

Implementation of the Pollen Tube Growth Model in the Mid-Atlantic Region



Keith Yoder and Greg Peck

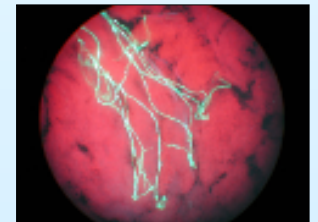
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**Virginia Tech AREC
Winchester, VA**

IFTA

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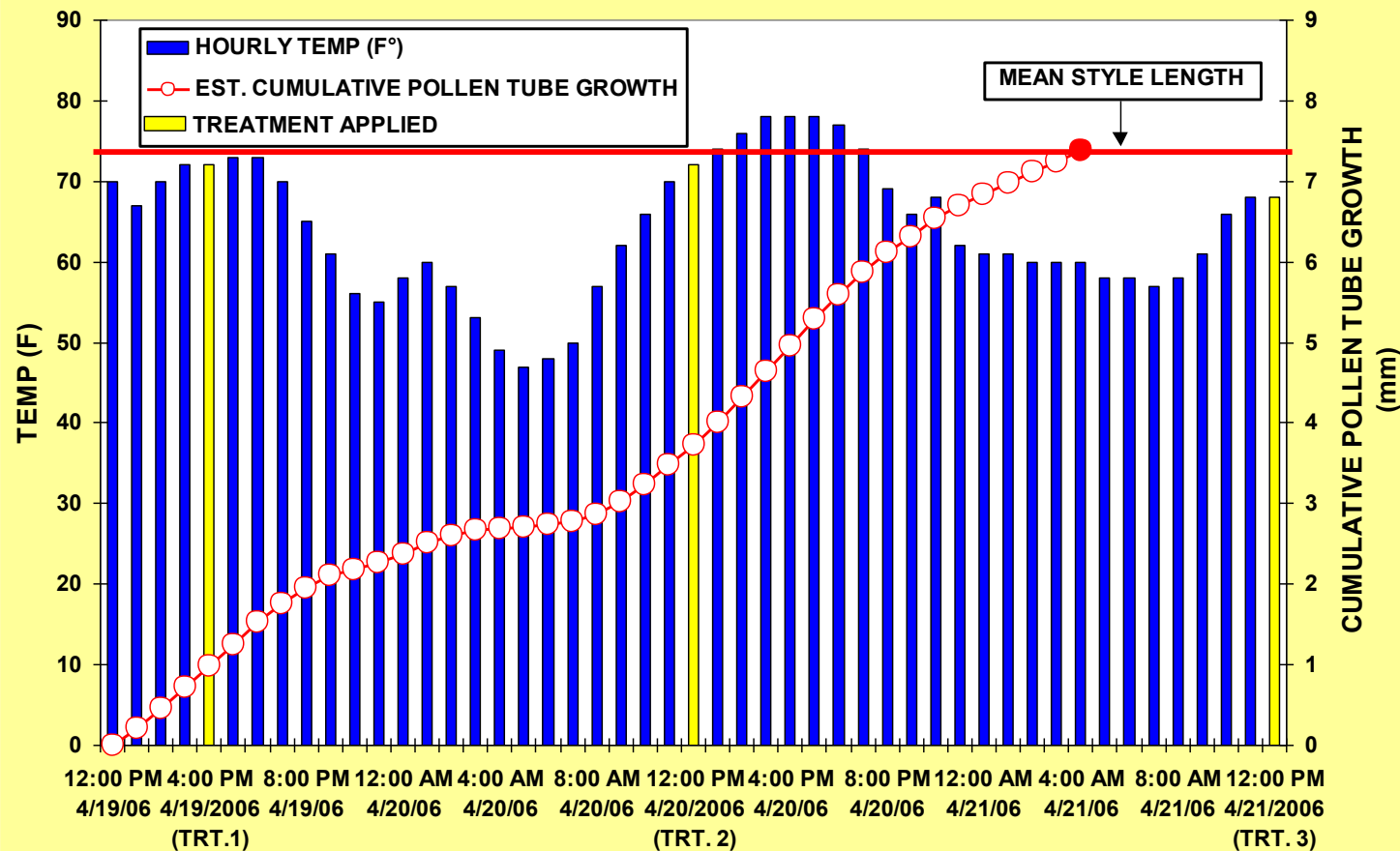


Early bloom thinning produces the largest fruit and the best return bloom

IDEAL: allow set of king bloom, then apply bloom thinner, with a minimum of injury, and prevent further set of later bloom

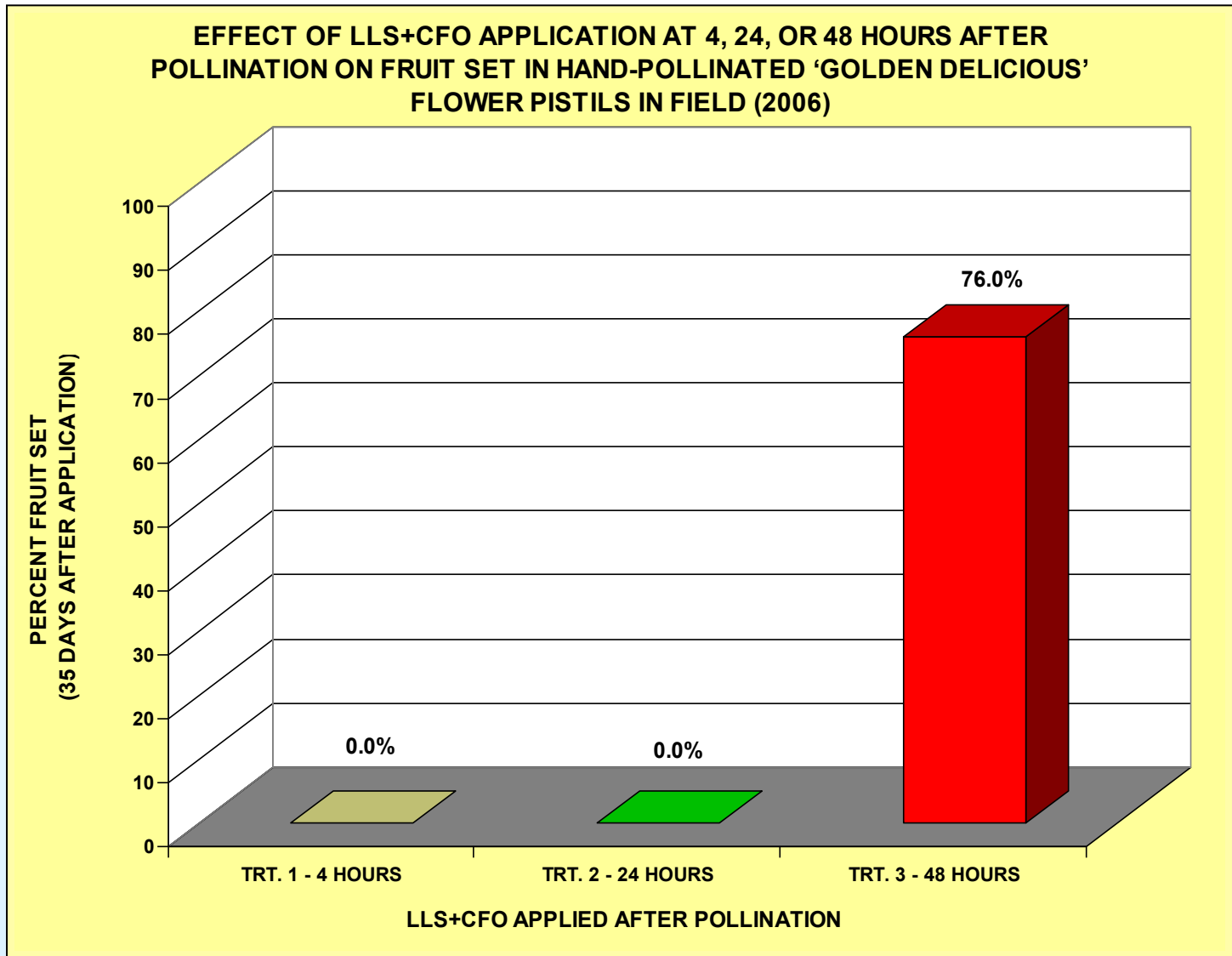
- With seeing some successes in the west, we were interested in also field-testing this in our situation in Virginia.

