CONTINUING PROJECT REPORT **YEAR**: 2008/2009

Project Title: Programs to increase packouts of apples

PI: Ines Hanrahan
Organization: Washington Tree Fruit Research Commission
Telephone/email: 1 509 669 0267
hanrahan@treefruitresearch.com
Address: 104 N 1st St., Suite 204
City: Yakima
State/Province/Zip WA, 98901

Cooperators: Jim McFerson, Tom Auvil, Felipe Castillo, Tory Schmidt, WTFRC, Wenatchee, WA

Budget 1:
Organization Name: WTFRC **Contract Administrator:** Kathy Schmidt
Telephone: 1 509 665 8271 **Email address:** Kathy@treefruitresearch.com

Item	Year 1: 2008	Year 2: 2009
Salaries	16,847	19,860
Benefits (32%)	7,929	9,346
Wages	30,464	36,557
Benefits (32%)	14,336	17,203
Equipment + supplies	5,000	6,000
RCA rental	9,600	33,800
USDA rental	750	750
Travel	2,000	2,000
Reimbursements	9,400	14,000
Total	**77,526**	**111,516***

*****potential budget reduction of $12,800 if sunburn and LB work is reduced

Salaries:	include proportional time spent on projects for Hanrahan, Castillo, Schmidt, Auvil
Wages:	covers timeslip expenses, increase in 2009 based on projected project expansion for Honeycrisp; if sunburn work gets suspended in 2009, budget will be reduced by $6,400; based on 2008/09 results LB trials will be cut by 50% or $6,400
RCA rental:	numbers based on fiscal year (80% of 2 rooms 2008, 80% of 6 rooms 2009)
USDA rental:	access to packingline and storage space for equipment
Travel:	fuel costs to travel to and from trial sites
Reimbursements:	monetary contributions by chemical suppliers
Other:	all chemicals were donated by industry suppliers

Acknowledgement: We would like to thank Pace Intl., BASF, Fine Americas, Valent, Monterrey Ag, Wilbur Ellis, Brandt Consolidated, Globachem, NW Wholesale, GS Long, Wilson Irrigation and D & M Chemicals for graciously donating chemicals.

Special thanks to our cooperating growers: Stan Olson, Clyde Buchler, Rick Kamphaus, McDougall & Sons, Jason Matson, Ed Tradeup, Bill Clark, Broetje, Del Feigal, Dave Silvernail, Jim Thornsberry, Mike van Pelt, Mike Young and Mike Copley.

OBJECTIVES:

1. Investigate chemical programs to improve fruit finish of 'Fuji' and 'Golden Delicious' apples.

2. Compare sunburn protectant efficacy in apple and evaluate ease of cleanup in the warehouse.

3. Facilitate field testing of promising approaches to mitigate lenticel breakdown in apples.

4. Can Honeycrisp apple storage performance be improved when utilizing DCA (dynamic controlled atmosphere) storage?

SIGNIFICANT FINDINGS:

Russet: No treatment significantly reduced Fuji flecking or Golden Delicious russet in 2008.

Sunburn: All materials tested increased the percentage of sunburn-free fruit. Most materials cleaned easily off fruit flanks. Residues of particle films remained visible in the stem bowl after drying.

LB: No consistent treatment effect was noted after preharvest application of hydrophobic spray emulsions (summer supreme oil, soybean oil, SylTac) in the 2007/08 season. 2008/09 trials are in storage.

Honeycrisp: Trials in storage.

METHODS

Russet suppression: In 2008, we conducted 8 fruit finish trials (3 x Golden Delicious, 5 x Fuji). *(A)* Trials (1 x Golden, 2 x Fuji) evaluating standard GA programs vs. alternatives were sprayed with a PropTec sprayer at 200 gal/acre using a randomized complete block design with 4 replications and 6-7 trees/treatment/rep. We tested the following materials: ProVide (GA_{4+7}) at 1.4 oz/acre, Raynox Plus at 1.25 gal/acre, Platina at 0.11 gal/acre, BlueStim at 4 lbs/acre and 8 oz/acre surfactant, SylTac at 16 oz/acre, Sylgard 309 at 4 oz/acre, and EpiShield as 2.5% solution (Table 1). Materials were applied at five weekly timings starting at petal fall, reflecting standard industry practice.

Table 1. Commercial products utilized in WTFRC fruit finish trials in 2008.

