

Pre-season storage meeting

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NYFVI incl. SC Block Grant program

Hatch Multistate (NE1836).

Valent Biosciences

AgroFresh



The many incredible cooperators – THANK YOU!

Priority varieties today – in terms of updates/reinforcements

- Gala
- Honeycrisp
- Empire
- NY1
- EverCrisp
- NY2

Quick comments

- Lots of materials
- Will make pdf available
- Any unanswered questions – chris.Watkins@cornell.edu; 607 351 0869

2021 growing season weather

- Prolonged blossom period
- Cloudy and cooler July
- Cloudy August
- Above average temperatures overall
- Lots of rain

????????????????????????????????????

Weather???

Internal browning typically associated with cloudy/cooler August, but that thinking dominated by Empire. 1-MCP changed that equation.

Heat – fruit stress, higher respiration rates, higher bitter pit potential.

Rain – larger fruit, typically more susceptible to disorders.

Variable maturity – greater in fruit from trees without PGRs?

[Earlier harvest – bitter pit and superficial scald; later harvest if picking gets behind – skin cracking, soft scald and senescent breakdown.]

Responses

- Spot picking??? Economic barriers. (early ripening fruit)
- Priority on moving fruit to shade at minimum, and preferably to cold storage.
- Applying 1-MCP or DPA as quickly as possible.
- Storage temperatures – hesitant to recommend any changes beyond standard recommendations.
- Storage potential – maybe difficult year, but of course don't know!

QUESTIONS/COMMENTS?



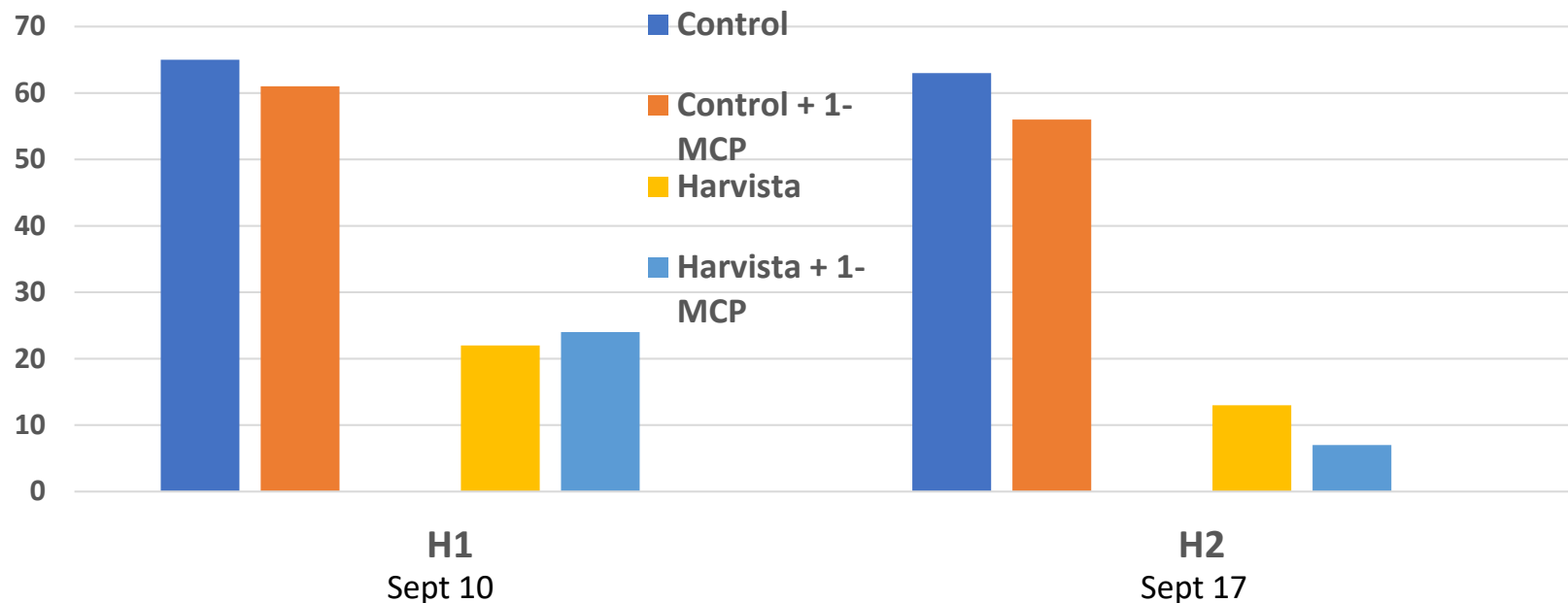
'Gala'

Factors affecting stem end flesh browning

- Strain
- Maturity
- PGRs – Harvista, ReTain
- Oxygen concentration in storage atmosphere
- Carbon dioxide concentration in storage atmosphere
- Storage temperature
- 1-MCP inconsistent – sometimes higher but often no effect or decrease
- [Fruit size]



Gala 6 months CA storage + 7 days: SEFB (%) [Fulton]

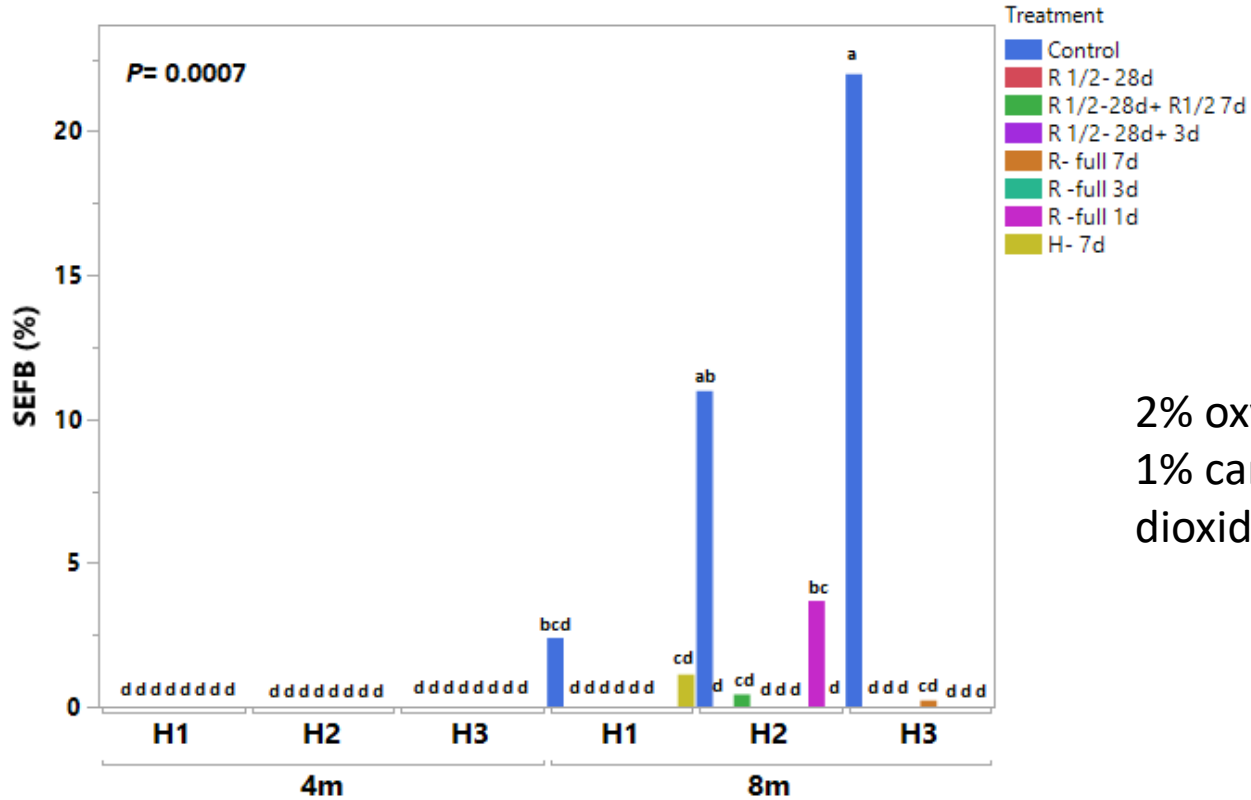


PGRs

Gala: SEFB (%) Retain and Harvista: 6 months CA storage

Field treatment		
	No 1-MCP	1-MCP
Control	26 a	28 a
ReTain 1/2 rate	6 b	5 b
ReTain 2/3 rate	10 b	7 b
Harvista	12 b	6 b