**EFFECT OF TIMING OF APPLICATION OF LLS+CFO AT 4, 24, OR 48 HOURS
AFTER POLLINATION ON POLLEN TUBE GROWTH IN HAND POLLINATED
'GOLDEN DELICIOUS'/M.27 FLOWER PISTILS IN FIELD (2006)**



**HOURLY TEMPERATURE AND ESTIMATED POLLEN TUBE GROWTH FROM
POLLINATION TO TIME OF LAST TREATMENT APPLICATION**

Based on test data, predicted growth progress of pollen tubes in styles can explain thinning success/failure of a 2% LLS+CFO application.



Based on predicted fertilization, in-orchard 2% LLS+CFO apps. effectively prevented fruit set at 24 hr but not at 48 hr.

**Effect of bloom thinning treatments on blossom injury,
Golden Delicious apples, 2011.**



Non-treated, 21 Apr



2% LS + CFO, 21 Apr

Materials tested

- Miller Lime Sulfur label : “Do not use this product within 30 days of an oil spray; Do not use this product for crop thinning”. It has several diseases listed for control.
- Crocker’ s Fish Oil: commonly used in the west
- JMS Stylet-Oil: several uses including powdery mildew
- MBI-106020: Experimental knotweed extract formulation; numerous diseases on Regalia label

- All have potential for OMRI approval
- Goal is to test at label rates and timings
- Look at integration of thinning and disease management

2011-12 thinning studies

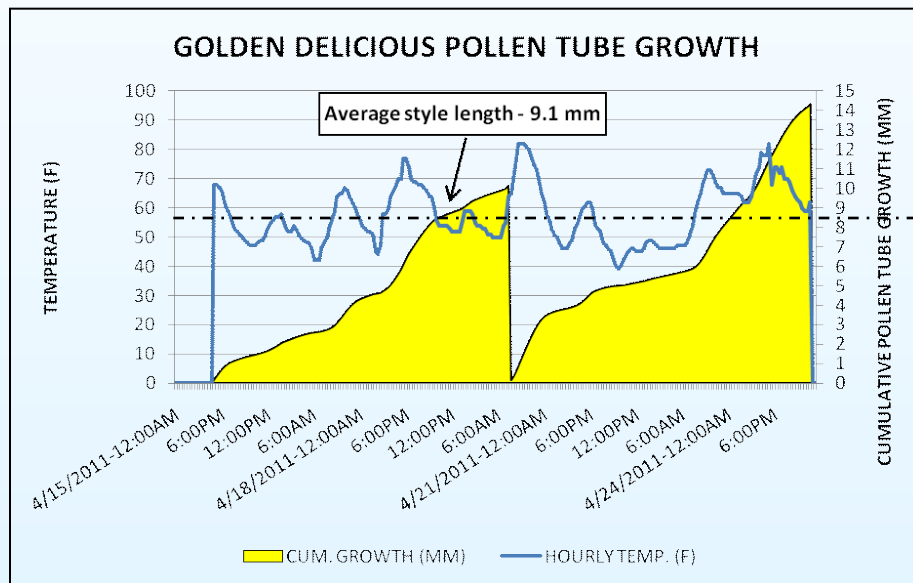


Experimental design

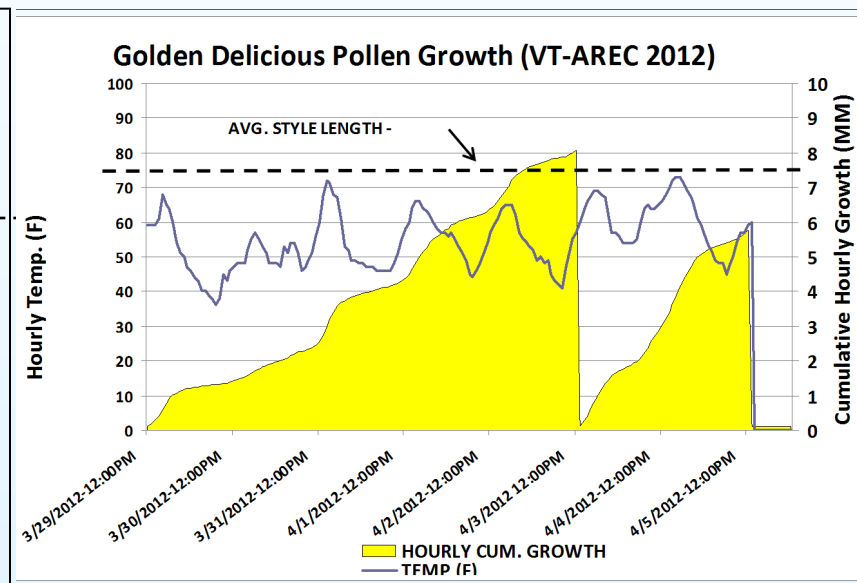
- 11-12-yr-old Golden Delicious/ M.9 trees, selected for uniform bloom
- Randomized block design with four single-tree replications
- Treatments applied dilute to runoff or with airblast sprayer
- Timing based on a bloom thinning/ pollen tube growth model
- Treatments applied 20 and 25 Apr 2011 and 3 Apr and 5 Apr 2012. Maintenance materials applied uniformly to the entire row at other times throughout the season.
- King bloom flower samples taken just before second bloom thinning application (5 Apr, 2012); 100 styles sampled.
- Fruit counts mid summer each year and harvest ratings as indicated.

Predicted pollen tube growth on Golden Delicious, 2011 and 2012

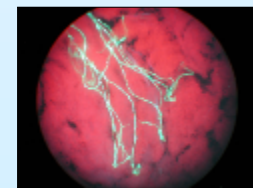
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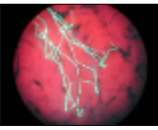


**Bloom treatments applied 20 Apr 2011
 (~10% king bloom set)
 and 25 Apr (later bloom)**



**Bloom treatments applied 3 Apr 2012
 (~10% king bloom set)
 and 5 Apr (later bloom)**





Effect of bloom thinning treatments on pollen tube growth and crop load of Golden Delicious apples, 2011.

Treatment ^z , rates per 100 gal dilute	Pollen tubes in stigma (visual rating-0-10) ^y	# pollen tubes per style penetrating stigma base	Mean length of longest pollen tube in style (mm)	# visible pollen tubes at end of styles
0 No treatment				
1 Lime Sulfur 2 gal + Crocker's Fish Oil 2 gal				
2 Lime Sulfur 2 gal + JMS Stylet-Oil 2 gal				
3 Lime Sulfur 1 gal + JMS Stylet-Oil 1 gal				
4 MBI-106020 2 pt + B-1956 8 fl oz				
5 MBI-106020 1 pt + B-1956 8 fl oz				
6 Carbaryl 4L 1 pt + NAA 5 ppm + Regulaid 11 fl oz	App. 9 May			

^zTreatments applied 20 Apr and 25 Apr. Maintenance materials applied to entire row.

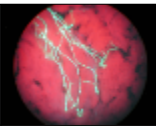
^y King bloom samples taken 48 hr after first thinning app. 22 Apr; 100 styles sampled.

^xMean separation within columns by Duncan's New Multiple Range Test ($P \leq 0.05$).

Comparisons:

Crocker's Fish Oil vs. JMS Stylet Oil; LS + JMS rates, 2% vs. 1%

MBI-106020: Marrone Bio Innovations, knotweed extract rates



Effect of bloom thinning treatments on pollen tube growth and crop load of Golden Delicious apples, 2011.

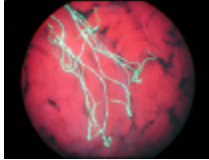
Treatment ^z , rates per 100 gal dilute	Pollen tubes in stigma (visual rating-0-10) ^y	# pollen tubes per style penetrating stigma base	Mean length of longest pollen tube in style (mm)	# visible pollen tubes at end of styles
0 No treatment	4.8 a ^x	38.7 a		
1 Lime Sulfur 2 gal + Crocker's Fish Oil 2 gal	5.2 a	37.7 a		
2 Lime Sulfur 2 gal + JMS Stylet Oil 2 gal	4.7 a	37.2 a		
3 Lime Sulfur 1 gal + JMS Stylet Oil 1 gal	4.9 a	39.2 a		
4 MBI-106020 2 pt + B-1956 8 fl oz	4.9 a	40.0 a		
5 MBI-106020 1 pt + B-1956 8 fl oz	5.2 a	42.9 a		
6 Carbaryl 4L 1 pt + NAA 5 ppm + Regulaid 11 fl oz	--	--		

^zTreatments applied 20 Apr and 25 Apr. Maintenance materials applied to entire row.

