FINAL PROJECT REPORT

Project Title: Winter pear quality maintenance

PI:	Jinhe Bai	**Co-PI(2):**	Kristi Deschuytter
Organization:	OSU, MCAREC	**Organization:**	OSU-MCAREC
Telephone/email:	Jinhe.bai@oregonstate.edu	**Telephone/email:**	541-386-2030 ex.27
Address:	3005 Experiment Station Dr.	**Address:**	
City:	Hood River	**City:**	Hood River
State/Province/Zip	OR 97031	**State/Province/Zip:**	OR 97031

Cooperators:

Total Project Funding: $33,693

Budget History:

Item	**Year 1:** 2007		
Salaries	19,760		
Benefits	9,880		
Wages			
Benefits			
Equipment			
Supplies	3,500		
Travel	500		
Miscellaneous			
Total	33,693		

Significant Findings:

2006-2007 season

- Pre-harvest spray with 1-MCP did not control scald
- Pre-harvest 1-MCP spray combined with delayed harvests of two and four weeks resulted in decreased fruit firmness and increased fruit yellowing
- Low-dose application of 1-MCP (65ppb) after 5months of RA storage, combined with five or ten days preconditioning at 50°F, allowed fruit to soften with moderate scald control.
- 65ppb of 1-MCP on 9mth CA stored pears, combined with five days preconditioning at 50°F allowed fruit to soften almost to eating quality (6lbs) with excellent scald control.
- 'd'Anjou' pears from an elevation of ~2000ft, applied with 100ppb 1-MCP, when combined with five or ten days preconditioning at 50°F for 3, 5, 6, and 9 months, completely controlled scald while allowing the fruit to soften.

2007-2008 season (in progress)

- Fruit stored for 3 months RA storage when combined with ten days preconditioning at 50°F softened to 7lbs with excellent scald control.
- Fruit from a higher elevation (~2000 ft), applied with 100ppm of 1-MCP, when combined with five or ten days preconditioning at 50°F softened to eating quality with good scald control.
- Fruit harvested from ~500 ft. in elevation, applied with 65ppb 1-MCP, stored for 3 months RA, and applied with ethylene for 48 hrs. at 70°F softened to eating quality with 6% scald.

Results and Discussion:

Pre-harvest 1-MCP application

FF is the pole indicator for Anjou and other pear harvest maturity judgment. Current harvest maturity of Anjou fruit is about 15 lb where soluble solids accumulate to 12-13%, and fruit will have a juicy and buttery texture upon long term storage and a proper ripening. When FF is greater than 15 lb, fruit does not accumulate enough soluble solids, and has a poor taste. In contrast, when FF is less than 15 lb, fruit is susceptible to decay, and tends to have a mealy texture upon long storage and ripening.

FF at commercial maturity was 15 lb, and decreased to 13.5 and 12 lb by 14 and 28 days delayed harvest, respectively. FF of 75 g 1-MCP treated fruit was slightly greater although there was no significant difference (Fig. 2). Because 1-MCP application often inhibits/delays softening of fruit during storage and subsequent ripening, we proposed that a 1-MCP + delayed harvest will decrease scald (1-MCP), and increase softening ability (delayed harvest) without mealiness (1-MCP).

In fruit treated with a 75 g dose of 1-MCP, SSC was about 13.5%, 1% higher than the control and the treatment of 150 g 1-MCP at commercial harvest maturity and 14 days delayed harvest. However SSC increased in the later two treatments to the same level in the 28 days delayed harvested fruit (Fig. 2). Titratable acidity content was 0.32% at commercial harvest maturity in all treatments, but decreased to 0.30% and 0.27% by 14 and 28 days delayed harvests, respectively, in the control. TA contents in the 1-MCP treatments remained constant by 14 days

delayed harvest but decreased to 0.30% by 28 days delayed harvest (Fig. 2). SSC in Anjou pears is 12-14% at commercial harvest maturity depending on the region and year, and SSC usually does not change by delaying harvest. Higher SSC and TA indicate a better taste. Therefore 1-MCP application, especially 75 g dose, was the best treatment (Fig. 2).

