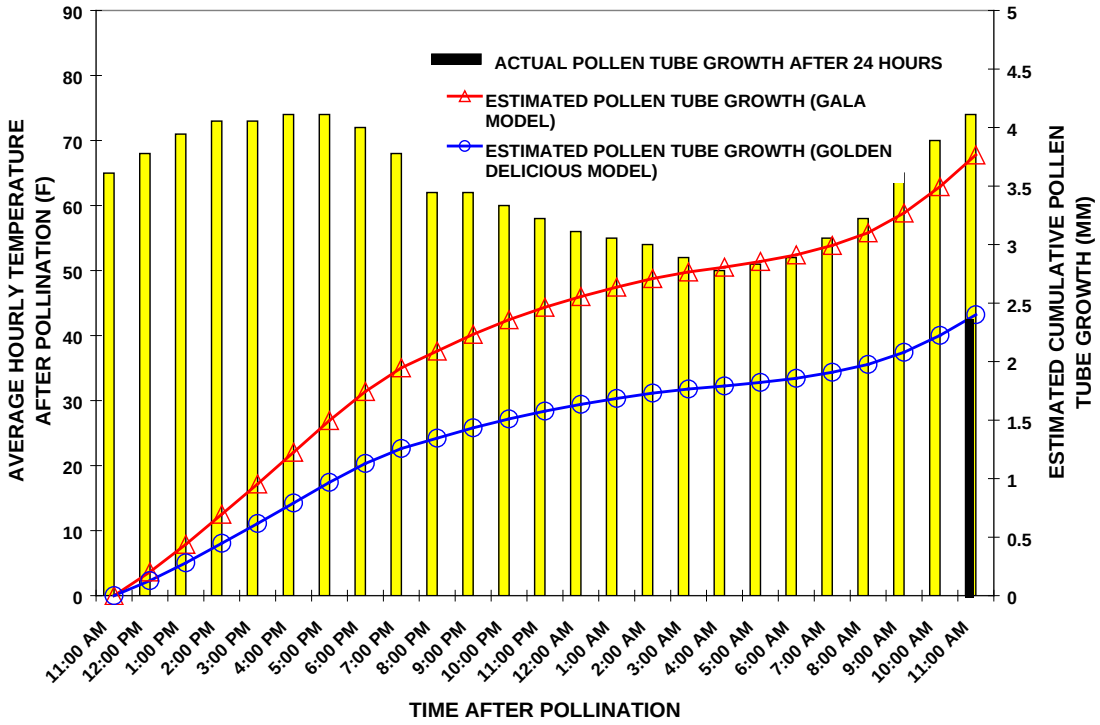
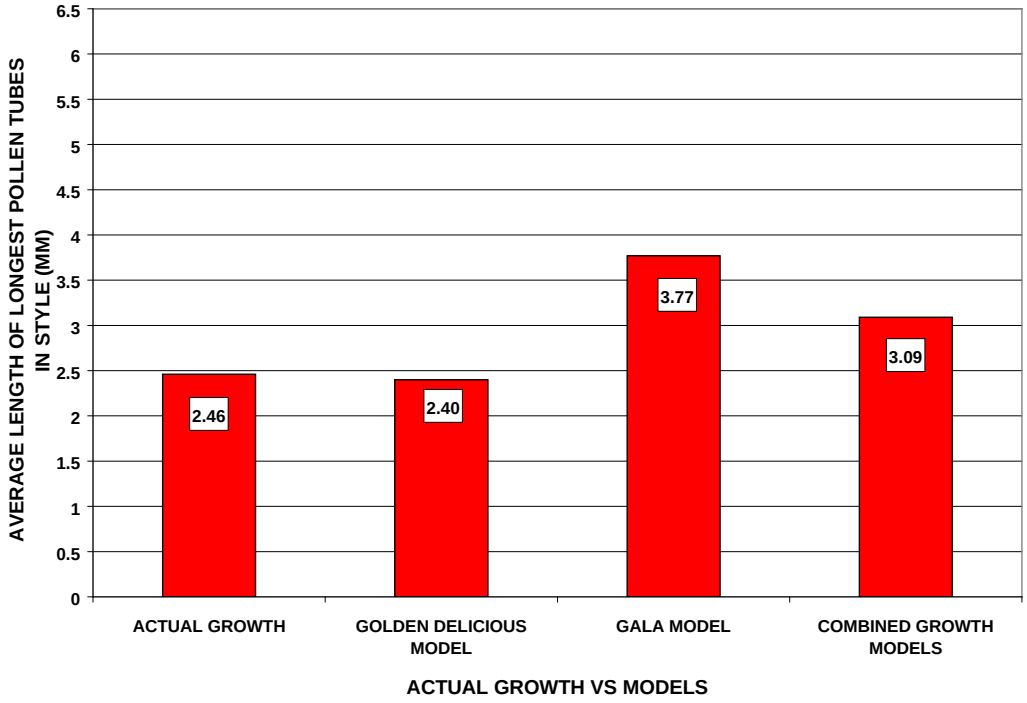