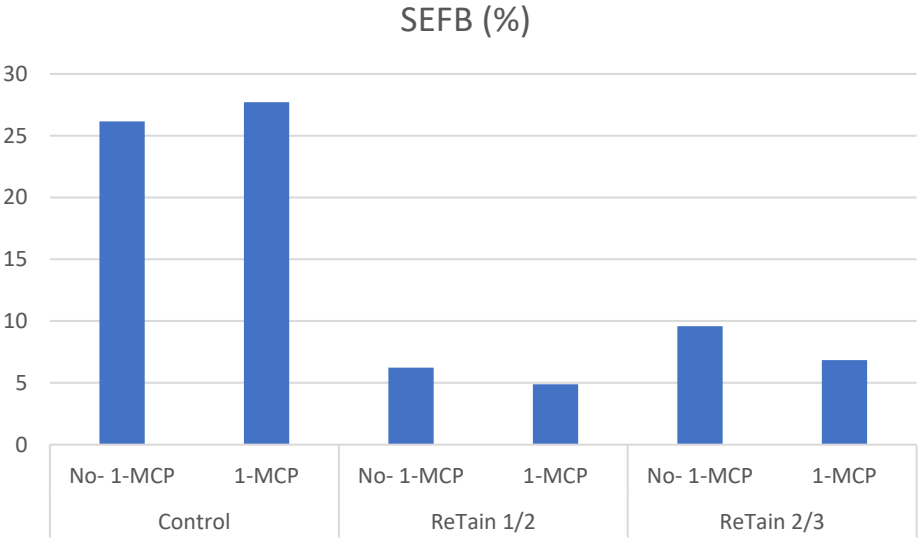
2020 harvest: Brookfield – CA for 8 months



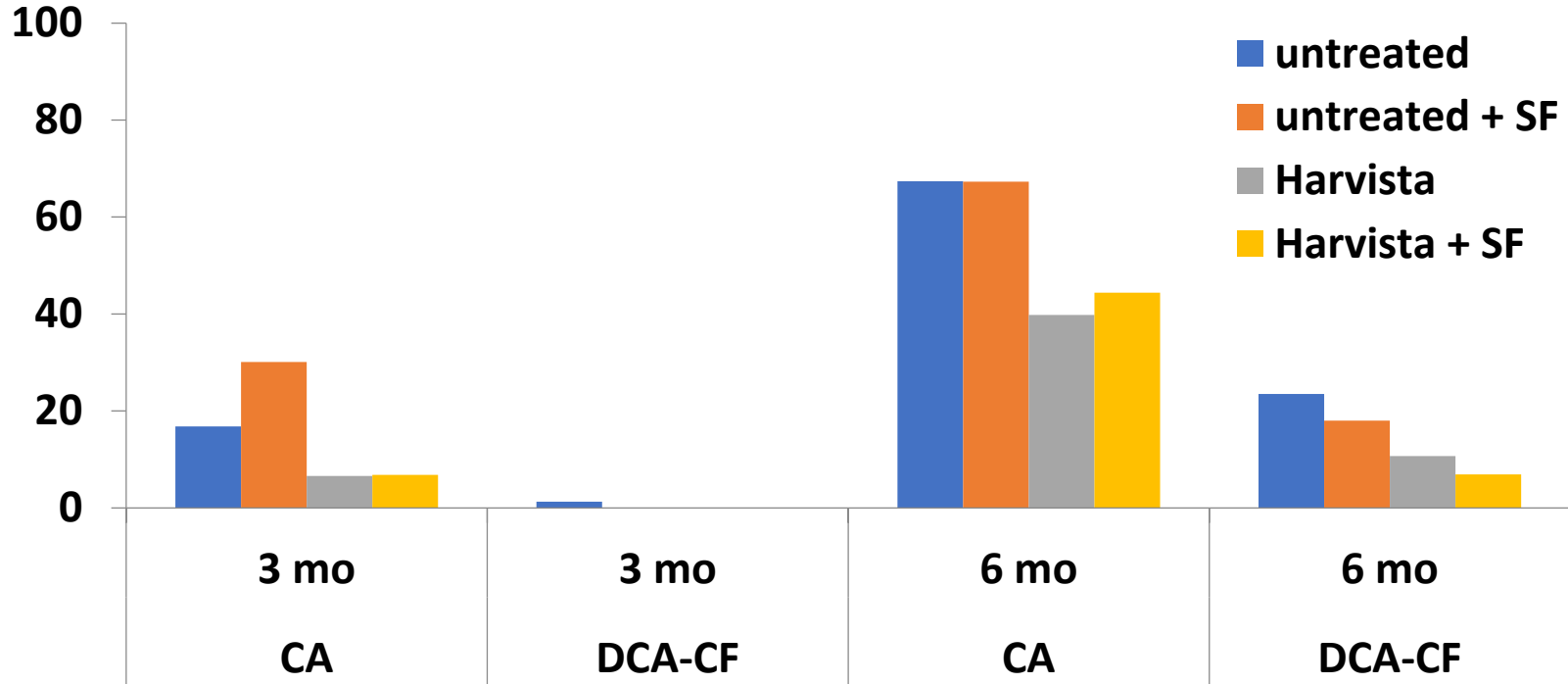
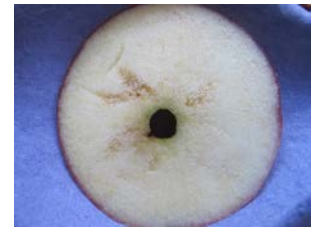
2% oxygen
1% carbon dioxide

2019 harvest: CA (2/1) for 6 months

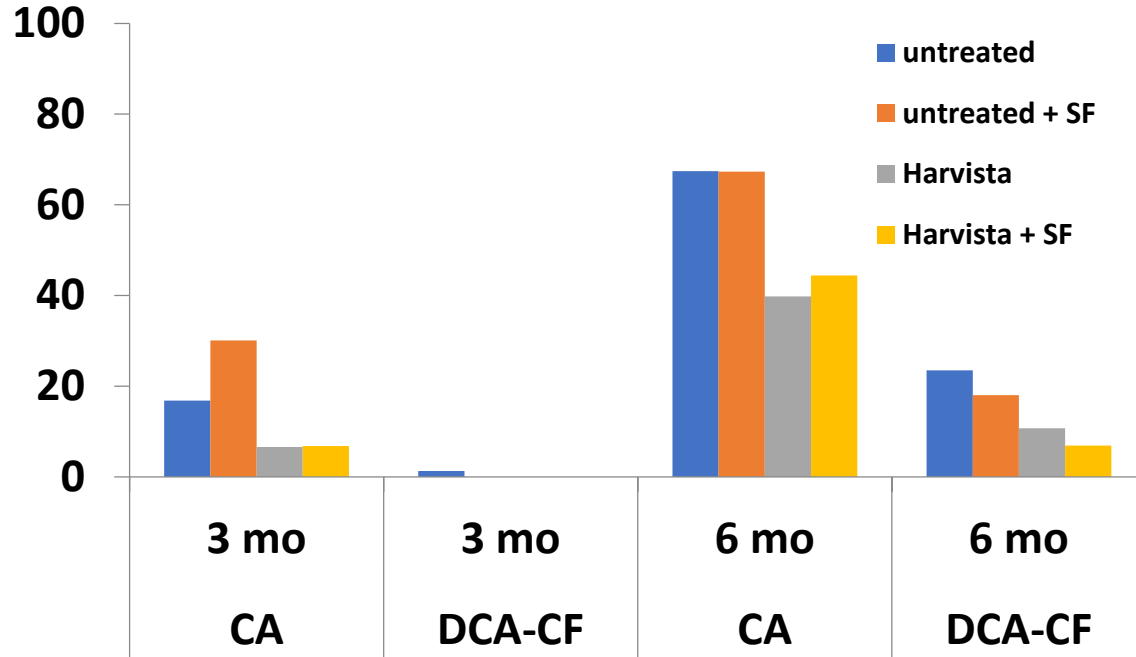
But one year earlier



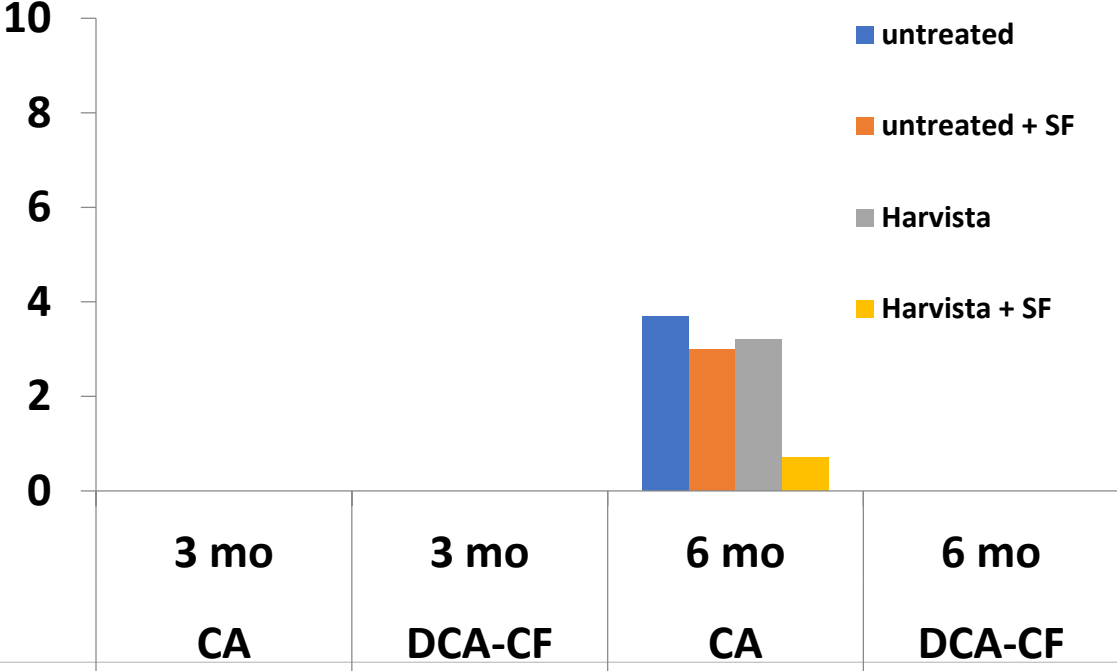
Effect of PGRs and low oxygen



Stem end browning (%)