Fruit surface color yellowed continually during the delayed harvests as indicated by an increased a* (degreening), b* (yellowing), C* (higher chroma) and L* (higher lightness) values, and a decreased h° (hue angle to lower green and higher yellow color) value. However, 1-MCP did not consistently influence the changes.

Average fruit size was 246 g at commercial maturity, and increased to 280 and 205 g by 14 and 28 days delayed harvests, respectively. The final fruit weight after 28 days delayed harvest was similar in all three treatments.

Fruit treated with 1-MCP and harvested at commercial maturity did not ripen to eating softness (<6 lb) when stored up to 9 months, regardless of 1-MCP dose and storage time. However, fruit ripened when harvest was delayed for 14 or 28 days. 1-MCP field application at doses of 132 ppm decreased scald incidence. However, the scald incidence was still unacceptable (more than 10%) in most of the cases. The only successful combination was 132 ppm of 1-MCP + 14 days delayed harvest + 6 months of CA storage where fruit ripened with an acceptable scald incidence. Fruit treated with 66 ppm of 1-MCP did not decrease scald. Delayed harvested fruit had higher scald incidence compared with commercial harvested fruit. Additionally, delayed harvested fruit had higher decay rates during storage and without 1-MCP treatment; delayed harvested fruit became mealy after 5 months of RA and 9 months of CA storage. However, with 1-MCP treatment, fruit maintained a juicy and buttery texture during the entire storage period regardless of harvest time (data not shown).

Post-Harvest 1-MCP application

Superficial scald is one of the major postharvest issues for ‘d’Anjou’ pears. It appears after the fruit has ripened, making it difficult to detect in the packinghouse. Currently, postharvest line sprays or drenching with ethoxyquin is being used to control scald. In some cases, however, these treatments give rise to phytotoxicity, which is also a cause for fruit rejection. 1-MCP, in pears, could be become a very good alternative to ethoxyqin because of the ease of application, efficacy, and low residues. It has been used very successfully on apples, and we have shown that there is great promise for its use on pears.

In the 2006-2007 season (Table 2), fruit treated were treated with 65 or 100ppb 1-MCP and stored for 3- and 5-months RA and 6 and 9- months CA. Overall, fruit firmness for fruit treated with 65ppb 1-MCP softened more than fruit treated with 100ppb. However, only one combination, fruit treated with 65ppb, stored for 5 months with 10 days preconditioning, ripened to eating quality. Although the 65ppb was able to soften, it also did not control scald as well as the 100ppb treatment. Both 1-MCP treatments were applied 1-2 days after harvest at 30°C for 24hrs. It is possible that applying the 1-MCP at a warmer temperature may increase it’s efficacy for scald control.

In the same harvest season, fruit from Parkdale, Oregon (~2000 ft in elevation) were also treated with 65 and 100ppb 1-MCP and stored for 3 and 5 months RA and 6 and 9 months CA (Table 2). Fruit firmness, regardless of length of storage, softened to eating quality with either 5 or a 10 day preconditioning period at 50°F. In all cases, scald was significantly decreased with 100ppb 1-MCP showing very little scald symptoms.

Fruit in the 2207-2008 season were harvested from both Hood River and Parkdale, Oregon (Table 3). Fruit from Hood River (elevation ~500 ft) was treated with 65ppb 1-MCP at 50°F for 24 hours and stored for 3-9 months in RA and CA. After three months of storage, fruit subjected to a preconditioning at 50° F for 10 days softened to approximately 7lbs with excellent scald control.