^y King bloom samples taken 48 hr after first thinning app. 22 Apr; 100 styles sampled.

^xMean separation within columns by Duncan's New Multiple Range Test ($P \leq 0.05$).

No significant effect on pollen abundance or tubes through stigma (uniform pollination).



Effect of bloom thinning treatments on pollen tube growth and crop load of Golden Delicious apples, 2011.

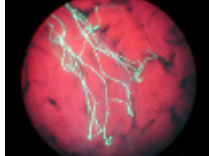
Treatment ^z , rates per 100 gal dilute	Pollen tubes in stigma (visual rating-0-10) ^y	# pollen tubes per style penetrating stigma base	Mean length of longest pollen tube in style (mm)	# visible pollen tubes at end of styles
0 No treatment	4.8 a ^x	38.7 a	4.5 a	1.0 ab
1 Lime Sulfur 2 gal + Crocker's Fish Oil 2 gal	5.2 a	37.7 a	3.7 ab	1.0 ab
2 Lime Sulfur 2 gal + JMS Stylet-Oil 2 gal	4.7 a	37.2 a	3.2 b	0.7 b
3 Lime Sulfur 1 gal + JMS Stylet-Oil 1 gal	4.9 a	39.2 a	3.9 ab	1.0 ab
4 MBI-106020 2 pt + B-1956 8 fl oz	4.9 a	40.0 a	3.7 ab	0.5 b
5 MBI-106020 1 pt + B-1956 8 fl oz	5.2 a	42.9 a	4.5 a	1.4 a
6 Carbaryl 4L 1 pt + NAA 5 ppm + Regulaid 11 fl oz	--	--	--	--

^zTreatments applied 20 Apr and 25 Apr. Maintenance materials applied to entire row.

^y King bloom samples taken 48 hr after first thinning app. 22 Apr; 100 styles sampled.

^xMean separation within columns by Duncan's New Multiple Range Test ($P \leq 0.05$).

Sig. reduction in pollen tube length (#2) and number of tubes to end of style (not fertilized, #2 & 4).



Effect of bloom thinning treatments on fruit set and crop load of Golden Delicious apples, 2011.

Treatment ^z , rates per 100 gal dilute	# visible pollen tubes at end of king styles ^y	% fruit set, side bloom, 15 clusters, 11 May 11	Fruit /cm ² limb cross sectional area (7 Jun 11)	Fruit /cm ² trunk cross sectional area before hand thinning
0 No treatment	1.0 ab	43.7 a	6.6 ab	9.9 a
1 Lime Sulfur 2 gal + Crocker's Fish Oil 2 gal	1.0 ab	18.7 b	2.1 e	2.2 d
2 Lime Sulfur 2 gal + JMS Stylet-Oil 2 gal	0.7 b	26.6 b	2.1 e	3.0 d
3 Lime Sulfur 1 gal + JMS Stylet-Oil 1 gal	1.0 ab	42.0 a	4.1 cd	5.2 c
4 MBI-106020 2 pt + B-1956 8 fl oz	0.5 b	28.0 b	5.4 bc	8.2 b
5 MBI-106020 1 pt + B-1956 8 fl oz	1.4 a	45.4 a	7.6 a	9.1 ab
6 Carbaryl 4L 1 pt + NAA 5 ppm + Regulaid 11 fl oz	--	--	3.0 de	5.7 c

^zTreatments applied 20 Apr and 25 Apr. Maintenance materials applied to entire row.

^y King bloom sampled 48 hr after first thinning app. 22 Apr; 100 styles sampled.

Mean separation within columns by Duncan's New Multiple Range Test ($P \leq 0.05$).

Significant reduction in set of side bloom by #1, 2, & 4.

Reduction in FCSA (limb) by #1-3, 6 and FCSA (trunk) by #1-4, 6 (harvest counts).

Sig. rate effects by LS + JMS and by MBI. NS: CFO vs. JMS.

Effect of bloom thinning treatments on crop load / excess fruit of Golden Delicious apples, 2011.

Treatment ^Z , rates per 100 gal dilute	Fruit /cm ² limb cross sectional area, 7 Jun 11	Average fruit weight (g) 14 Jul 11	Mean no. fruit thinned / tree 25 Jul 11
0 No treatment	6.6 ab	64.6 e	562.0 a
1 Lime Sulfur 2 gal + Crocker's Fish Oil 2 gal	2.2 e	95.6 a	24.2 d
2 Lime Sulfur 2 gal + JMS Stylet-Oil 2 gal	2.3 e	87.3 b	66.4 cd
3 Lime Sulfur 1 gal + JMS Stylet-Oil 1 gal	4.1 cd	75.8 cd	164.2 c
4 MBI-106020 2 pt + B-1956 8 fl oz	5.4 bc	70.8 de	313.0 b
5 MBI-106020 1 pt + B-1956 8 fl oz	7.6 a	71.9 de	416.6 b
6 Carbaryl 4L 1 pt + NAA 5 ppm + Regulaid 11 fl oz	3.0 de	80.4 bc	115.8 cd

^ZTreatments applied 20 Apr and 25 Apr. Crop load rated on two limbs.

^Y Fruit samples taken 14 Jul 2011.

^XMean separation within columns by DNMRT ($P \leq 0.05$).

Excess fruit removed by hand thinning, 25 Jul; General trends: stronger thinning resulted in larger fruit; fewer fruit had to be removed by hand thinning.

Effect of bloom thinning treatments on blossom injury, Golden Delicious apples, 2011.



Non-treated, 21 Apr



LS + CFO 2%, 21 Apr



LS + JMS 2%, 21 Apr



Non-treated, 26 Apr



LS + CFO 2%, 26 Apr



LS + JMS 2%, 21 Apr

Effect of bloom thinning treatments on blossom injury, Golden Delicious apples, 2011.



Non-treated, 21 Apr



LS +JMS 1%, 21 Apr



MBI 2 pt, 21 Apr



Non-treated, 26 Apr



LS +JMS 1%, 26 Apr



MBI 2 pt, 26 Apr

Effect of bloom thinning treatments on crop load and fruit russet Golden Delicious apples, 2011.

Treatment ^z , rates per 100 gal dilute	Fruit /cm ² trunk cross sectional area before		Russet rating (0-5) ^w	% USDA grade, based on down- grading from russet ^w			fruit russet, % area
	hand thinning ^y	harvest fruit wt (g)		X-Fcy	X-Fcy /Fcy	Utility	
0 No treatment	9.9 a	146.9 b	1.8 a	67 a	92 a	2 a-c	0 a
1 Lime Sulfur 2 gal + Crocker's Fish Oil 2 gal	2.2 d	170.7 a	3.6 e	5 d	37 e	30 e	10 c
2 Lime Sulfur 2 gal + JMS Stylet-Oil 2 gal	3.0 d	169.0 a	2.9 d	21 c	55 d	13 d	7 b
3 Lime Sulfur 1 gal + JMS Stylet-Oil 1 gal	5.2 c	148.1 b	2.3 a-c	53 ab	78 bc	9 cd	0 a
4 MBI-106020 2 pt + B-1956 8 fl oz	8.2 b	144.2 b	2.4 bc	47 b	84 a-c	2 ab	0 a
5 MBI-106020 1 pt + B-1956 8 fl oz	9.1 ab	144.6 b	2.1 ab	55 ab	86 ab	1 a	0 a
6 Carbaryl 4L 1 pt + NAA 5 ppm + Regulaid 11 fl oz	5.7 c	163.3 a	2.7 cd	43 b	71 c	8 b-d	0 a

^z Treatments applied 20 Apr and 25 Apr 2011; Fruit harvested 26 Sep 2011.

^y Crop load based on total fruit removed by hand 25 Jul, plus those harvested 26 Sep.

^x Mean separation within columns by Duncan's New Multiple Range Test ($P \leq 0.05$).

^w Russetting rated on a scale of 0-5 (0=perfect finish; 5=severe russet). USDA Extra fancy, fancy and utility grades after downgrading by russet.