Active Ingredient	Commercial product(s)
Gibberellic acid mixture	ProVide
Plant wax	Raynox Plus
Lipid emulsion	EpiShield
Silicone surfactant	SylTac, SylGard 309
Glycine Betaine (osmoregulator)	Bluestim
L-Tryptophan (auxin synthesis)	Platina

(B) Trials (1 x Golden, 2 x Fuji) were conducted utilizing cooperators spray equipment and covering several acres depending on row length. General trial layout was a randomized complete block design with 4 replications. BlueStim (4 lbs/acre and 8 oz/acre surfactant) and Platina (0.11 gal/acre) were applied at five weekly timings starting at petal fall.

(C) Trials (one each: Golden and Fuji) evaluating Platina timings were sprayed with a hand-held sprayer to run-off. A completely randomized design was applied using 6 single tree reps/trt. Platina was applied in 5 timing combinations (PF, PF + 14, PF + 14 + 28, 14 + 28, 5 x weekly, starting at PF) at 0.11 gal/acre.

Sunburn suppression: Three trials were established near Manson, WA, (Granny Smith/M.106, Golden Delicious/M.26 Manson, Braeburn/M.26) testing a variety of commercially available sunburn protectants (Cocoon, Eclipse, Fruit Shield, Invelop, Raynox Plus, Sun Guard, Surround WP). All materials were applied starting on July 3 four times according to each product's respective labeled rate. At harvest, individual fruit was graded for sunburn according to the Schrader/McFerson system (0 = clean, 6 = necrosis). The ease of cleanup was evaluated by running fruit over the USDA-ARS packing line in Wenatchee. No wax was applied. Fruit was allowed to dry for 24 hours before evaluation.

Lenticel breakdown: In 2007 we conducted 2 trials sprayed with a PropTec at 100 gal/acre in Desert Aire & Royal City testing the following materials: Summer Supreme Oil (2%), soybean oil (2%), and SylTac (2 pt/acre). Timings were: 4, 2, 1 weeks before anticipated harvest alone or in combination. Samples were stored under CA conditions and evaluated for LB incidence after 3 and 6 months of storage. Secondly, we applied BlueStim (at 4 lbs/acre and 8 oz/acre surfactant) to Galas and Fujis (both in Orondo) using a handgun sprayer and utilizing a completely randomized design with 6 single tree replications/treatment. Treatments were: mid-season, one week preharvest, postharvest dip. In addition, Gala apple samples were taken from several Extenday trials and a rootstock trial. Lenticel breakdown was induced by running fruit over the ARS packingline.

In 2008 we conducted 2 trials sprayed with a PropTec (100gal/acre unless otherwise specified) using a randomized complete block design with 4 replications and 20 trees/treatment/rep. We tested the following materials: EpiShield as 2.5% or 1.5% solution with one or two weekly applications, Safe-T-Side at 32 oz/acre, BlueStim at 4 lbs/acre and 8 oz/acre surfactant and Platina at 0.11 gal/acre. Materials were applied at 2 weekly timings starting at 2 weeks before anticipated harvest. We also conducted 4 grower-applied trials (3 Gala, 1 Fuji) utilizing whole rows. Trial layout was a randomized complete block design with 4 replications. EpiShield was applied once or twice as 2.5% solution, starting 2 or one week prior to anticipated harvest. All samples are currently stored under CA conditions and will be evaluated for LB incidence after 6 months.

Honeycrisp storage: We selected 3 orchards (Prescott, Brewster, Manson) based on the following criteria: even crop load with minimal alternate bearing, trees being at least 4 years old. Harvest timings were a) one week prior to anticipated first pick, and b) first pick (or best-storing pick). Fruit was transported to Stemilt RCA facility and held for 1-3 weeks at 50F before being stored at 38F in RA, CA (0.5% CO_2, 1.5% O_2) or DCA (0.5% CO_2, 0.7% O_2) until the end of February 2009. Monthly pulls will evaluate storage performance.

RESULTS AND DISCUSSION

Russet suppression: Fruit russet is typically induced early in the growing season and is likely aggravated by a combination of weather conditions, spray chemicals, and/or topical biotic pests. Few practical options are available to orchardists to suppress russet. Standard gibberellic acid programs include up to five weekly applications starting around petal fall and amount to considerable spray material costs ($100-300/acre). After encouraging results in 2007, we continued testing commercial spray materials with novel chemistries (Table 2).