Additional fruit applied with 65ppb 1-MCP underwent exposure to ethylene for 24 or 48 hour at either 60° or 70° F (Table 4). No temperature preconditioning was applied for this experiment. After three months of RA storage, fruit stored at 70°F for 24hrs or ethylene exposure had the most scald control. However, the fruit failed to reach eating quality. However, fruit treated with 1-MCP and exposed to 48 hours of ethylene at 70°F did soften to eating quality with good scald control. However, 48 hours of ethylene exposure, did increase yellowing in the fruit, but those fruit treated with 1-MCP did appear greener than those that were not treated.

Fruit from Parkdale, Oregon was treated with 100ppb 1-MCP for 24hours at 30°F and then stored for 3-9 months in RA and CA (Table 3). After three months of storage, fruit that were subjected to a five or ten day preconditioning period at 50°F softened to eating quality. However, scald control was not as good as expected. Although the conditions remained the same from the previous year, it is possible that an increase in temperature when applying the 1-MCP could impact its efficacy.

Evaluations for 5, 6, and 9 months are in progress and will be completed in June 2008.

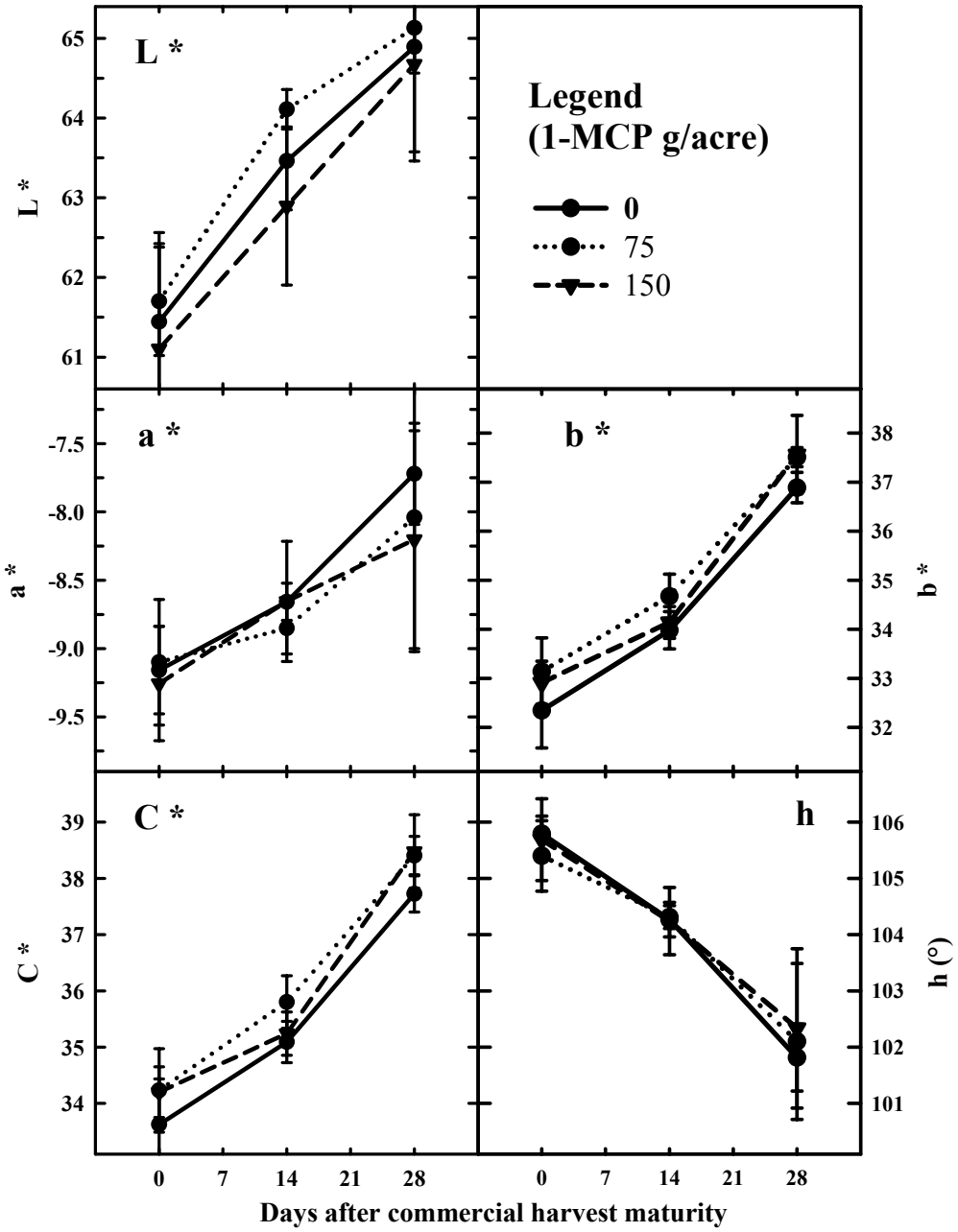

Fig. 1. Changes of surface color factors of 'Anjou' pear fruit during 28 days of delayed harvest period. Application of 1-MCP (0, 75 or 100 g/acre) was carried out 7 days before commercial harvest maturity.