Core browning (%)



Effect of 1-MCP

	CA				DCA			
Orchard block	5 months		8 months		5 months		8 months	
	No 1-MCP	1-MCP	No 1-MCP	1-MCP	No 1-MCP	1-MCP	No 1-MCP	1-MCP
	Stem end flesh browning (%)							
1	67	60	78	76	7	1	49	38
2	20	16	43	32	1	0	40	33
3	0	0	54	46	0	0	29	46
4	19	23	68	76	1	0	51	63

Effects of storage temperature

8 orchard blocks (WNY) 9/16/21)

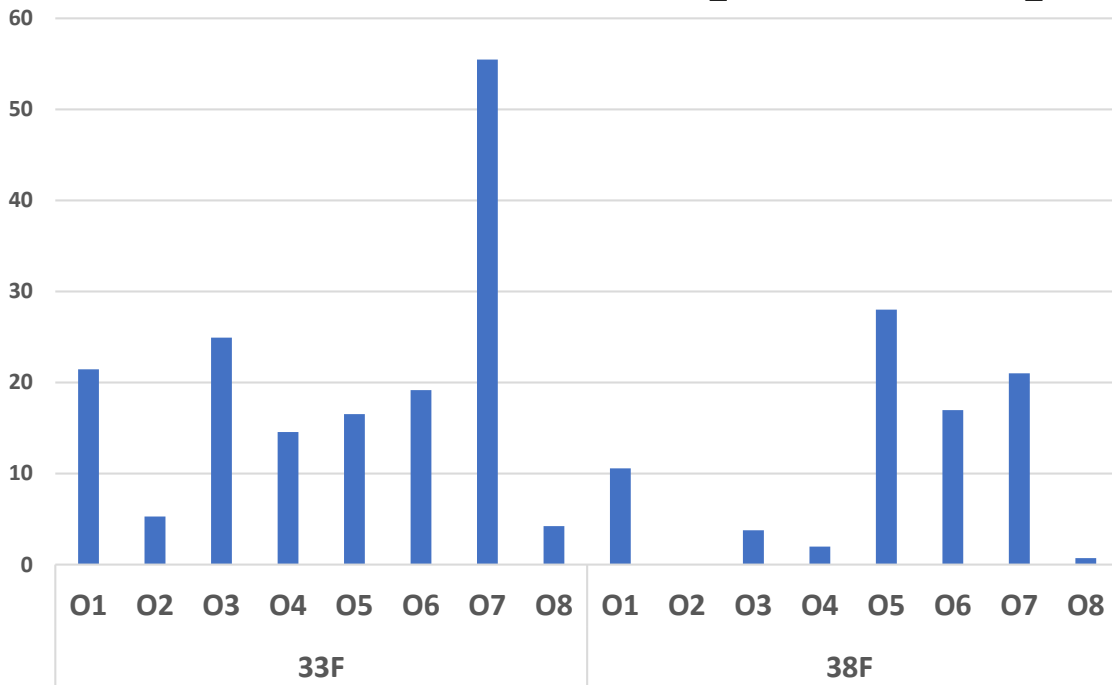
0.5% O₂ and 1.0 % CO₂

33°F and 38°F

9 months storage

Effect of storage temperature on SEFB

9 months storage in 0.5% O₂ and 1% CO₂



Average SEFB (%)

18% at 33°F

8% at 38°F

O1- Brookfield

O2- Brookfield

O3- Brookfield

O4- Imperial

O5- Imperial

O6- Imperial

O7- Imperial

O8- Brookfield

Gala. Western NY (9/16/2021)

Orchard	Firmness (lb)	IEC	I(AD)	SSC	TA	SPI	SEFB (%)
1	18.0	0.64	0.62	11.8	0.39	3.1	21
2	19.0	0.52	0.80	10.5	0.48	3.0	5
3	19.1	0.83	0.45	12.5	0.46	4.1	26
4	17.0	0.44	0.57	10.4	0.42	5.0	14
5	18.1	0.36	0.43	10.7	0.48	4.2	18
6	19.7	0.84	0.33	11.6	0.50	3.2	19
7	18.4	1.48	0.20	11.4	0.44	6.1	56
8	17.2	0.78	0.51	10.6	0.42	5.2	4

Effect of storage temperature on fruit quality

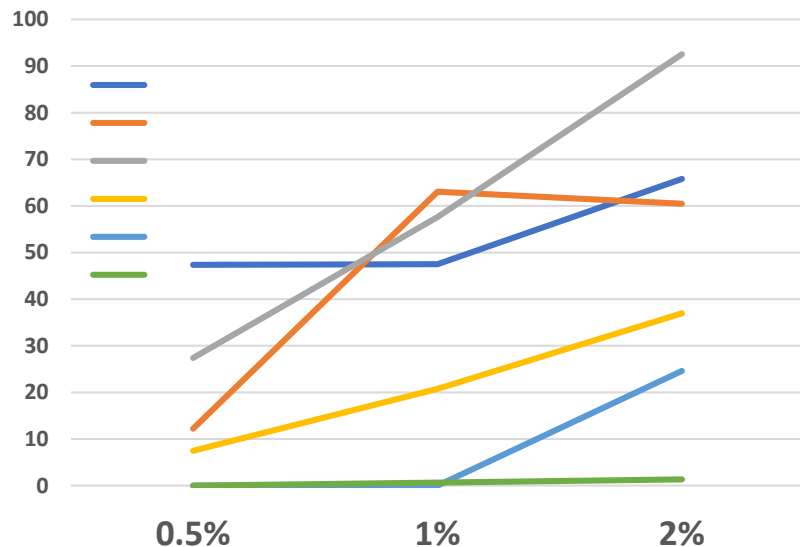
9 months storage in 0.5% O₂ and 1% CO₂

Average of 8 orchard blocks

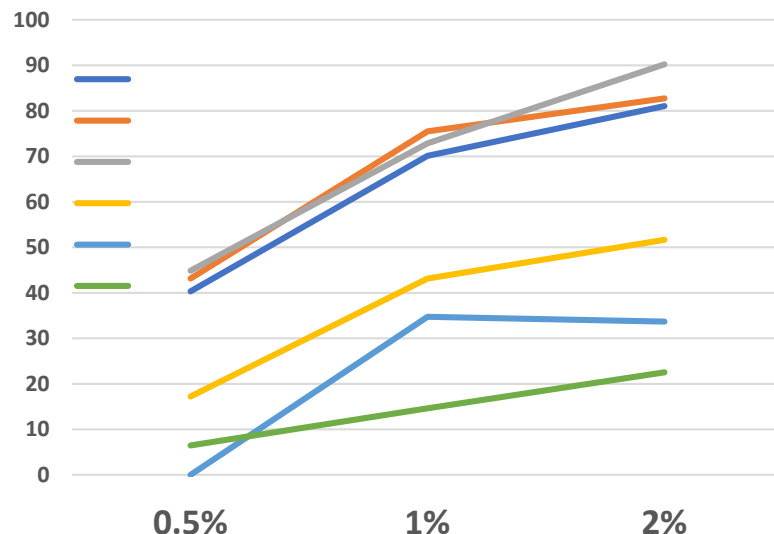
Days after storage	Temperature (°F)	Firmness (lb)	Acidity (%)	I _{AD}
1	33	17.2	0.40	0.36
	38	16.7	0.35	0.33
7	33	17.6	0.36	0.37
	38	17.1	0.34	0.34

Gala – SEFB (%) effect of oxygen (6 orchard blocks)

6 months



10 months



Gala: harvest 9/16/20

Strain	preharvest PGRs	Orchard	IEC (ppm)	Firmness (N)	SSC(%)	TA	SPI	IAD value						
Brookfield	1/2 ReTain-2WBH	O1	AB	1.493825	AB	85.1084	B	12.825	AB	0.490504	B	4.3625	C	0.263958
Fulford	1/2 ReTain 11 dBH	O2	BC	1.257175	D	71.34078	C	11.375	BC	0.43956	AB	5.2	C	0.250646
Brookfield	1/2 ReTain	O3	A	1.903925	C	77.59414	A	13.4	AB	0.487039	A	5.4	C	0.215568
Brookfield	No PGRs	O4	AB	1.477275	BC	80.08631	AB	13.175	AB	0.467651	AB	4.975	B	0.433676
Brookfield	2/3 ReTain 2WBH+ full rate at 1WBH	O5	D	0.275875	A	86.49958	C	11.575	A	0.504818	C	2.975	A	0.619248
Brookfield	2/3 ReTain 3 WBH	O6	C	0.92245	C	78.36115	C	11.85	C	0.394515	AB	4.475	B	0.396551
		P value		<.0001		<.0001		<.0001		<.0001		<.0001		<.0001

Effect of carbon dioxide (in 2% oxygen)

CO ₂ (%)	Flesh firmness (lb)	SEFB (%)
0.5	16.1 a	11.8 b
1	15.9 ab	16.1 ab
2	15.6 b	25.2 a

Take home messages

- Strain selection – early coloring
- PGRs beneficial by delaying development of SEFB
- 0.5% oxygen beneficial by delaying development of SEFB
- 1% carbon dioxide is recommended
- 1-MCP does not have consistent effects in our work
- 38°F reduces incidence compared with 33°F but not a recommendation
- Conditioning can work, but another management step?
- Delayed CA? uncertain, but probably should use 1-MCP if you want to try.