**Significant. russet effect on X-Fcy grade-out by #1, 2, 4, & 6 (conventional);
X-Fcy + Fcy reduced by #1, 2, 3, & 6. JMS better than CFO.
Dilute rates probably higher than needed- more phytotoxicity and russet**

2012 study

Treatment (rate/100 gal water)	Average style length (mm)	Mean length of longest pollen tube in style mm)	% of styles with pollen tubes at end of styles	Pollen tubes in stigma visual rating (0-10)	Mean pollen tubes/ style penetrating stigma base	Mean number of visible pollen tubes at end of styles
No treatment	7.9 a	6.7 a	84 a	6.0 a ^x	46.3 a	1.7 a
Lime Sulfur 2 gal + Crocker' s Fish Oil 2 gal	7.6 bc	2.4 d	11 c	3.4 bc	22.2 b	0.3 cd
Lime Sulfur 2 gal + JMS Stylet Oil 2 gal	7.4 cd	1.4 e	8 c	2.7 d	13.6 c	0.1 d
Lime Sulfur 2 gal + JMS Stylet Oil 2 gal (Airblast)	7.6 b	2.8 cd	23 bc	3.9 b	20.9 b	0.3 cd
Lime Sulfur 1 gal + JMS Stylet Oil 1 gal	7.4 cd	3.6 b	45 b	3.6 b	22.6 b	0.7 b
MBI-106020 4 pt + B-1956 8 fl oz	7.6 bc	3.1 bc	29 bc	3.5 b	19.8 b	0.5 bc
MBI-106020 2 pt + B-1956 8 fl oz	7.5 bcd	3.0 cd	20 bc	3.9 b	22.6 b	0.3 cd
NAA 5 ppm + Carbaryl 1 pt + Regalaid 11 fl oz <i>10 mm</i>	--	--	--	--	--	--

Compared to non-trt, all sig. reduced longest pollen tube in style ; similar effect on % styles with tubes at end of styles
 Strongest effect by higher rate of 2% LS + JMS, dilute; (airblast app. weaker). 2% + JMS stronger than 2% + CFO.
 Significant effects by both rates of MBI

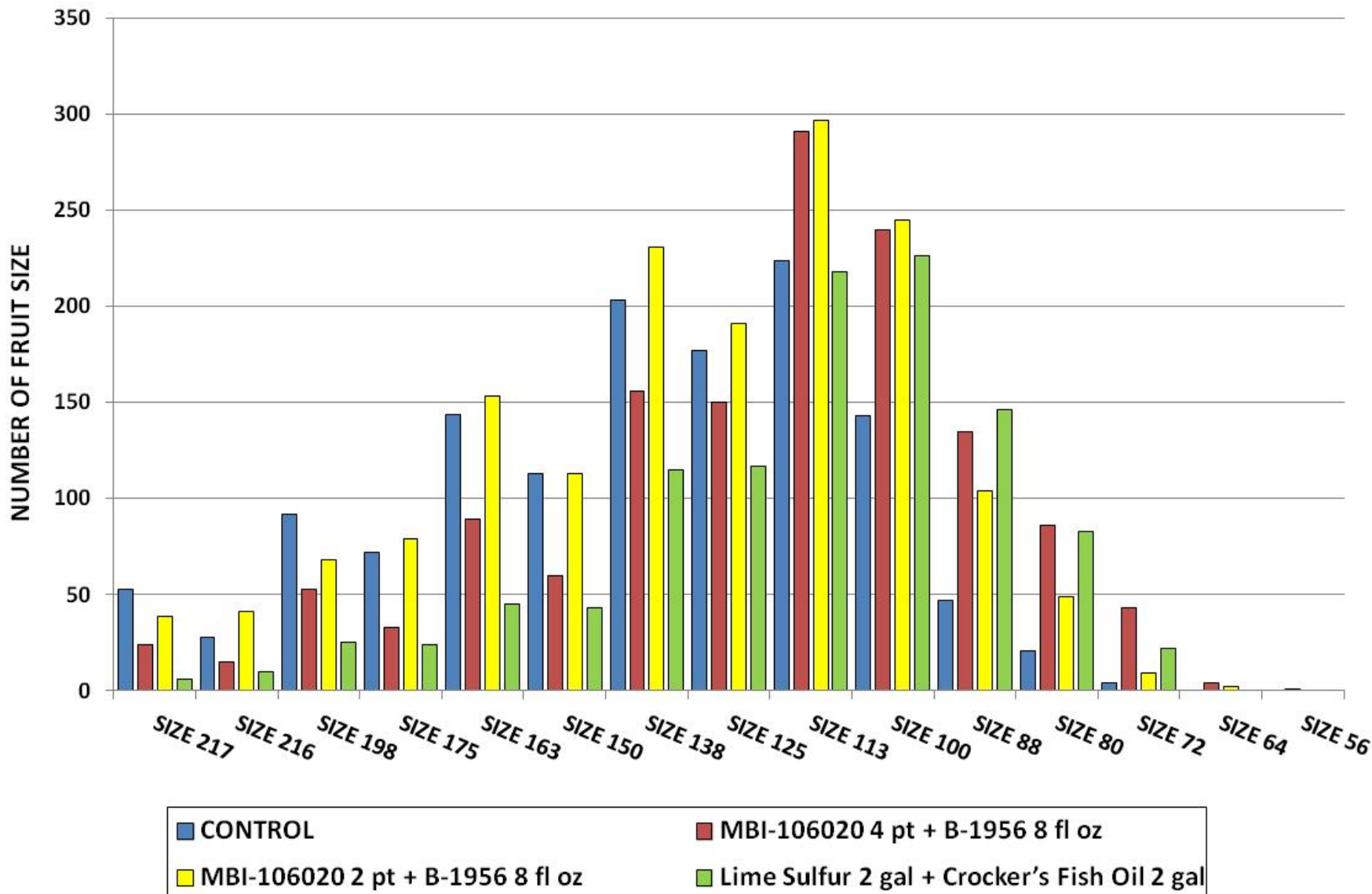
Treatment ^z (rate/100 gal water)	Fruit /cm ² limb cross sectional area, 11 Jul 12	Average fruit length (cm) 13 Sep 12	Average fruit diameter (cm) 13 Sep 12	Average fruit weight (g) 13 Sep 12
No treatment	6.8 a ^y	162.3 e	176.6 c	151.6 e
Lime Sulfur 2 gal + Crocker's Fish Oil 2 gal	4.3 cd	170.3 cd	182.5 b	183.8 bc
Lime Sulfur 2 gal + JMS Stylet Oil 2 gal	1.9 e	177.0 ab	190.5 a	195.4 ab
Lime Sulfur 2 gal + JMS Stylet Oil 2 gal (Airblast)	5.4 a-c	172.1 a-d	183.6 b	181.4 bc
Lime Sulfur 1 gal + JMS Stylet Oil 1 gal	3.7 d	177.3 a	190.7 a	202.2 a
MBI-106020 4 pt + B-1956 8 fl oz	4.3 cd	171.0 b-d	187.0 ab	179.5 bc
MBI-106020 2 pt + B-1956 8 fl oz	6.2 ab	168.3 de	184.7 b	161.2 de
NAA 5 ppm + <i>10 mm</i> Carbaryl 1 pt + Regulaid 11 fl oz	1.4 e	166.4 a-c	190.1 a	211.4 a

Strongest thinning resulted in fewer fruit/LCSA in July and larger fruit in Sept.

Treatment ^z (rate/100 gal water)	Mean single fruit wt (g) at harvest	Russet rating (0-5)	% USDA grade, based on down-grading from russet		
			X-Fcy	X-Fcy/Fcy	Utility
No treatment	151.6 e	2.7 a-d	32 b-d	61 b-d	13 a-c
Lime Sulfur 2 gal + Crocker' s Fish Oil 2 gal	183.8 bc	3.7 e	9 a	30 a	20 cd
Lime Sulfur 2 gal + JMS Stylet Oil 2 gal	195.4 ab	2.4 ab	41 cd	71 cd	9 a-c
Lime Sulfur 2 gal + JMS Stylet Oil 2 gal (Airblast)	181.4 bc	2.2 a	48 d	70 cd	3 ab
Lime Sulfur 1 gal + JMS Stylet Oil 1 gal	202.2 a	2.3 a	52 d	80 d	4 a
MBI-106020 4 pt + B-1956 8 fl oz	179.5 bc	3.1 b-e	19 a-c	43 ab	12 a-c
MBI-106020 2 pt + B-1956 8 fl oz	161.2 de	2.5 a-c	35 b-d	63 b-d	4 ab
NAA 5 ppm + <i>10 mm</i> Carbaryl 1 pt + Regulaid 11 fl oz	211.4 a	3.4 de	16 ab	46 a-c	27 c