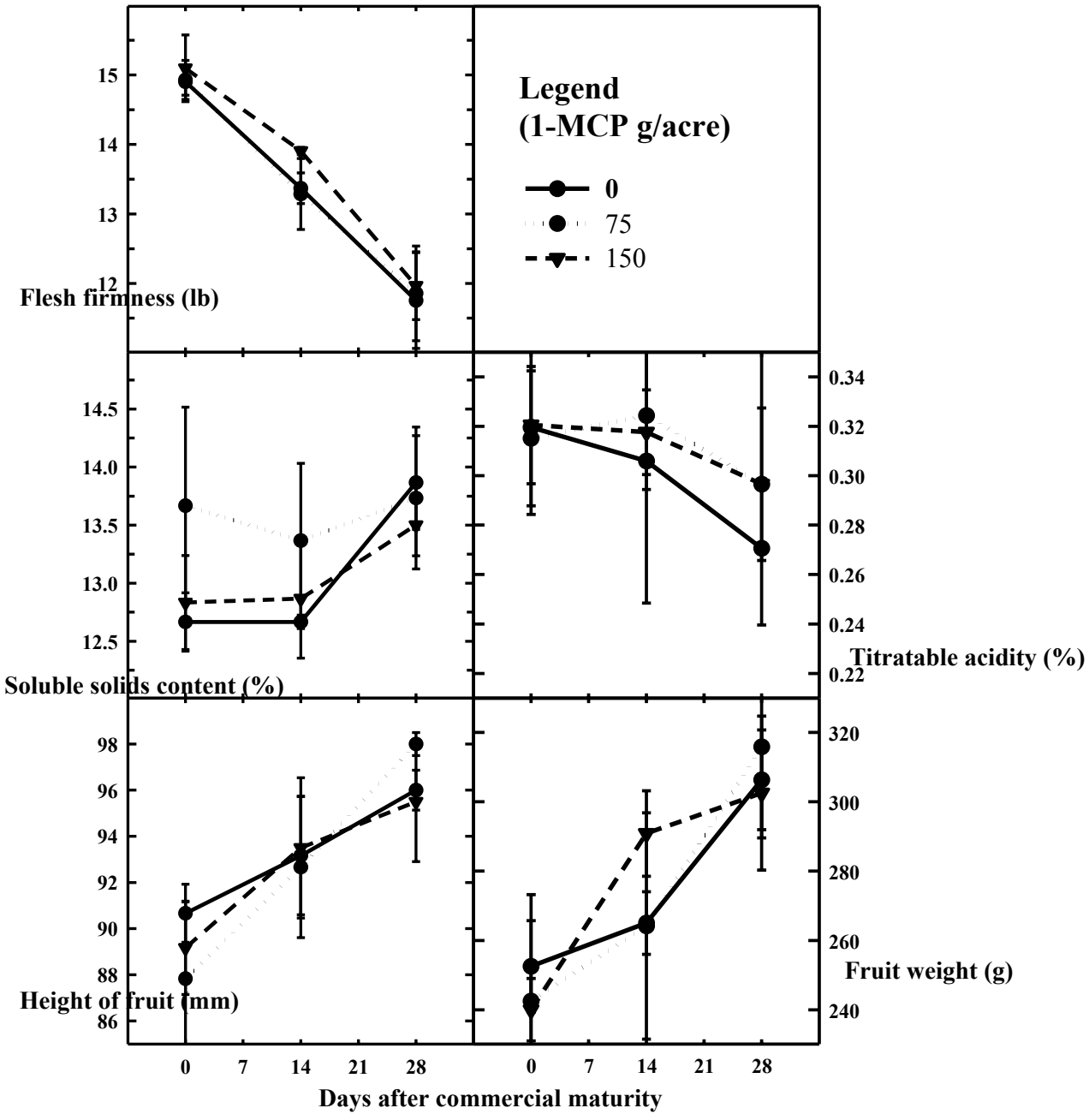

Fig. 2. Changes of quality parameters of 'Anjou' pear fruit during 28 days of delayed harvest period. Application of 1-MCP (0, 75 or 100 g/acre) was carried out 7 days before commercial harvest maturity.

Table 1. Effect of MCP dose and harvest maturity on flesh firmness and the incidence of superficial scald of Anjou pears. MCP was field-sprayed 7-days before commercial harvest time. Fruit were harvested at commercial maturity or 14 or 28-days delayed. After 3-9 months of storage in RA or CA at -1°C, fruit were transferred to 20°C for 7 days to simulate ripening condition.

MCP dosage (ppm)	Harvest delay (day)	Storage atmosphere and time							
		RA 3 months		RA 5 months		CA 6 months		CA 9 months	
		FF (lb)	Scald (%)	FF (lb)	Scald (%)	FF (lb)	Scald (%)	FF (lb)	Scald (%)
0	0	4.0 de	0.0 a	3.2 c	92.9 a	2.7 b	8.9 b	3.0 b	33.5 bc
	14	2.5 e	0.0 a	2.8 c	85.5 a	2.4 b	22.4 ab	2.8 b	66.7 ab
	28	3.4 e	0.0 a	2.7 c	89.1 a	2.0 b	40.4 ab	2.1 b	89.0 a