Focus in this year's trials are block performance in relation to minerals

QUESTIONS?



‘Honeycrisp’

Factors to consider

- Storage temperature and conditioning
- Effect of PGRs on disorder incidence and responses to 1-MCP

Storage temperatures and conditioning

Standard recommendation:

Conditioning at 50°F for 7 days, followed by storage at 38°F

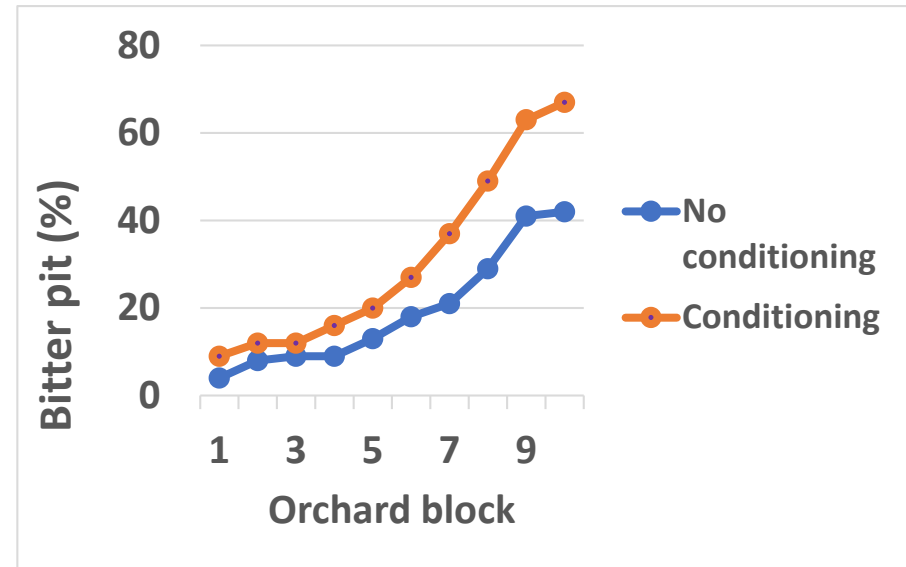
control of soft scald and soggy breakdown

downside is that it greatly increases losses due to bitter pit

[Same for CA although delay of a month if DPA is not used is current recommendation.]

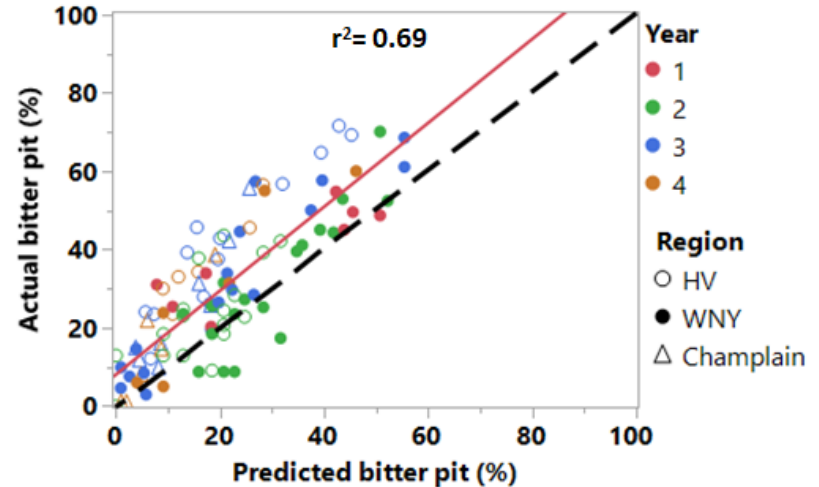
Bitter pit is exacerbated by conditioning

- Conditioning exacerbates bitter pit.
- Soft scald/soggy breakdown does not always occur (lowest in HV)
- Often relationship between high bitter pit risk and low soft scald risk
- Can we avoid conditioning by being able to predict bitter risk at harvest?



Prediction of bitter pit

- Sap analysis of minerals
- Harvest of fruit 3 weeks before commercial harvest and keep fruit at room temperature



Not perfect but may be a method for you to avoid large losses

Recommendations - postharvest

1. If the predicted bitter pit risk is greater than 30%, fruit should not be conditioned. Fruit should be cooled rapidly and stored at 38°F. This is especially true if you have used ReTain or Harvista.
2. Only fruit with a predicted bitter pit risk of less than 10% should be marketed immediately.

3. Do not market fruit with higher than 10% bitter pit risk within the first month as it continues to develop over time, with negative effects in the marketplace (Conditioning immediately after harvest will cause rapid development of bitter pit and therefore is recommended to allow the bitter pit to express before marketing.)
4. Consider storing fruit at 33°F without conditioning (if bitter pit risk is high, e.g. > 50%) to further reduce bitter pit development for short term periods (**less than a month**), but **only in fruit from the HV (and PA)**. *Note that while this is a possible approach, careful monitoring of fruit, e.g. eating several fruit from each block for any hint of alcoholic off-flavors, must be carried out at weekly intervals. There is a risk but likely less than with ongoing bitter pit development.*

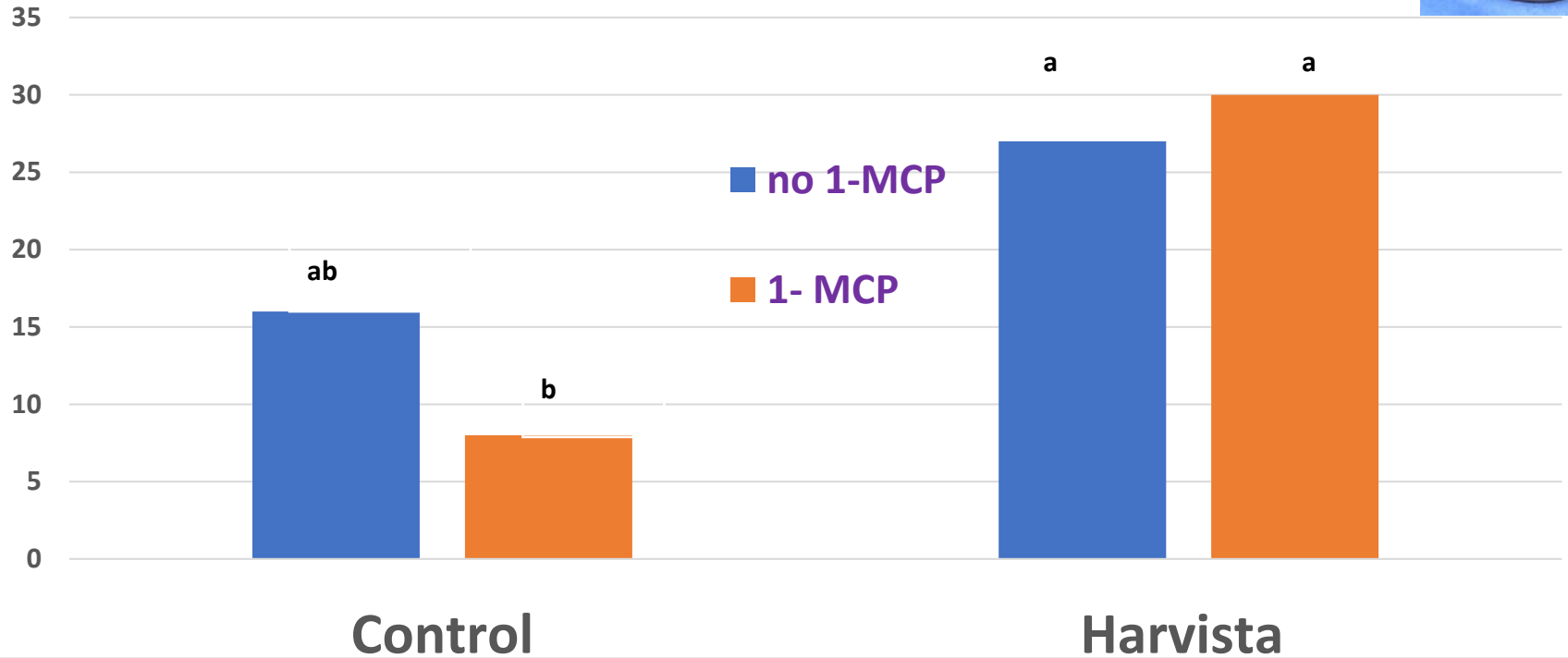
Storage temperatures and conditioning

Some areas have reluctance at running storage room at 38°F because of lack of volume