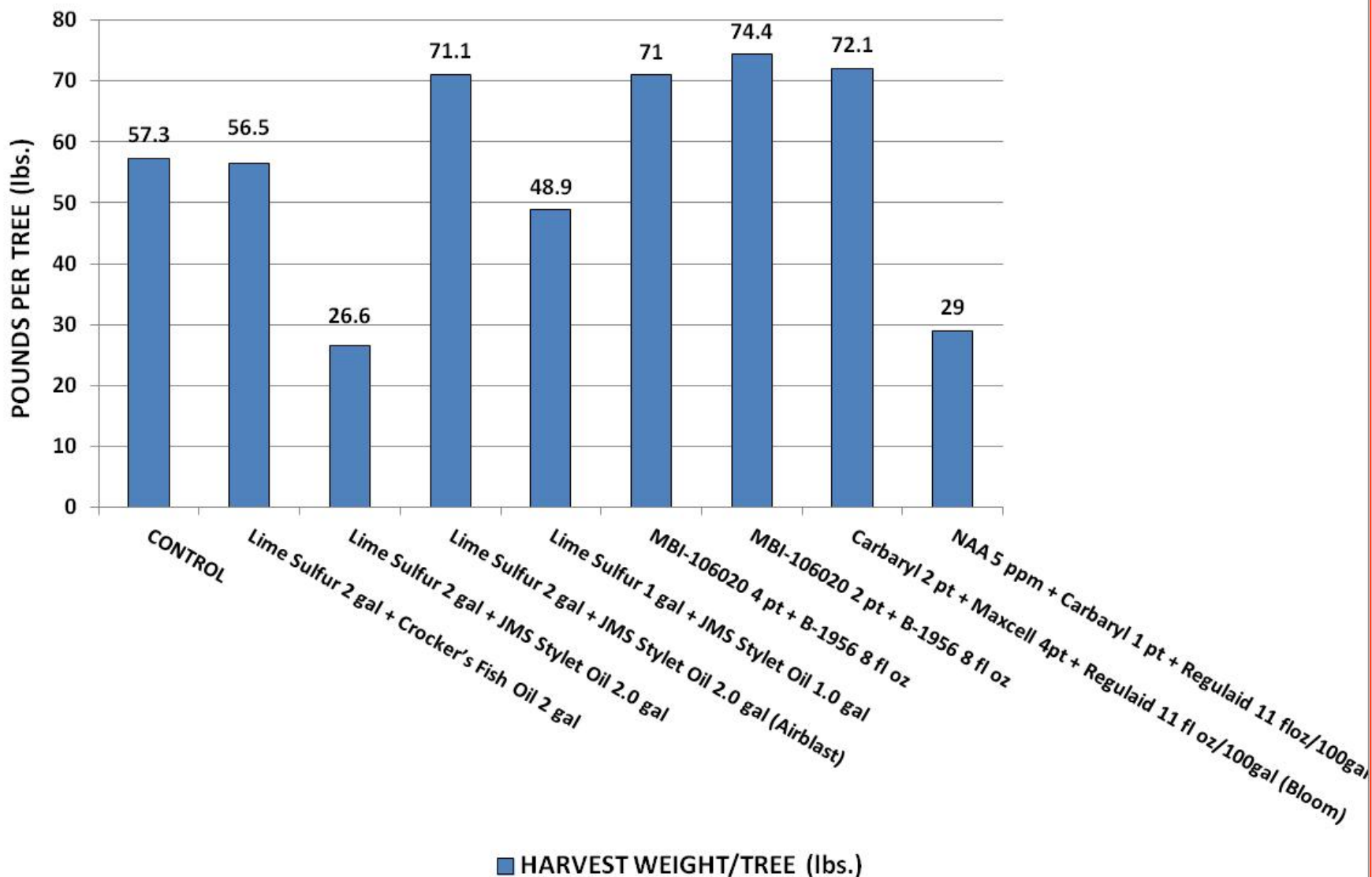
Finish generally poor in ' 12; most russet on 2% LS + CFO, conventional, and MBI 4 pt. Relatively less russet and good fruit size by LS +JMS 2% or 1%

Golden Delicious Bloom Thinning - Hort Block #26 (2012)



Shift to larger size distribution with LS + CFO and MBI 4 and 2 pt.

Golden Delicious Bloom Thinning - Hort Block #26 (2012)



Overall yield by LS + JMS 2% and both MBI rates generally high

Disease control by lime sulfur and oils applied as bloom thinners

Ginger Gold, Virginia Tech AREC, 2011

Bloom treatment and rate/ 100 gal; (all trts covered with Rally 12 May-5 Jul)	Bloom timing	Scab, % inf. lvs 1-10	fruit	Mildew , % inf lvs 1-10	area
0 No fungicide	---	29 c	88 c	48 b	46 b
1 Lime Sulfur 2% + Crocker's Fish Oil 2%	4/19, 22, & 27	7 a	19 ab	21 a	5 a
2 Lime Sulfur 2% + Crocker's Fish Oil 2%	4/20, 22, & 27	8 a	18 ab	21 a	4 a
3 Lime Sulfur 2% + Crocker's Fish Oil 2%	4/22 & 27	10 ab	33 b	22 a	5 a
4 Lime Sulfur 2% + JMS Stylet Oil 2%	4/22 & 27	7 a	15 a	21 a	4 a
5 Lime Sulfur 1% + JMS Stylet Oil 1%	4/22 & 27	6 a	35 b	19 a	5 a
6 Lime Sulfur 1% + JMS Stylet Oil 1% + Rally 1.25 oz	4/22 & 27	6 a	24 ab	16 a	4 a
7 Rally 40W 1.25 oz	4/22 & 27	18 b	77 c	20 a	4 a

Waller-Duncan K-ratio t-test (p=0.05). Four single-tree replications.

Treatments applied 4/19 (trt. #1 only, pink-PF); 4/20 (trt. #2 only, pink to petal fall); 4/22 (all trts, full bloom); 4/27 (follow up for late bloom thinning, all treatments, PF).

- * Except for Rally on fruit scab, all treatments gave significant control of all diseases.
- * Supplemental app. of LS + Crocker's Fish Oil 19 or 20 Apr and treatments of Stylet Oil (1 or 2%) with Lime Sulfur all gave more foliar scab control than the Rally alone.
- * Scab control by Rally may have been affected by SI-resistant scab in the test area.
- * All treatments gave control of mildew; no sig. differences among treatments whether considering only terminal shoot leaves 1-10 (early season), all leaves or percent area affected of all leaves.

Crop load with lime sulfur and oils applied as bloom thinners Ginger Gold, Virginia Tech AREC, 2011

Bloom treatment and rate/ 100 gal	Bloom spray timing	Estimates of % of crop load on tree *	
		14 Jul	19 Aug
0 No fungicide	---	96 b	111 b
1 Lime Sulfur 2% + Crocker's Fish Oil 2%	4/19, 22, & 27	66 ab	61 a
2 Lime Sulfur 2% + Crocker's Fish Oil 2%	4/20, 22, & 27	30 a	44 a
3 Lime Sulfur 2% + Crocker's Fish Oil 2%	4/22 & 27	78 ab	94 ab
4 Lime Sulfur 2% + JMS Stylet Oil 2%	4/22 & 27	66 ab	66 a
5 Lime Sulfur 1% + JMS Stylet Oil 1%	4/22 & 27	73 ab	93 ab
6 Lime Sulfur 1% + JMS Stylet Oil 1% + Rally 1.25 oz	4/22 & 27	120 b	93 ab
7 Rally 40W 1.25 oz	4/22 & 27	125 b	114 ab

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four single-tree reps. Applications: 4/19 (trt. #1 only, pink to petal fall); 4/20 (trt. #2 only, pink to PF); 4/22 (all trts, full bloom); 4/27 (follow up for late bloom thinning, all trts, PF).

*Crop load evaluated by two observers before harvest or at harvest 19 Aug.

- * Compared to non-treated trees Trt #2, Lime Sulfur 2% + Crocker's Fish Oil 2%, applied on 20, 22, and 27 Apr did the most thinning, although this treatment was not significantly different from several others in crop load.
- * Greater effectiveness may have been due to warmer weather on 20 Apr (max 82 F) compared to the application made earlier 19 Apr (max 59 F) or those made later (max 43 F).