66	0	10.7 b	0.0 a	5.6 b	56.4 b	9.5 a	8.1 b	7.0 a	48.0 a-c
	14	5.7 dc	0.0 a	3.5 bc	89.4 a	3.1 b	33.1 ab	3.4 b	84.2 a
	28	3.1 e	0.0 a	2.5 c	94.0 a	1.9 b	50.6 a	2.2 b	65.3 a-c
132	0	14.0 a	0.0 a	10.9 a	22.1 c	9.7 a	8.2 b	8.3 a	21.9 c
	14	6.2 c	0.0 a	3.8 bc	81.9 a	3.0 b	8.8 b	3.5 b	37.9 bc
	28	3.5 de	0.0 a	2.7 c	95.4 a	2.3 b	29.4 ab	2.3 b	81.9 a
Source	df	F value and significance							
MCP dose (M)	2	62.3 ***	0 NS	28.8 ***	17.8 ***	57.8 ***	6.3 **	34.9 ***	8.6 **
Harvest (H)	2	33.1 ***	0 NS	14.9 ***	6.5 **	15.7 ***	1.4 NS	9.8 **	1.7 NS
M x H	4	13.2 ***	0 NS	10.4 ***	7.4 **	11.8 ***	0.4 NS	6.1 **	1.6 NS

*** P < 0.001; ** P < 0.01; * P < 0.05; NS: not significant

Table 2. Effect of orchard location, MCP dose and pre-conditioning time on flesh firmness and the incidence of superficial scald of Anjou pears. Fruit were treated with MCP after harvest, stored in RA or CA at -1°C for 3-9 months, and then pre-conditioned at 10°C for 0-10 days before transfer to 20°C for 7 days.