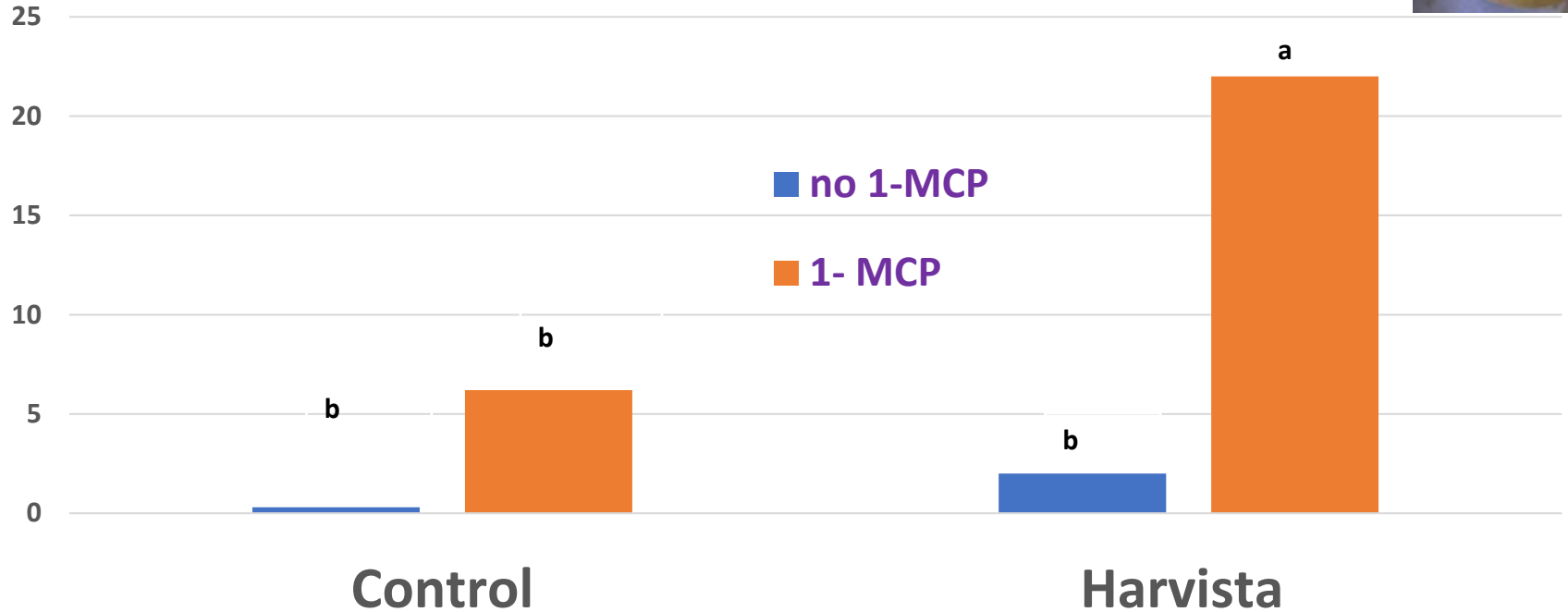
- Solutions?
 - Conditioning will usually allow safe storage at 33°F in southern regions
 - 33°F is an option but can be risky
 - Share room with compatible 38°F varieties (SD, RF, Evercrisp), or with other varieties that have been treated with 1-MCP.

Effect of PGRs on disorder incidence and responses to 1-MCP

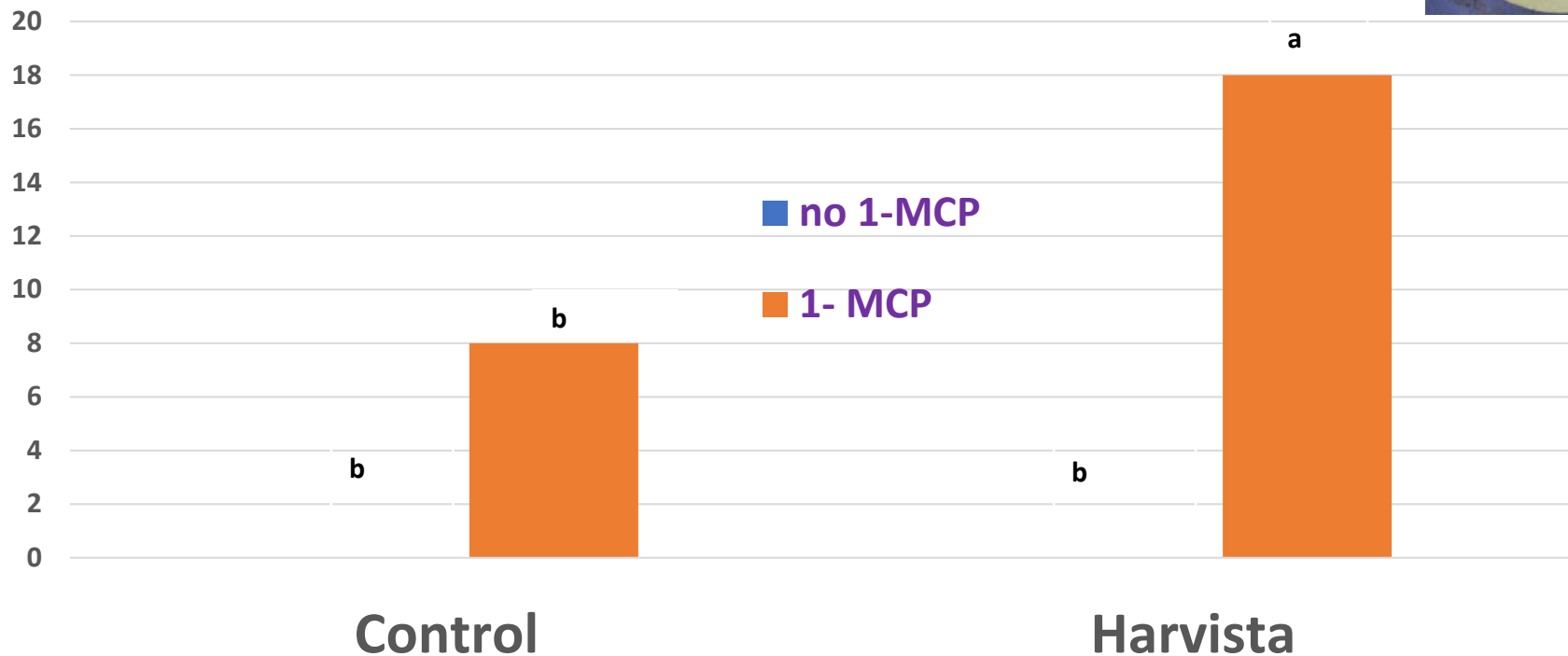
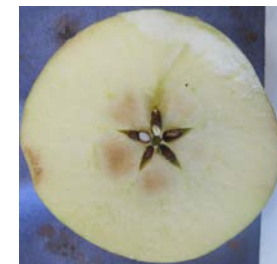
Bitter pit (%)



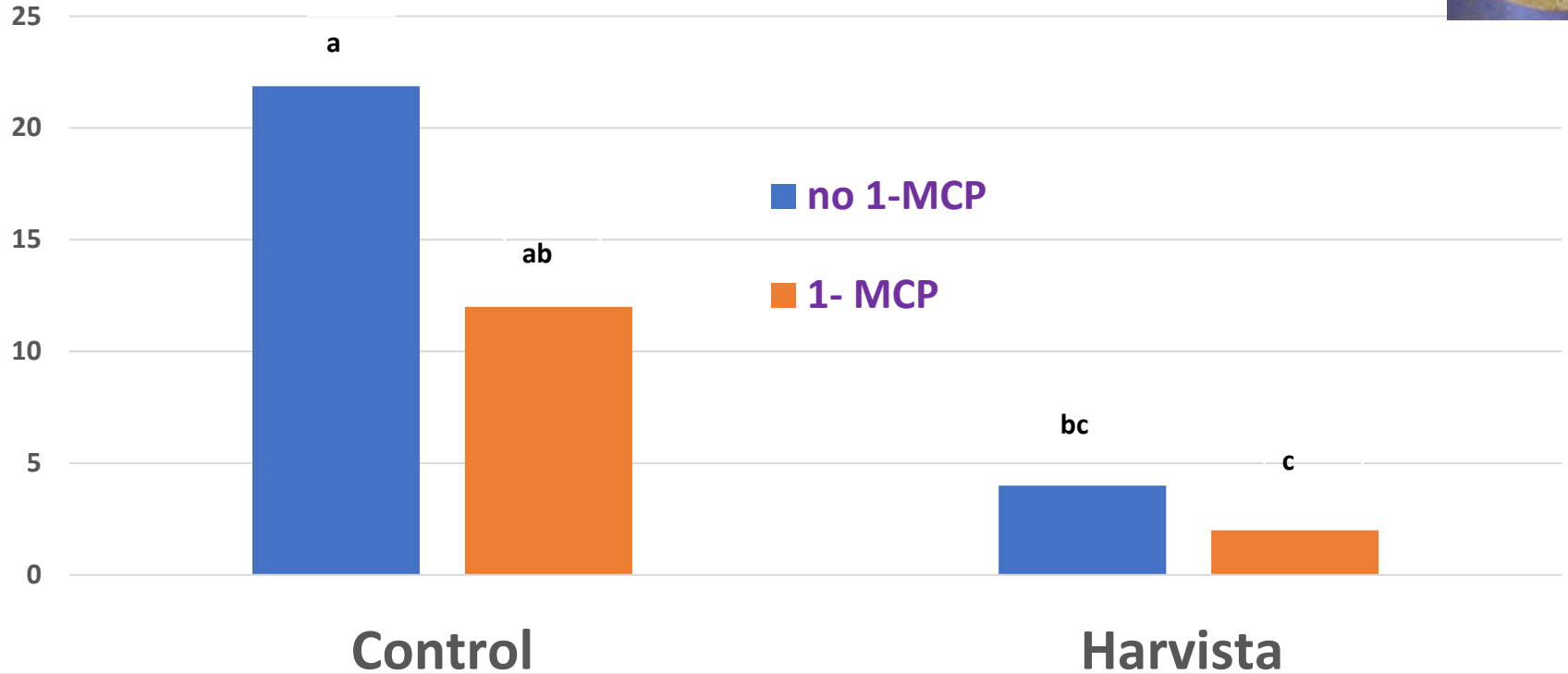
Leather blotch (%)