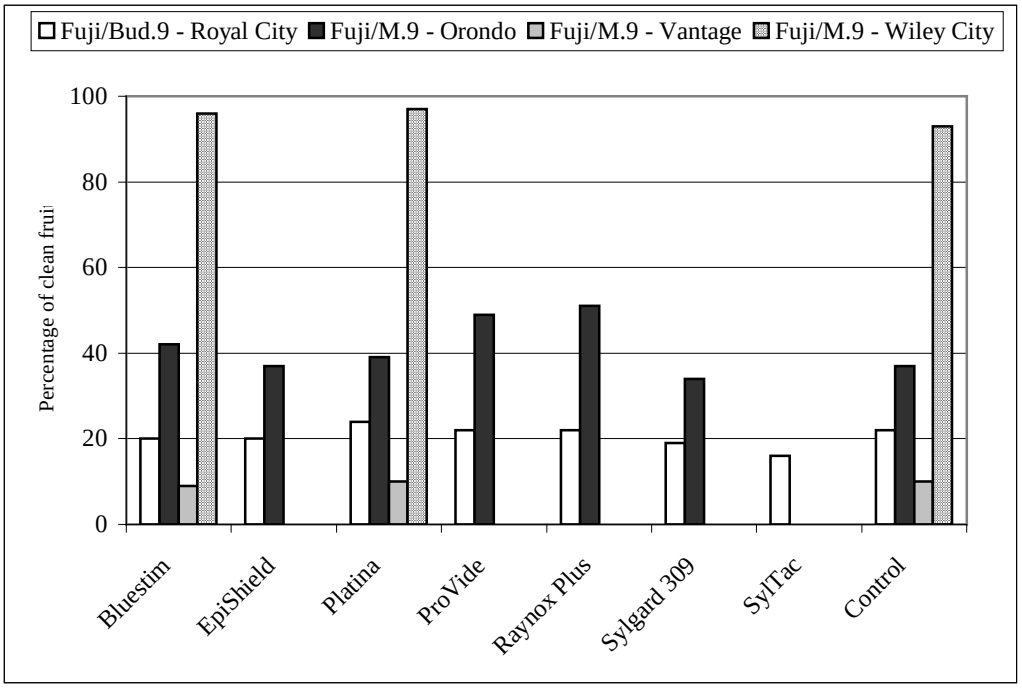
Golden Delicious: No product evaluated in 2008 increased the percentage of premium grade fruit or influenced the degree of russet development (Table 2). Just like 2007, low russet pressure as

indicated by 83-94% WAEXF in highly russet prone orchards, has significantly impacted the outcome of our trials.

Table 2. Field russet incidence and commercial grades of Golden Delicious after application of standard GA and alternative spray programs for russet suppression in 2008.

	FIELD RUSSET INCIDENCE				CHANGE IN GRADE			
TREATMENT	CLEAN (%)	BOWL (%)	SHOULDER (%)	NET 10% (%)	WAEXF (%)	WAF (%)	US#1 (%)	CULLS (%)
Golden Delicious / M.111 - Wapato (handgun)								
Platina PF	33 ns	55 ns	8 ns	4 ns	88 ns	12 ns	0 ns	0 ns
Platina PF + 14	31	63	4	3	93	7	0	0
Platina 14 + 28	30	60	5	4	91	9	0	0
Platina PF + 14 ·	28	62	7	3	89	11	0	0
Platina 5 times	35	56	5	4	92	8	0	0
Control	27	66	2	4	94	6	0	0
Golden Delicious / M.111 - Wapato (PropTec)								
Bluestim	42 ns	41 ns	12 ns	5 ns	83 ns	17 ns	2 ns	0 ns
EpiShield	48	37	14	2	84	16	1	0
Platina	41	45	11	4	86	15	1	0
ProVide	42	45	11	3	87	13	1	0
Raynox Plus	46	38	14	2	85	16	1	0
Sylgard 309	48	39	11	2	87	13	0	0
SylTac	42	41	15	4	84	19	1	0
Control	45	38	14	3	83	17	0	0
Golden Delicious / Selah (grower applied)								
Bluestim	62 ns	34 ns	4 ns	1 ns	95 ns	5 ns	0 ns	0 ns
Platina	60	36	4	1	96	4	0	0
ProVide	59	35	6	0	94	6	0	0

Figure 1. Influence of early season spray programs on prevention of Fuji flecking in 2008.



Fuji: Fuji flecking was not influenced by any spray program tested in 2008 regardless of orchard susceptibility (Figure 1).
Conclusion: Standard GA programs are still the most reliable strategy for improving apple fruit finish. GA alternatives (BlueStim, Raynox, Platina, SylTac) have shown some effectiveness for improving Fuji fruit finish in previous years, but year-to-year consistency is lacking.
2009 trials: We are planning on a third year of trials aiming to verify GA alternative product efficacy. In addition, we are moving towards more basic work such as determining the actual position of fruit affected by russet/flecking within the tree canopy and the determination of the onset of Fuji flecking.