Location	MCP dosage (ppb)	Pre-conditioning time (days)	Storage atmosphere and time							
			RA 3 months		RA 5 months		CA 6 months		CA 9 months	
			FF (lb)	Scald (%)	FF (lb)	Scald (%)	FF (lbs)	Scald (%)	FF (lbs)	Scald (%)
Hood River	0	0	8.5 cd	20.3 a	3.8 e	100.0 a	2.3 de	60.0 a	3.0 ef	70.6 a
	65	0	13.1 a	0.0 b	10.0 b	40.0 bc	13.8 a	0.0 b	9.9 b	3.3 d
		5	10.6 ab	0.0 b	6.2 d	30.0 bc	10.1 b	0.0 b	8.4 c	0.0 d
		10	8.5 cd	0.0 b	2.1 ef	37.8 b	7.1 c	1.4 b	6.5 d	19.1 cd
	100	0	14.4 a	0.0 b	13.9 a	0.0 c	14.6 a	0.0 b	13.1 a	0.0 d
		5	14.3 a	0.0 b	13.5 a	0.0 c	14.1 a	0.0 b	12.7 a	0.0 d
		10	13.1 a	0.0 b	9.3 bc	0.0 c	11.8 ab	0.0 b	11.9 a	4.8 d
Parkdale	0	0	4.2 de	12.4 a	2.6 ef	36.7 b	3.1 de	1.6 b	3.1 ef	30.9 bc
	65	0	3.8 de	0.0 b	2.1 ef	26.7 bc	3.2 de	0.0 b	3.0 ef	37.7 bc
		5	1.7 e	0.0 b	1.6 f	46.7 b	1.8 e	0.0 b	2.2 ef	33.3 bc
		10	5.2 c-e	0.0 b	1.9 f	39.7 b	1.8 e	14.8 b	2.1 f	46.7 b
	100	0	12.4 a	0.0 b	8.0 c	0.0 c	10.2 b	0.0 b	6.8 d	0.0 d
		5	8.5 bc	0.0 b	2.5 ef	0.0 c	5.0 cd	6.7 b	3.5 e	6.7 d
		10	4.7 c-e	0.0 b	1.8 f	0.0 c	2.6 de	0.0 b	3.1 ef	0.0 d
Source		df	F value and significance							
Location (L)		1	53.88 ***	1.24 NS	288.1 ***	4.55 *	136.5 ***	14.89 ***	573.3 ***	0.54 NS
MCP dose (M)		2	32.52 ***	22.23 ***	204.2 ***	48.21 ***	72.12 ***	28.02 ***	200.4 ***	29.9 ***
Pre-conditioning (P)		2	8.18 **	0 NS	87.83 **	1.07 NS	26.74 ***	0.73 NS	29.41 ***	1.17 NS
L x M		2	1.41 NS	1.24 NS	50.19 ***	10.21 ***	14.69 ***	25.12 ***	58.81 ***	15.11 ***
L x P		2	1.05 NS	0 NS	13.01 ***	0.17 NS	0.73 NS	0.49 NS	2.62 NS	0.31 NS
M x P		2	0.94 NS	0 NS	1.87 NS	1.07 NS	0.44 NS	1.52 NS	0.77 NS	1.22 NS
L x M x P		2	8.98 ***	0 NS	27.1 ***	0.17 NS	8.39 **	1.15 NS	9.7 ***	0.07 NS

*** P < 0.001; ** P < 0.01; * P < 0.05; NS: not significant

Table 3: The effects of preconditioning on fruit firmness, soluble solid content, titratable acidity and % scald incidence for fruit from Hood River and Parkdale, Oregon. Fruit were treated one day after harvest with 1-MCP and stored for 3-9 months at -1°C (30°F). Prior to evaluation, fruit were stored at 10°C (50°F) for 0, 5, or 10 days and ripened for seven days at 20°C (70°F).