Figure 4

ACTUAL AND PROJECTED GROWTH OF POLLEN TUBES 24 HOURS AFTER HAND POLLINATION OF 'PINK LADY' IN ORCHARD USING POLLEN TUBE GROWTH MODELS (2008)



WASHINGTON STATE UNIVERSITY *World Class. Face to Face.* Campuses WSU Home WSU Search MyWSU

Tree Fruit Research and Extension Center

Integrated Pest Management Decision Aids

Weather Data provided by WSU- AgWeather Net

Model Output:
- by site
- by model
- User Setup
- Add User Data

User Sites:
- Quincy
- WSU-TFREC
- Mattawa
- Royal City

Other Links:
- TFREC home
- TFREC Entomology
- Ag Weather Net
- Fruit Pathology
- Crop Protection DB
- WTFRC

V. Jones Home

Bloom development and pollination

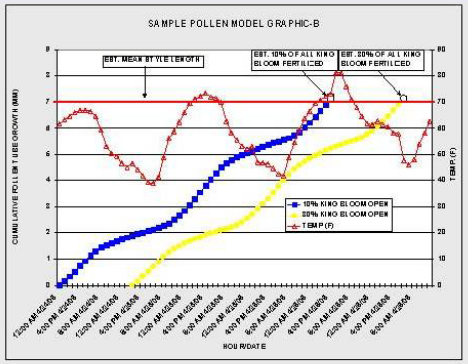
Site: WSU-TFREC

28 April 2008

Date	High Temp (°F)	Cumulative Degree-Days	Bloom Stage*	Pollination Conditions
25 Apr	64	300	10% KB (2% FB)	Fair
26 Apr	60	309	30% KB (6% FB)	Poor
27 Apr	69	326	90% KB (20% FB)	Good
Today	72	349	50% FB	Good
29 Apr	78	378	90% FB	Very Good
30 Apr	68	393	First Petal Fall	Good
1 May	65	404	30% PF	Fair

If bloom stage projections do not match your conditions, recalibrate to increase model accuracy

Recalibrate Bloom Stage



Recommendation

Strong pollination conditions require aggressive chemical thinning; preliminary application of bloom thinner should be on no later than today. Second application should be made before first petal fall. Be prepared to make initial application of postbloom thinning materials shortly thereafter.

Current Estimates*	
King bloom fertilized	25%
King bloom pollinated, but not yet fertilized	70%
Side bloom fertilized	2%
Side bloom pollinated, but not yet fertilized	35%

* based on whole tree assessment

WSU Spray Guide

Materials for Bloom Thinning
- Lime sulfur (Rex Lime Sulfur)
- Horticultural spray oils

Materials for Postbloom Thinning
- Carbaryl (Sevin)
- BA (MaxCel, Exilis Plus, RiteWay, Genesis 6-BA)
- NAA (K-Salt Fruit Fix, Fruitone)
- NAD (Amid-Thin)
- Ethephon (Ethrel)

Figure 5. An example of a possible layout of computer modeling program with interface for dissemination of relevant data into computer generated output programs (see graphic above), (from Tory Schmidt).

EXECUTIVE SUMMARY

Earlier thinning at bloom can result in better quality fruit at harvest and reduced cost for post-bloom and hand thinning. The grower wants to produce the best product that will net premium prices and we believe that this modeling program will help the grower achieve that goal. Prior to our recent studies, little was known about the influence of temperature on pollen germination, pollen tube growth, fertilization, fruit set, and the action of applied pollination/fertilization inhibitors on this process. To incorporate our data into a predictive model to be used by Washington growers, extensive field research studies using previous experimental data are required to validate and justify use of this program as a beneficial aid for growers in bloom thinning of apples. Also, data gathered in 2008 at orchard sites at Wenatchee, WA showed the need for testing additional cultivars in regards to the effect of temperature on pollen tube growth specific to cultivars. By actual use of the program concept, beta testers can evaluate the program and suggest improvements or modifications that would help refine the model into a more grower-friendly tool.

In-orchard pollen tube growth tests conducted at Va Tech AREC in Winchester, VA this spring on Pink Lady compared actual pollen tube to predicted tube growth using preliminary growth models showed similar growth rate using Golden Delicious model as standard for Pink Lady. In comparison Gala model projection was significantly different when compared to actual growth of Pink Lady pollen tubes. By combining the two growth models (Golden Delicious and Gala) the projection improves but still misses the actual growth rate, thus not providing the most accurate estimate needed for use in bloom thinning. Our preliminary results on other cultivars tested this spring demonstrate the unknown and, as of yet unverified, effects of temperature on pollen tube growth in these varieties. Without testing of these cultivars projecting pollen tube growth rates using the model could not be done correctly. By future testing, combining the growth rates for different cultivars may be possible and could be incorporated into the model as such. In the case of Pink Lady, the pollen tube growth rate is comparable to Golden Delicious but extensive tests, as was done on Golden Delicious, are needed on this variety as well to verify that fact. The development of this model will be a work in progress as new cultivars are developed in the future.