Fruit finish by lime sulfur and oils applied as bloom thinners Ginger Gold, Virginia Tech AREC, 2011

Bloom treatment and rate/ 100 gal	Bloom spray timing	Fruit finish assessments**		
		% of fruits with side russet, on tree 14 Jul	% fruit area russetted	stem-end russet (0-5)
0 No fungicide	---	4 a	0.8 a	1.1 a
1 Lime Sulfur 2% + Crocker's Fish Oil 2%	4/19, 22, & 27	28 b	9.7 bc	1.7 ab
2 Lime Sulfur 2% + Crocker's Fish Oil 2%	4/20, 22, & 27	34 b	7.0 b	2.3 b
3 Lime Sulfur 2% + Crocker's Fish Oil 2%	4/22 & 27	29 b	7.2 b	1.8 ab
4 Lime Sulfur 2% + JMS Stylet Oil 2%	4/22 & 27	30 b	12.8 cd	1.8 ab
5 Lime Sulfur 1% + JMS Stylet Oil 1%	4/22 & 27	49 b	14.0 d	1.3 a
6 Lime Sulfur 1% + JMS Stylet Oil 1% + Rally 1.25 oz	4/22 & 27	45 b	12.6 cd	1.6 ab
7 Rally 40W 1.25 oz	4/22 & 27	3 a	0.5 a	1.1 a

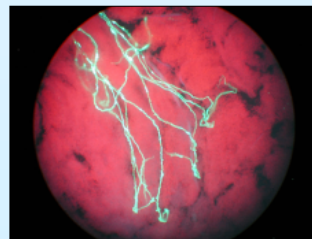
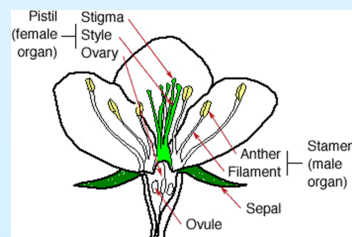
Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four single-tree reps.
Applications: 4/19 (trt. #1 only, pink to petal fall); 4/20 (trt. #2 only, pink to PF);
4/22 (all trts, full bloom); 4/27 (follow up for late bloom thinning, all trts, PF).

** Fruit russet ratings means of 25-fruit /rep on tree or after harvest 19 Aug.
Stem russet rated on a scale of 0-5 (5= severe russet).

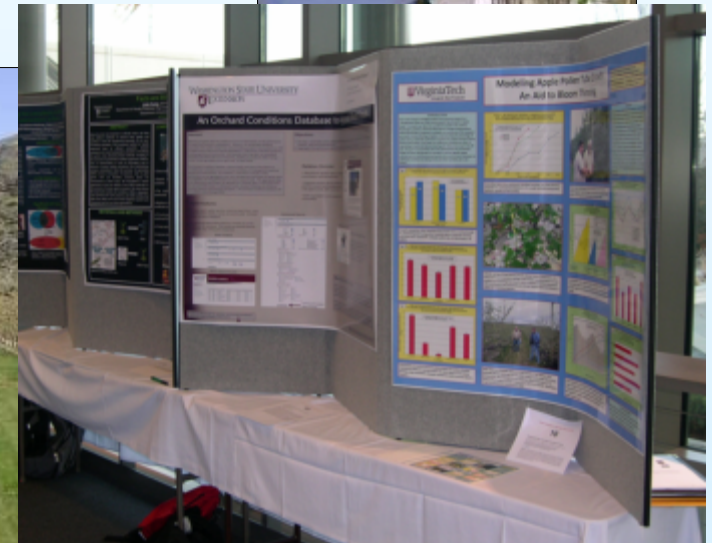
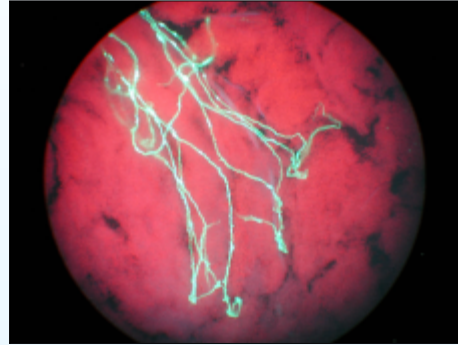
- * All LS-related treatments increased the percent of fruits with russet and percent area russetted.
- * Combinations of Lime Sulfur with JMS Stylet Oil tended to have more area russetted than those with Crocker's Fish Oil.
- * The 20 Apr app. of Lime Sulfur 2% + Crocker's Fish Oil 2% was the only treatment that resulted in a significantly higher stem end russet rating.

Summary

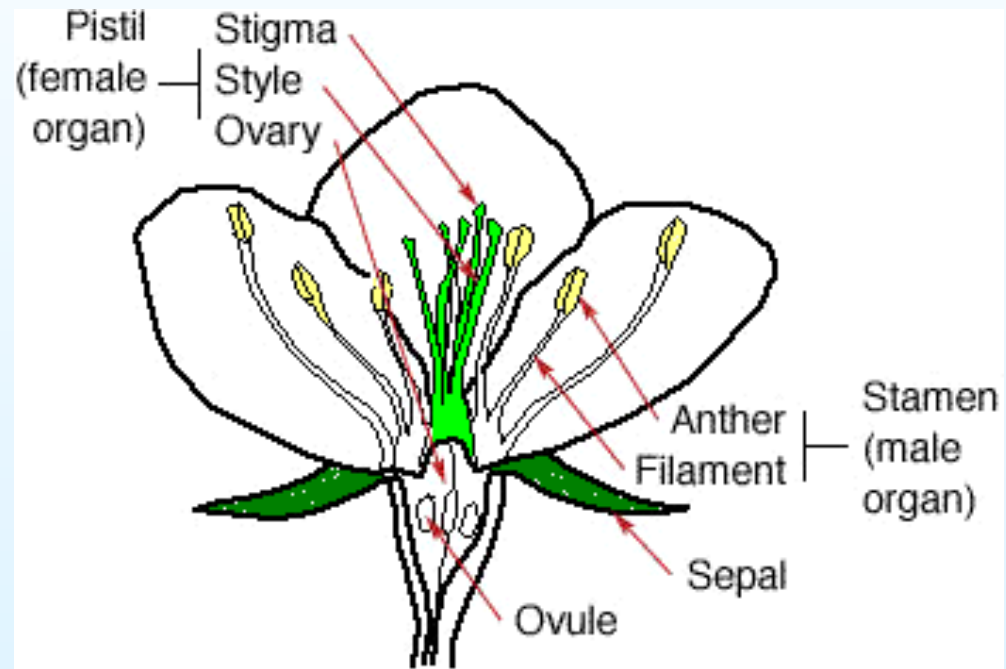
- The pollen tube growth model can be used to improve bloom thinning application timing in the east as well as the west.
- There is potential for utilizing disease management products for bloom thinning, but some eastern labels warn against that use.
- Combinations of Lime Sulfur with Crocker's Fish Oil or JMS Stylet Oil and an experimental knotweed extract give some disease control.
- At the rates tested, all treatments gave some petal injury and various amounts of russeting.
- Hopefully, with fine-tuning of rates and optimal timing and other approaches, more thinning can be achieved with minimal fruit russeting and more favorable labeling can be obtained.

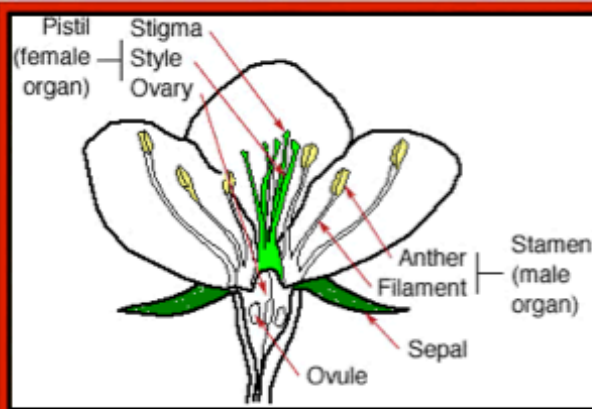


QUESTIONS/COMMENTS?