Location	Preconditioning	MCP dosage	FF (lbs)	SS	TA	% scald
Hood River	0 days	65	11.78667	12.6	0.40803	0.775194
	5 days		11.34333	12.63333	0.364033	0
	10 days		7.57	13.06667	0.37989	1.646341
	p-value		0.259	0.393	0.122	0.279
Parkdale	0 days	100	12.82	11.93333	0.29145	7.004831
	5 days		4.993333	12.13333	0.265767	7.786358
	10 days		2.653333	12.16667	0.247453	9.982882
	p-value		0*	0.134	0.147	0.898

Table 5: Analysis on the effects of temperature and length of exposure to ethylene on fruit control and fruit treated with 65ppb 1-MCP. Fruit were treated one day after harvest with 65ppb 1-MCP at 20°C (50°F) for 24 hours and stored for 3-9 months in RA or CA storage. After storage, boxes were treated with ethylene (100-1000ppm) for either 24 or 48 hours at 60° of 70° F. Fruit was then placed back in -1°C (30°F) RA for five days before subjecting the fruit to a seven day ripening period. The following measurements were taken after the seven day ripening period.

			L*	a*	b*	C*	h°	FF (lbs)	SS	TA	%SI
24 hrs	**60°F**	**no-MCP**	64.086	-6.8197	38.563	39.198	100.052	9.7	12.67	0.391	31.92
		65ppb MCP	63.395	-7.274	38.352	39.062	100.749	8.04	12.87	0.427	9.77
	70°F	**no-MCP**	62.813	-6.633	38.498	39.084	99.795	6.42	12.73	0.421	55.94
		65ppb MCP	64.0198	-7.098	37.948	38.634	100.568	10.92	12.57	0.398	1.85
two-way anova		MCP (M)	0.739	0.156	0.471	0.557	0.16	0.21	0.937	0.437	0.001*
		Temp (T)	0.676	0.553	0.652	0.585	0.657	0.953	0.581	0.916	0.335
		M x T	0.24	0.987	0.744	0.75	0.939	0.032*	0.392	0.007*	0.077
48 hrs	**60°F**	**no-MCP**	65.412	-5.132	41.06	41.437	97.157	3.533	12.6	0.339	28.9
		65ppb MCP	64.514	-6.531	39.456	40.036	99.432	7.51	12.8	0.408	8.26
	70°F	**no-MCP**	66.892	-3.62	42.913	43.114	94.807	2.066	13.3	0.345	26.45
		65ppb MCP	65.462	-4.72	40.622	40.975	96.77	4.316	12.97	0.39	6.34
two-way anova p-values		MCP (M)	0.172	0.135	0.08	0.082	0.115	0.034*	0.772	0.014*	0.034*
		Temp (T)	0.156	0.058	0.159	0.18	0.07	0.093	0.087	0.756	0.79
		M x T	0.741	0.847	0.733	0.689	0.9	0.5	0.265	0.542	0.974
	Source		**p-value and significance**								
	MCP (M)		0.412	0.05*	0.049*	0.058	0.042*	0.013*	0.87	0.006*	0*
	Temperature (T)		0.421	0.036*	0.261	0.319	0.051	0.17	0.308	0.806	0.607
	Hrs of Ethylene (E)		0.002*	0*	0*	0*	0*	0*	0.185	0.001*	0.206
	M x T		0.535	0.859	0.645	0.61	0.928	0.23	0.154	0.058	0.18
	M x E		0.205	0.342	0.172	0.162	0.299	0.366	0.785	0.023*	0.132
	T x E		0.172	0.085	0.13	0.137	0.095	0.195	0.086	0.74	0.373
	M x T x E		0.276	0.85	0.76	0.836	0.883	0.037*	0.785	0.392	0.166

* <0.05