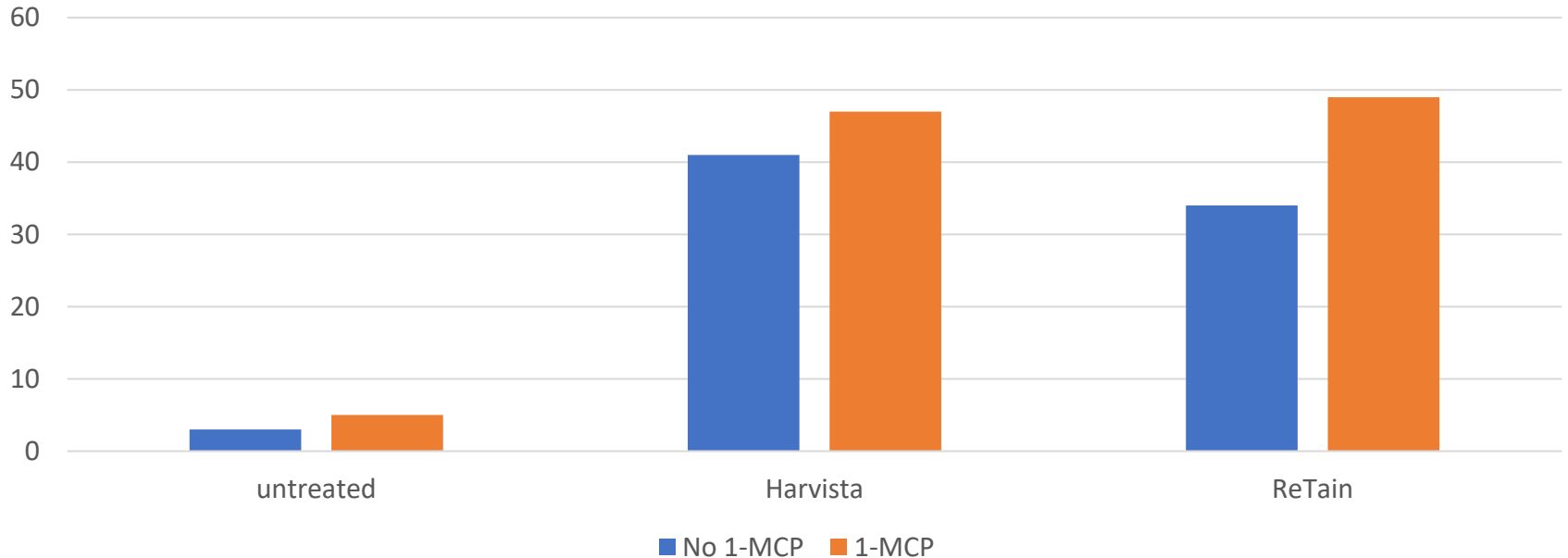
Core browning (%)



Senescent breakdown (%)



From another trial focused on CA: Carbon dioxide injury (%)



Take home messages

- Follow standard postharvest recommendations for conditioning unless following prediction models
- Do not apply PGRs to high bitter pit risk blocks
- 1-MCP use should be carefully considered depending on history (be aware of interactions with preharvest 1-MCP)

QUESTIONS

Your help – please let us know asap if you have a high bitter pit risk block

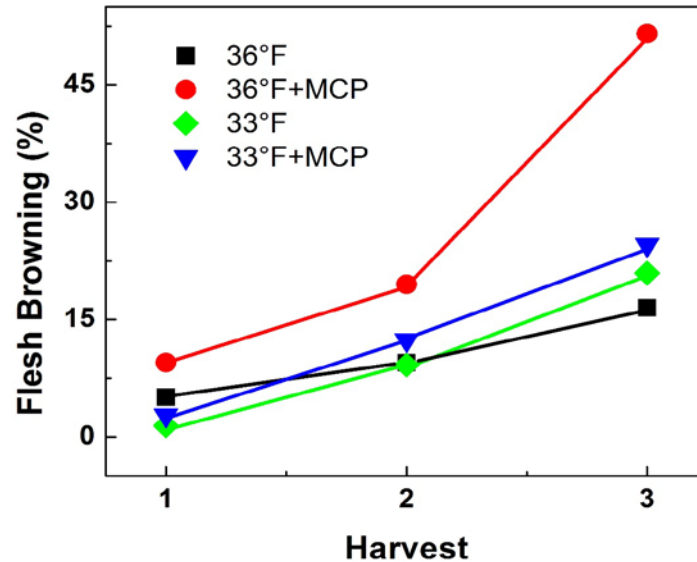


‘Empire’

CA recommendations

- 2% O₂/2% CO₂ still recommended atmospheres (perhaps slightly higher if using manual CA control)
- If using DPA then no concerns about CO₂ injury
- If not using DPA
 - Rigid protocol of as low as possible CO₂ in storage for first 4-6 weeks, but then must bring up to 1-2%.
 - Preferably delay 1-MCP treatment to 7 days.
 - Remember Harvista and ReTain increase risk of injury.

Flesh browning in relation to harvest date, storage temperature and 1-MCP treatment



CA and DCA – post-storage 1-MCP all treatments at 38°F

T1	Control- 8 months CA
T2	1-MCP at harvest- 8 months CA
T3	Control- 8 months CA+ 1 month air
T4	1-MCP at harvest- 8 months CA+ 1month in air
T5	Control- 8 months CA+ 1-MCP after CA+ 1 month air
T6	1-MCP at harvest- 8- CA+1-MCP after CA+ 1month in air

Fruit from 2 orchard blocks

CA – post-storage 1-MCP all treatments at 38°F

Flesh browning
(%)

		<u>CA</u>	<u>DCA</u>
T1	Control- 8 months CA	0	0
T2	1-MCP at harvest- 8 months CA	29	2
T3	Control- 8 months CA+ 1 month air	0	0
T4	1-MCP at harvest- 8 months CA+ 1month in air	38	17
T5	Control- 8 months CA+ 1-MCP after CA+ 1 month air	0	0
T6	1-MCP at harvest- 8- CA+1-MCP after CA+ 1month in air	43	21

Fruit from 2 orchard blocks

CA 8 months – post-storage 1-MCP^(lb)

Flesh firmness
all treatments at 38°F

		<u>CA</u>	<u>DCA</u>
T1	Control- CA	9.6	12.4
T2	1-MCP at harvest- CA	12.7	15.6
T3	Control- CA+ 1 month air	9.3	10.4
T4	1-MCP at harvest- CA+ 1month in air	10.0	11.4
T5	Control- CA+ 1-MCP after CA+ 1 month air	9.7	13.8
T6	1-MCP at harvest- CA+1-MCP after CA+ 1month in air	11.7	15.0

Fruit from 2 orchard blocks

Take home messages

- No changes to recommendations yet, but impact of DCA in combination with 1-MCP may be a break through