Apple flower pollination/ fertilization





Pollen Tubes

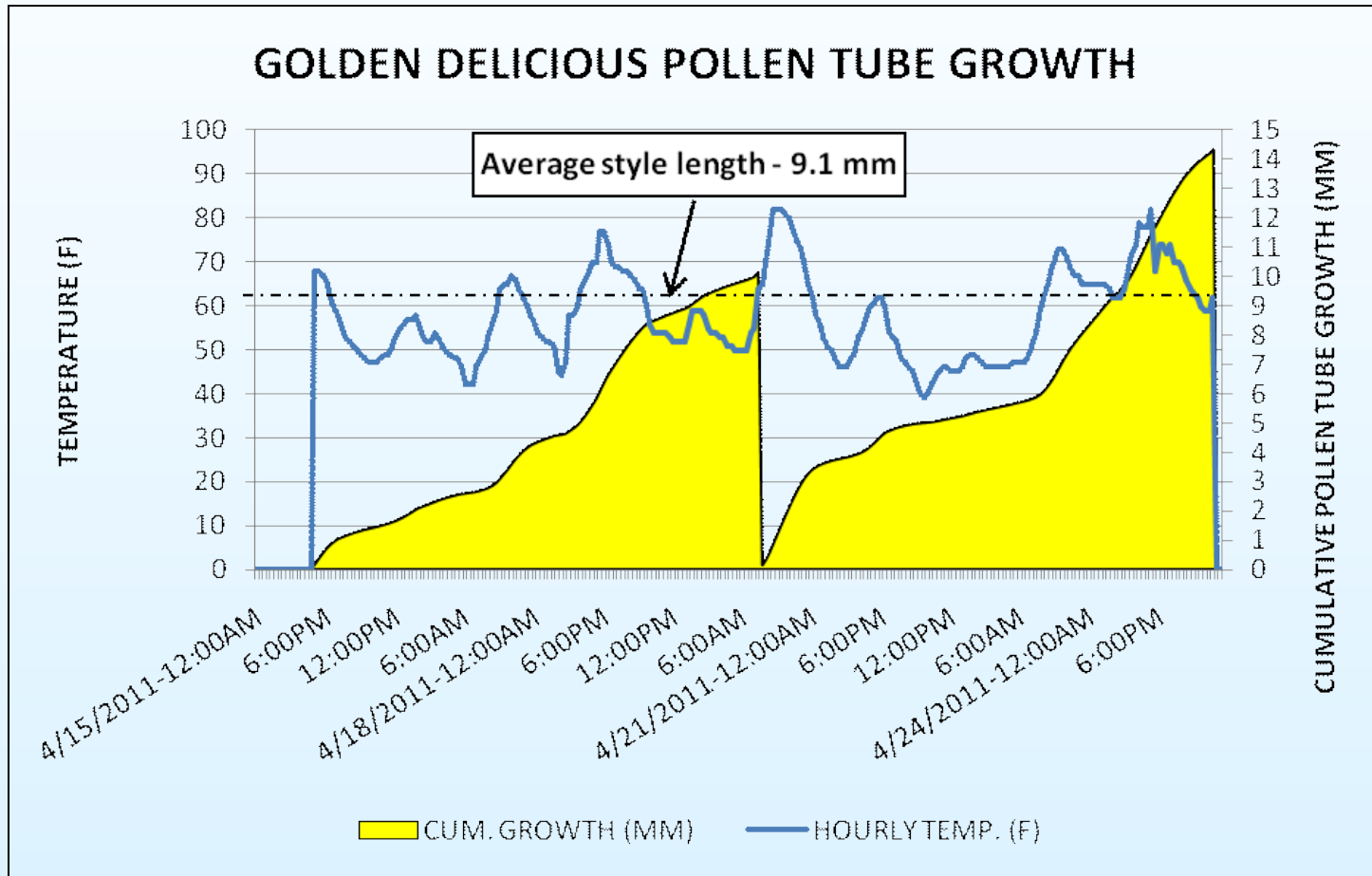
Ovule

Ovule

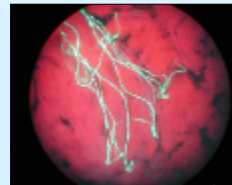
Fertilization is determined by evaluating stained pollen tubes using fluorescence microscopy.

Predicted pollen tube growth on Golden Delicious, 2011

Virginia Tech AREC, Winchester

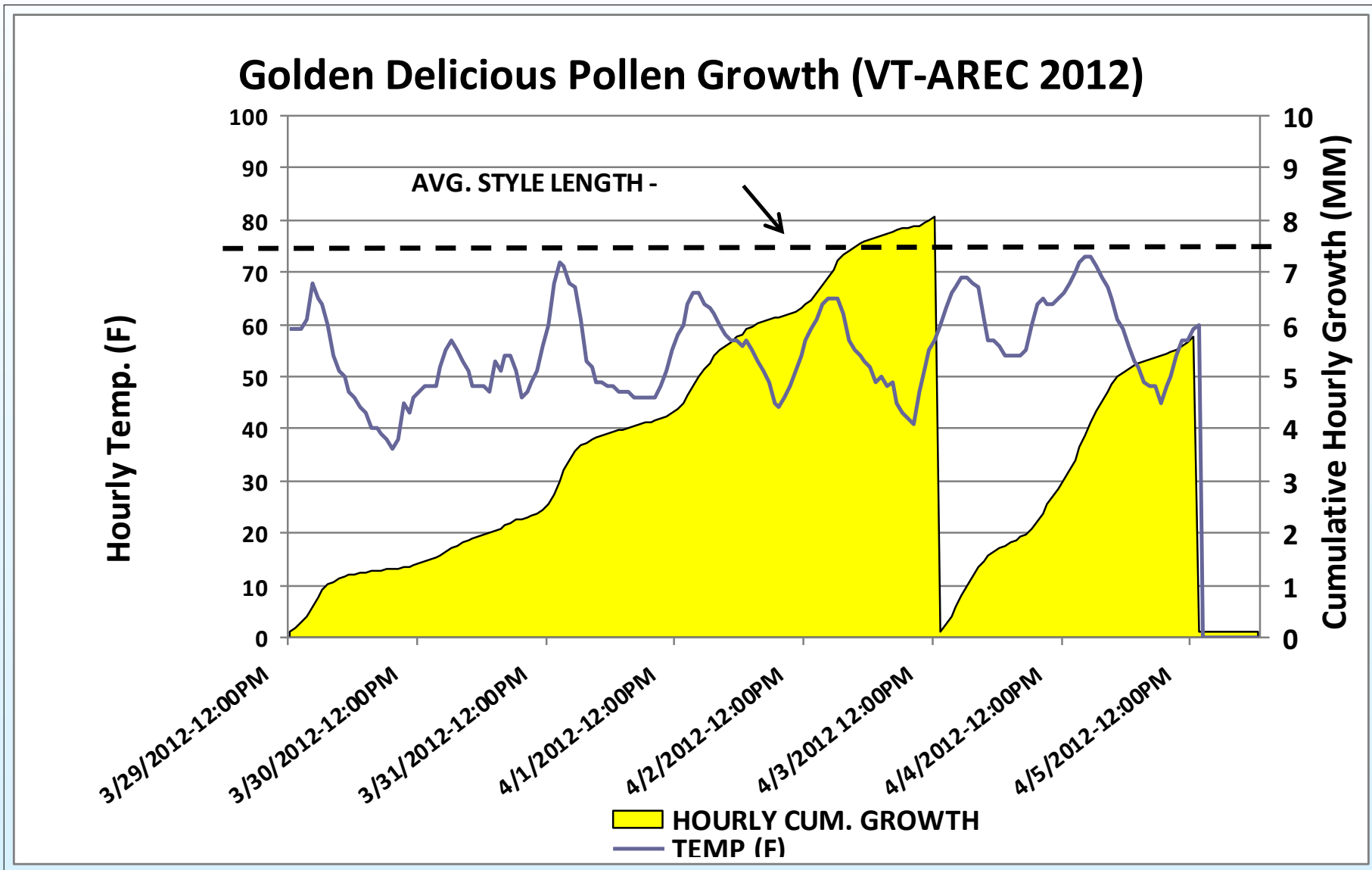


**Bloom treatments applied 20 Apr (~10% king bloom set)
and 25 Apr (later bloom)**



Predicted pollen tube growth on Golden Delicious, 2012

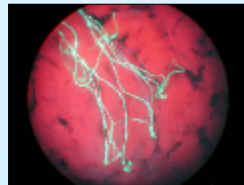
Virginia Tech AREC, Winchester



Bloom thinning test on Golden Delicious, 2011

Virginia Tech AREC, Winchester

- 11-yr-old Golden Delicious/ M.9 trees, selected for uniform bloom
- Randomized block design with five single-tree reps.
- Treatments applied dilute to runoff with a single nozzle handgun
- Timing based on a bloom thinning/ pollen tube growth model
- Treatments applied 20 Apr, (~10% king bloom fertilized),
and again at late bloom 25 Apr.
- King bloom flower samples taken 22 Apr, 48 hr after first bloom app.
- Evaluated pollen tube growth in 100 styles using fluorescence microscopy
- Conventional trt.: Carbaryl + Maxcell + Regulaid, applied at 5-7 mm 6 May
- Crop load assessed on two representative limbs 7 Jun
- Random fruit samples were weighed 14 Jul
- Excessively set trees were hand-thinned 25 Jul to prevent limb breakage
- Maintenance fungicides and insecticides applied airblast through the season
- Fruit harvested 26 Sep and weighed on a grader
- Fruit finish was visually rated on 25 fruit per replicate tree.