Sunburn suppression: Sunburn is the primary physiological cause of cullage, sometimes damaging up to 50% of the fruit in a given orchard. Previously, WTFRC trials have shown calcium-based products (Eclipse, FruitShield) to perform as well as industry standards (Raynox, Surround WP). We revisited the question of sunburn protection product efficacy in 2007 and repeated the trials in 2008 (Table 3).

Table 3. Sunburn protectants used in 2008 WTFRC comparative trials.

Type	Product(s)
Plant wax	Raynox Plus
Kaolin clay	Surround WP, Cocoon
Talc	Invelop
Calcium carbonate	SunGuard, Eclipse, FruitShield

All materials tested increased the percentage of sunburn-free fruit (Table 4). A common concern with sunburn protectants is the ease of cleanup in the warehouse. Ideally, fruit emerges free of residue after a standard washing and rinsing. We simulated this process by running fruit over the USDA-ARS packingline in Wenatchee. Visible residues were observed before placing fruit on the line and after 24 hours of drying time. All materials cleaned easily off fruit flanks. Residues remained in the stem bowls at significantly higher levels for kaolin clay and calcium carbonate-based products (Table 5). Our results on product efficacy and ease of clean-up have been very consistent over the past few years and indicate no further study.

Table 4. Sunburn severity readings at harvest in Braeburn and Granny Smith apples. WTFRC 2008.

	FIELD SUNBURN INCIDENCE[a]					
TREATMENT	Clean (%)	Y1 (%)	Y2 (%)	Y3 (%)	Tan (%)	Black (%)
Braeburn / M.26 - Manson						
Cocoon	54 ns	20 ns	11 ab	6 ns	4 ns	5 ns
Eclipse	57	20	14 ab	3	4	3
Fruit Shield	55	23	9 b	6	4	3
Invelop	50	20	12 ab	10	6	2
Raynox Plus	52	23	11 ab	8	6	1
Sun Guard	54	22	13 ab	5	5	2
Surround WP	59	22	11 ab	6	3	1
Control	48	25	15 a	6	3	4
Granny Smith / MM.106 - Manson						
Cocoon	51 ab	17 b	14 ab	10 ns	6 ns	4 ns
Eclipse	50 ab	23 ab	13 ab	8	3	3
Fruit Shield	55 a	21 ab	10 ab	7	5	3
Invelop	51 ab	22 ab	12 ab	10	4	1
Raynox Plus	50 ab	21 ab	15 ab	9	2	3
Sun Guard	49 ab	22 ab	16 ab	8	4	2
Surround WP	57 a	20 ab	9 b	6	5	4
Control	40 b	24 a	17 a	10	4	5

[a] based on 'Schrader-McFerson' scale

Table 5. Ease of sunburn protectant product clean-up when submitted to commercial packing line.

	SPRAY RESIDUE PRE WASH				SPRAY RESIDUE POST WASH			
TREATMENT	Clean (%)	Side (%)	Bowl (%)	Caylx (%)	Clean (%)	Side (%)	Bowl (%)	Caylx (%)
Braeburn / M.26 - Manson								
Cocoon	1 b	86 a	79 a	81 a	70 ab	0 ns	30 abc	0 ns
Eclipse	0 b	86 a	77 a	68 bcd	70 ab	0	28 bc	2
Fruit Shield	0 b	78 a	76 a	79 ab	71 ab	0	27 bc	2
Invelop	0 b	56 b	56 bc	64 cd	73 ab	1	25 bc	2
Raynox Plus	1 b	63 b	58 bc	60 cd	75 a	0	23 c	2
Sun Guard	2 b	84 a	70 ab	73 abc	64 bc	0	35 ab	1
Surround WP	0 b	82 a	82 a	83 a	56 c	0	41 a	3
Control	5 a	61 b	52 c	58 d	77 a	0	22 c	1
Golden Delicious / M.26 - Manson								
Cocoon	3 c	69 ab	50 b	49 bc	75 abc	3 ns	20 cd	2 b
Eclipse	8 bc	56 b	53 b	60 ab	66 bcd	2	30 bc	3 b
Fruit Shield	12 bc	58 b	34 b	68 a	78 abc	1	18 cd	5 b
Invelop	19 bc	29 c	42 b	56 ab	68 abcd	0	18 d	16 a
Raynox Plus	27 ab	25 c	30 b	34 cd	80 ab	1	15 d	4 b
Sun Guard	5 c	66 ab	55 b	70 a	64 cd	0	33 b	3 b
Surround WP	2 c	81 a	81 a	70 a	51 d	0	45 a	7 ab
Control	38 a	20 c	35 b	21 d	83 a	0	17 d	0 b
Granny Smith / MM.106 - Manson								
Cocoon	0 b	87 ns	75 a	83 ns	65 a	1 ns	28 b	7 ns
Eclipse	0 b	82	53 b	81	59 ab	1	30 b	10
Fruit Shield	0 b	93	75 a	81	58 ab	0	37 ab	6
Invelop	0 b	86	81 a	77	63 a	1	28 b	9
Raynox Plus	0 b	84	75 a	74	65 a	0	28 b	8
Sun Guard	0 b	87	87 a	82	63 a	1	33 b	3
Surround WP	0 b	92	84 a	83	46 b	0	46 a	8
Control	2 a	84	82 a	78	69 a	0	29 b	3