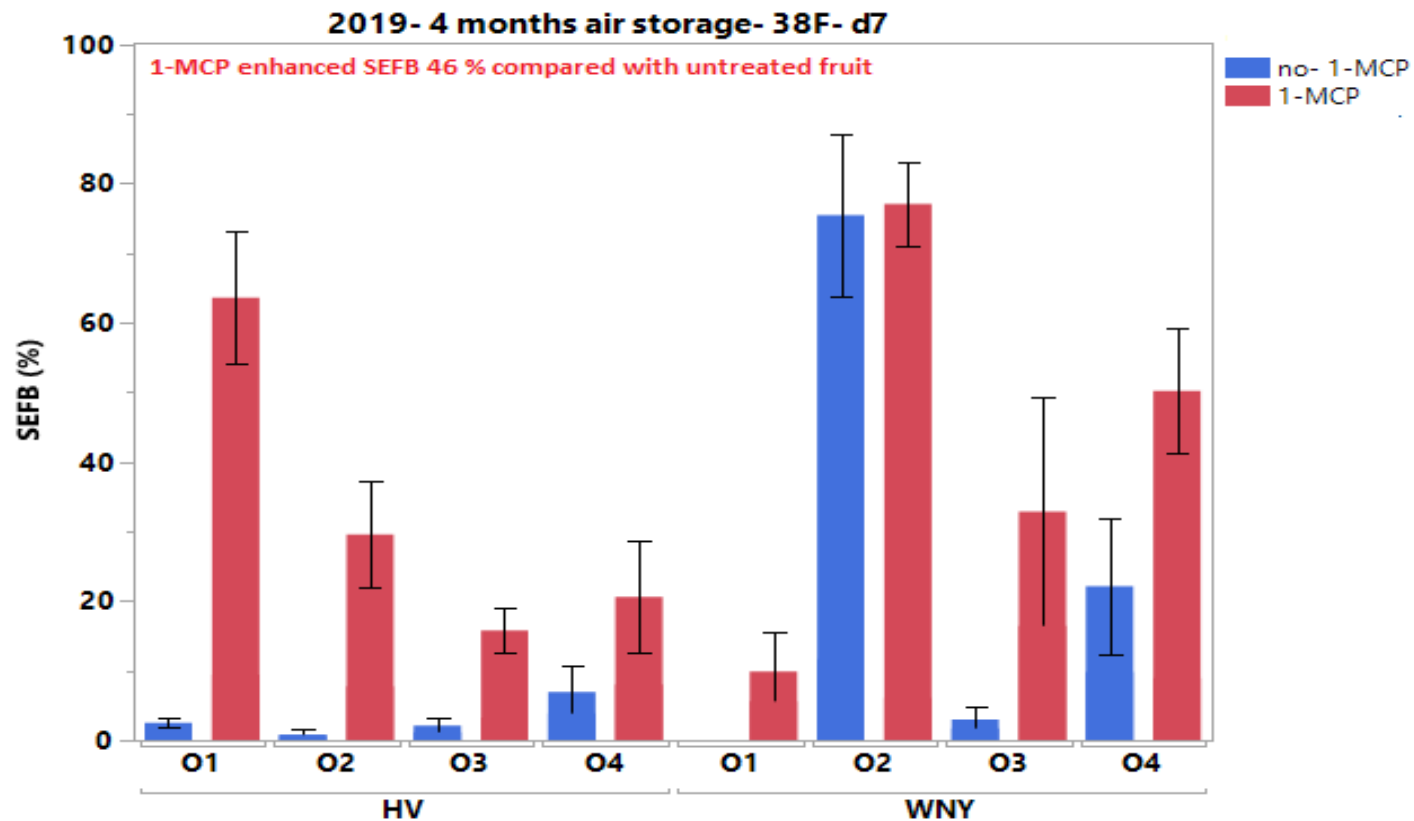
QUESTIONS?



'NY1'
SnapDragon

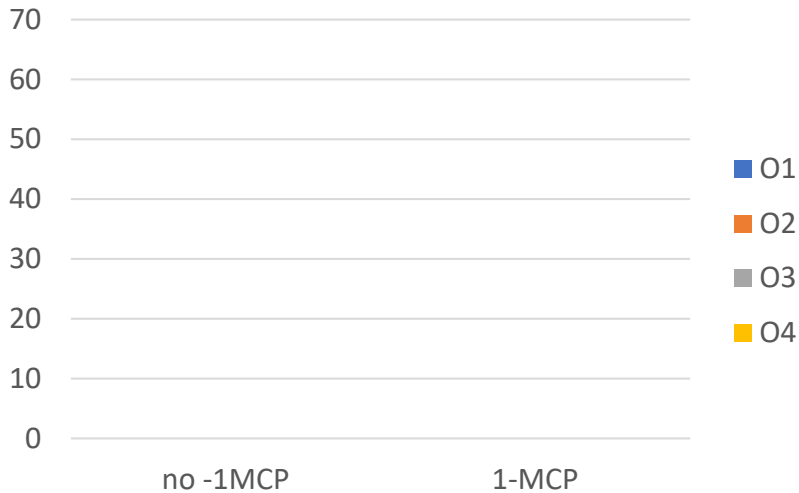
NY1 – air storage

- 38°F
- 1-MCP is not recommended, but with a time caveat (< 2 months?)
 - Why not?
 - Why time limitation?

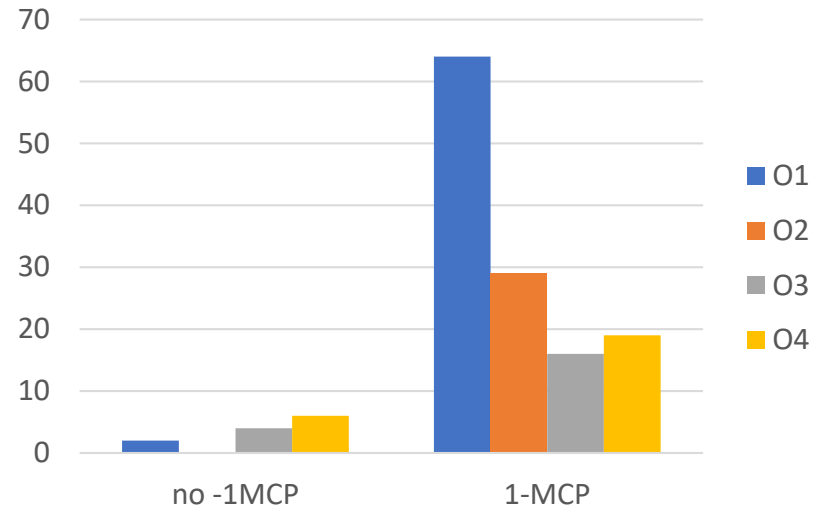


Storage length critical HV 2019 air- SEFB (%)

2 months



4 months

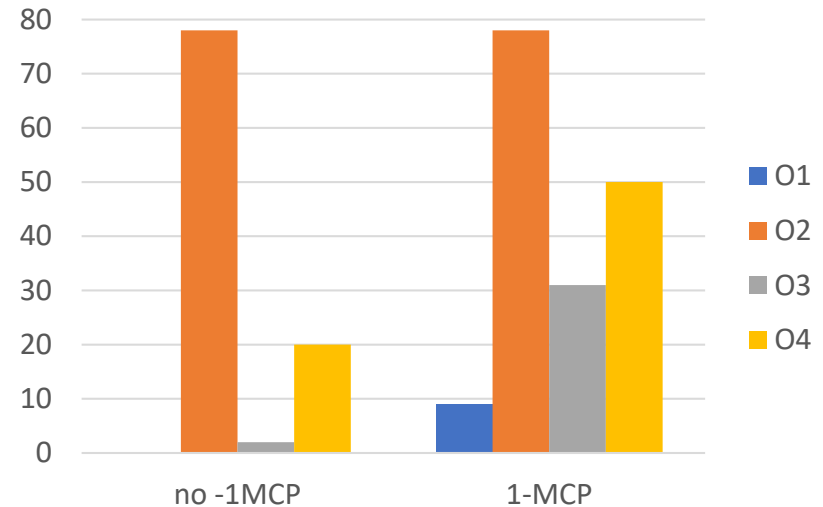
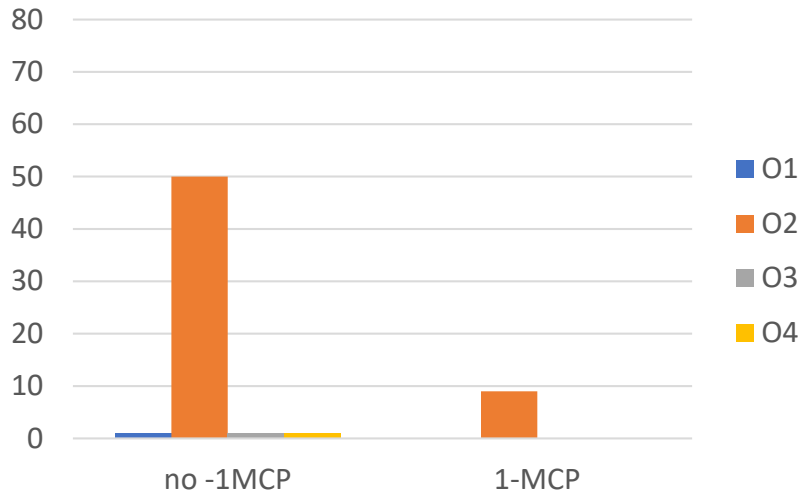


WNY 2019 air - SEFB (%)

Orchard 2 highlights that when things are bad, all is bad regardless of 1-MCP

2 months

4 months



Flesh firmness (lb)

		Hudson Valley		Western NY	
		No 1-MCP	1-MCP	No 1-MCP	1-MCP
2 months	Day 1	15.5	16.0	15.2	16.2
	Day 7	15.2	15.9	14.7	16.3
4 months	Day 1	13.8	14.8	13.1	14.7
	Day 7	13.7	15.0	12.9	14.2