2012 study



- Examines several critical issues
 - Can a pollen tube growth model be used to improve bloom thinning application timing?
 - Can bloom thinning be successful in the Eastern US?
 - What materials and rates are most efficacious?
- Experimental design
 - 12-yr-old Golden Delicious/ M.9 trees, selected for uniform bloom, in Winchester, VA
 - Randomized block design with four single-tree replications
 - Treatments applied dilute to runoff with a single nozzle handgun or airblast sprayer
 - Timing based on a bloom thinning/ pollen tube growth model
 - Treatments applied 3 Apr and 5 Apr. Maintenance materials applied uniformly to the entire row at other times throughout the season.
 - Fruit count taken July 11, 2012. King bloom flower samples taken 5 Apr just before the second bloom thinning application (5 Apr, 2012); 100 styles sampled.
 - Mean separation within columns by Waller-Duncan K-ratio t Test

2012 study

Treatment (rate/100 gal water)	Average style length (mm)	Mean length of longest pollen tube in style mm)	% of styles with pollen tubes at end of styles	Pollen tubes in stigma visual rating (0-10)	Mean pollen tubes/ style penetrating stigma base	Mean number of visible pollen tubes at end of styles
No treatment	7.9 a	6.7 a	84 a	6.0 a ^x	46.3 a	1.7 a
Lime Sulfur 2 gal + Crocker' s Fish Oil 2 gal	7.6 bc	2.4 d	11 c	3.4 bc	22.2 b	0.3 cd
Lime Sulfur 2 gal + JMS Stylet Oil 2 gal	7.4 cd	1.4 e	8 c	2.7 d	13.6 c	0.1 d
Lime Sulfur 2 gal + JMS Stylet Oil 2 gal (Airblast)	7.6 b	2.8 cd	23 bc	3.9 b	20.9 b	0.3 cd
Lime Sulfur 1 gal + JMS Stylet Oil 1 gal	7.4 cd	3.6 b	45 b	3.6 b	22.6 b	0.7 b
MBI-106020 4 pt + B-1956 8 fl oz	7.6 bc	3.1 bc	29 bc	3.5 b	19.8 b	0.5 bc
MBI-106020 2 pt + B-1956 8 fl oz	7.5 bcd	3.0 cd	20 bc	3.9 b	22.6 b	0.3 cd
MaxCel 4 pt + Carbaryl 2 pt + Regulaid 11 fl oz	7.3 d	2.7 cd	25 bc	2.9 cd	17.7 bc	0.4 c
NAA 5 ppm + Carbaryl 1 pt + Regulaid 11 fl oz <i>10 mm</i>	--	--	--	--	--	--

Treatment ^z (rate/100 gal water)	Fruit /cm ² limb cross sectional area, 11 Jul 12	Average fruit length (cm) 13 Sep 12	Average fruit diameter (cm) 13 Sep 12	Average fruit weight (g) 13 Sep 12
No treatment	6.77 a ^y	162.3 e	176.6 c	151.6 e
Lime Sulfur 2 gal + Crocker's Fish Oil 2 gal	4.33 cd	170.3 cd	182.5 b	183.8 bc
Lime Sulfur 2 gal + JMS Stylet Oil 2 gal	1.86 e	177.0 ab	190.5 a	195.4 ab
Lime Sulfur 2 gal + JMS Stylet Oil 2 gal (Airblast)	5.41 a-c	172.1 a-d	183.6 b	181.4 bc
Lime Sulfur 1 gal + JMS Stylet Oil 1 gal	3.70 d	177.3 a	190.7 a	202.2 a
MBI-106020 4 pt + B-1956 8 fl oz	4.25 cd	171.0 b-d	187.0 ab	179.5 bc
MBI-106020 2 pt + B-1956 8 fl oz	6.19 ab	168.3 de	184.7 b	161.2 de
MaxCel 4 pt + Carbaryl 2 pt + Regulaid 11 fl oz	5.13 b-d	174.5 a-c	186.2 ab	172.6 cd
NAA 5 ppm + Carbaryl 1 pt + Regulaid 11 fl oz	1.40 e	166.4 a-c	190.1 a	211.4 a

10 mm

Treatment ^z (rate/100 gal water)	Mean single fruit wt (g) at harvest	Russet rating (0-5)	% USDA grade, based on down-grading from russet		
			X-Fcy	X-Fcy/Fcy	Utility
No treatment	151.6 e	2.7 a-d	32 b-d	61 b-d	13 a-c
Lime Sulfur 2 gal + Crocker' s Fish Oil 2 gal	183.8 bc	3.7 e	9 a	30 a	20 cd
Lime Sulfur 2 gal + JMS Stylet Oil 2 gal	195.4 ab	2.4 ab	41 cd	71 cd	9 a-c
Lime Sulfur 2 gal + JMS Stylet Oil 2 gal (Airblast)	181.4 bc	2.2 a	48 d	70 cd	3 ab
Lime Sulfur 1 gal + JMS Stylet Oil 1 gal	202.2 a	2.3 a	52 d	80 d	4 a
MBI-106020 4 pt + B-1956 8 fl oz	179.5 bc	3.1 b-e	19 a-c	43 ab	12 a-c
MBI-106020 2 pt + B-1956 8 fl oz	161.2 de	2.5 a-c	35 b-d	63 b-d	4 ab
MaxCel 4 pt + Carbaryl 2 pt + Regulaid 11 fl oz	172.6 cd	3.2 c-e	17 ab	51 a-c	16 bc
NAA 5 ppm + Carbaryl 1 pt + Regulaid 11 fl oz	211.4 a	3.4 de	16 ab	46 a-c	27 c

10 mm

Disease control by lime sulfur and oils applied as bloom thinners

Ginger Gold, Virginia Tech AREC, 2011

Bloom treatment and rate/ 100 gal; (all trts covered with Rally 12 May-5 Jul)	Bloom timing	Scab, % infection			Mildew , % inf., leaves		
		lvs 1-10	all lvs	fruit	lvs 1-10	all lvs	area
0 No fungicide	---	29 c	26 d	88 c	48 b	72 b	46 b
1 Lime Sulfur 2% + Crocker's Fish Oil 2%	4/19, 22, & 27	7 a	8 ab	19 ab	21 a	36 a	5 a
2 Lime Sulfur 2% + Crocker's Fish Oil 2%	4/20, 22, & 27	8 a	6 a	18 ab	21 a	32 a	4 a
3 Lime Sulfur 2% + Crocker's Fish Oil 2%	4/22 & 27	10 ab	12 bc	33 b	22 a	34 a	5 a
4 Lime Sulfur 2% + JMS Stylet Oil 2%	4/22 & 27	7 a	9 ab	15 a	21 a	33 a	4 a
5 Lime Sulfur 1% + JMS Stylet Oil 1%	4/22 & 27	6 a	8 ab	35 b	19 a	36 a	5 a
6 Lime Sulfur 1% + JMS Stylet Oil 1% + Rally 1.25 oz	4/22 & 27	6 a	7 ab	24 ab	16 a	28 a	4 a
7 Rally 40W 1.25 oz	4/22 & 27	18 b	19 cd	77 c	20 a	33 a	4 a

Mean separation by Waller-Duncan K-ratio t-test (p=0.05). Four single-tree replications.

Treatments applied 4/19 (trt. #1 only, pink to petal fall); 4/20 (trt. #2 only, pink to petal fall); 4/22 (all trts, full bloom); 4/27 (follow up for late bloom thinning, all treatments, petal fall).

Foliar data counts of ten terminal shoots each of four single-tree reps 17 Jun.

Fruit counts are of 25-fruit samples / rep on the tree (russet rating), at harvest 16 Jul.

- * Except for Rally on fruit scab, all treatments gave significant control of all diseases.
- * Supplemental app. of LS + Crocker's Fish Oil 19 or 20 Apr and treatments of Stylet Oil (1 or 2%) with Lime Sulfur all gave more foliar scab control than the Rally alone.
- * Scab control by Rally may have been affected by SI-resistant scab in the test area.
- * All treatments gave control of mildew; no sig. differences among treatments whether considering only terminal shoot leaves 1-10 (early season), all leaves or percent area affected of all leaves.

Golden Delicious Bloom Thinning - Hort Block #26 2012