Lenticel breakdown: The complete data set for the 2007 field trials will be discussed, since it was not yet available at last year's research review. The 2008 data set will be available in March 2009. In 2007 we set up 2 trials to determine if the application of hydrophobic materials within 3 weeks of harvest would alleviate LB development after storage.

All fruit was harvested at commercial maturity suitable for long term CA storage. We found no differences for common maturity parameters at harvest between control and treated fruit (data not shown). Fruit from both orchards expressed symptoms after 3 and 6 months of CA storage at about the same level (Table 6). No significant treatment effect was seen regarding oil type or spray frequency (Table 6). Preliminary results comparing fruit from Extenday plots with untreated fruit indicated no significant effect on LB development of Gala apples after storage (data not shown).

Utilizing the existing rootstock evaluation trial planted in 2004 in Wapato, we assessed fruit susceptibility to LB in relation to the rootstock used (Figure 2). Compared to our orchard trials, we observed higher LB symptom expression after 6 months of CA storage, possibly due to advanced maturity at harvest. When comparing new rootstocks against M.26 in terms of susceptibility to LB

development after storage, no significant treatment effect could be established. This finding has been consistent over 2 seasons. Perceived differences within the industry regarding LB susceptibility among rootstocks may be due to secondary effects caused by crop load and overall tree structure.
2009 plan: Provided the 2008 data confirms the ineffectiveness of hydrophobic materials, we will discontinue trial work. We have started using EpiShield, a commercial product known to reduce LB expression after storage when applied preharvest. We are planning on continuing our work on the Wapato rootstock trial and will feed data generated into the Hoheisel/Olmstead database of fruit quality and production parameters.

Table 6. Effects of preharvest application of hydrophobic materials on LB development of Gala apples after 3 and 6 months of CA storage during the 2007-08 storage season.

	LENTICEL READINGS				LENTICEL READINGS			
TREATMENT	CLEAN (%)	SLIGHT (%)	SEVERE (%)	TOTAL LB (%)	CLEAN (%)	SLIGHT (%)	SEVERE (%)	TOTAL LB (%)
	3 months CA				6 months CA			
Galaxy Gala / M.9 Royal Slope								
Soybean once	82 abc	18 bc	0 ns	18 bc	82 ab	18 c	0 b	18 b
Soybean twice	92 a	8 c	0	8 c	90 a	9 c	1 b	10 b
Soybean thrice	34 d	37 ab	29	66 a	31 c	51 a	18 a	69 a
Summer oil once	88 ab	13 bc	0	13 bc	86 a	13 c	1 b	14 b
Summer oil twice	60 bcd	40 ab	0	40 abc	59 abc	37 abc	4 ab	41 ab
Summer oil thrice	80 abc	20 bc	0	20 bc	80 ab	19 c	1 b	20 b
SylTac once	94 a	6 c	0	6 c	88 a	13 c	0 b	13 b
SylTac twice	78 abc	21 bc	1	23 bc	76 ab	23 bc	1 b	24 b
SylTac thrice	47 cd	53 a	0	53 ab	48 bc	48 ab	1 b	49 ab
Control	83 ab	16 bc	1	18 bc	81 a	15 c	4 ab	19 b
Imperial Gala / M.26 Desert Aire								
Soybean once	78 ns	22 ns	0 ns	22 ns	71 ns	27 ns	2 ns	29 ns
Soybean twice	85	13	3	15	82	13	5	18
Soybean thrice	78	21	1	23	76	21	3	24
Summer oil once	72	24	4	28	68	20	11	32
Summer oil twice	85	15	0	15	85	14	1	15
Summer oil thrice	65	29	6	35	65	25	10	35
SylTac once	75	25	0	25	74	25	1	26
SylTac twice	59	41	0	41	58	40	3	43
SylTac thrice	62	34	4	38	61	35	4	39
Control	81	16	3	19	80	15	5	20

Figure 2. Rootstock effects on lenticel breakdown (LB) in Gala after 6 months of CA storage. 2006-2007.