We need to think through strategies, that also involve your history/experience

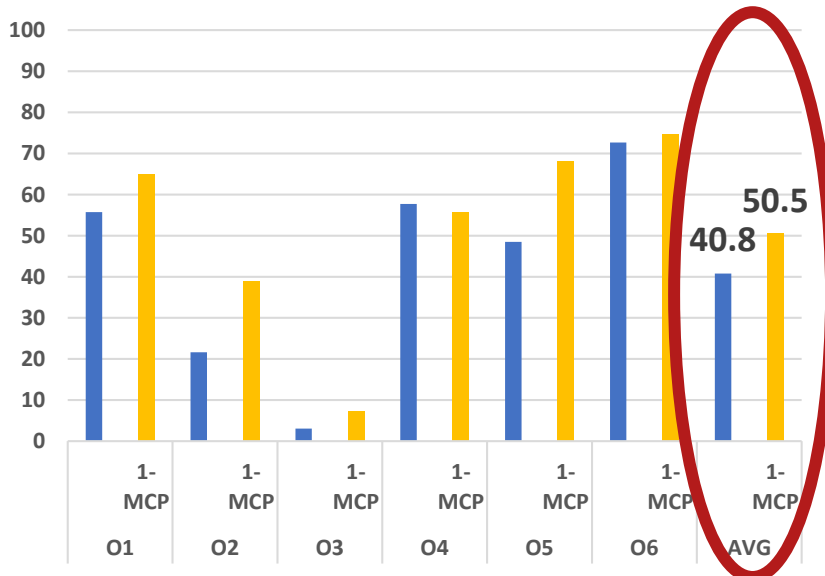
NY1 – CA storage

- 38°F
- 1-MCP is not recommended without delay
 - may be necessary for delay treatments to maintain firmness and acidity.
- Delay CA storage at least 7 days? (after last fruit in the room)
- DCA has potential to provide 1-MCP-like benefits

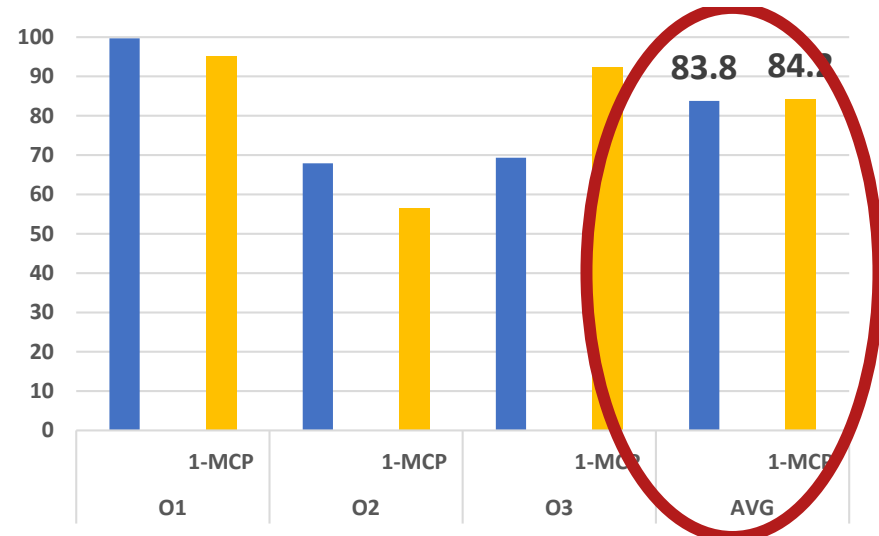
As always, not 100% consistent

Flesh browning (%) after 5 months of CA storage (+ 7 d) **2017**

Hudson Valley

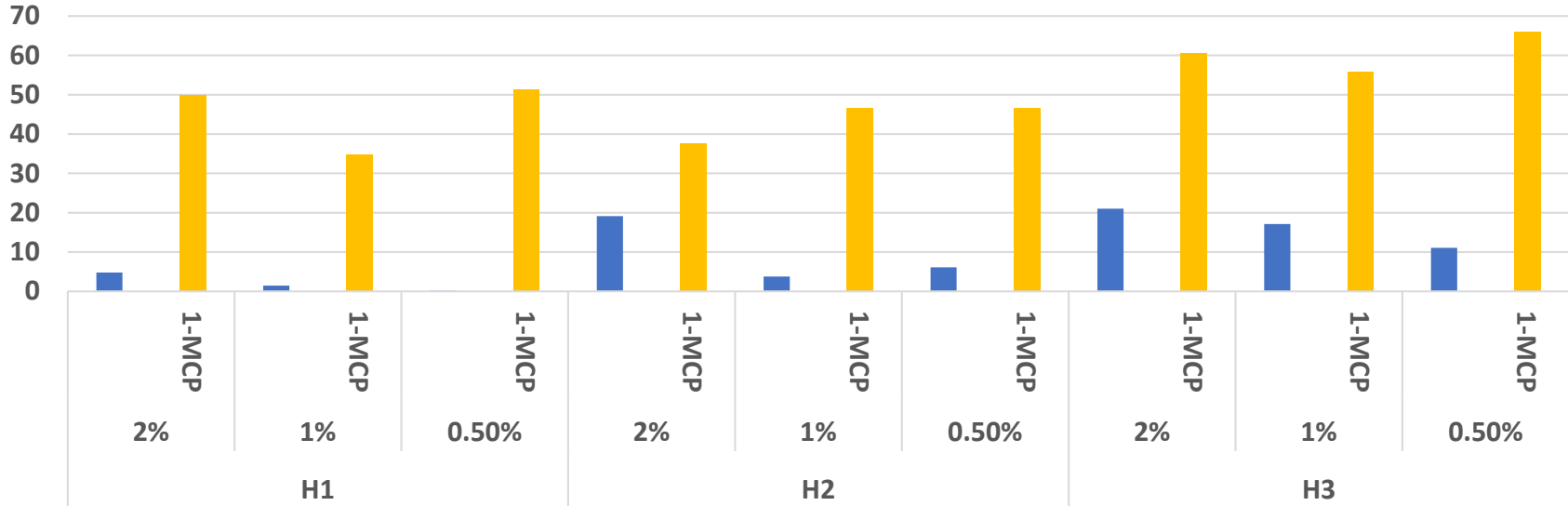


Western NY



Three harvests 9/20, 9/27, and 10/4

SEFB (%) after 6 months CA: effect of harvest date and CO₂ concentration (2018)



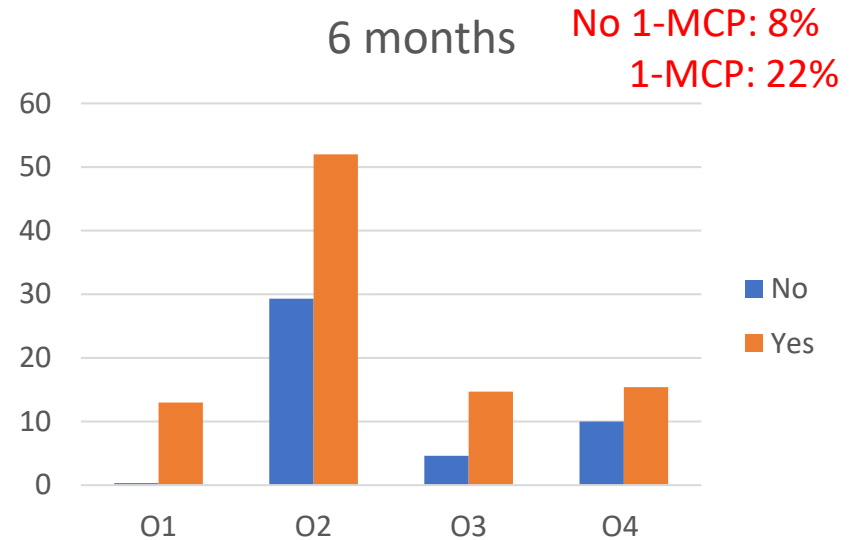
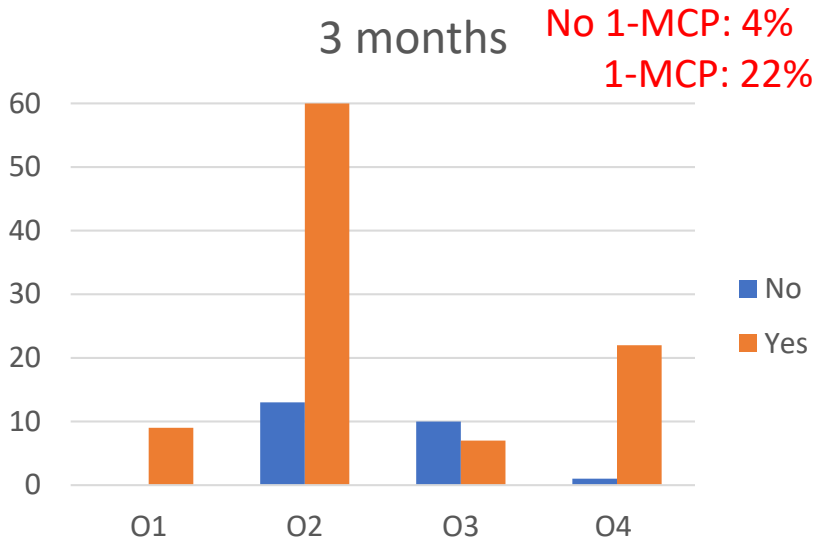
Small harvest date effect

No effect of CO₂. H1, 2, 3 = 18%, 24%, 37%;

1-MCP 50% cf. 8%

HV: Internal CO₂ injury (%) (2019)

the side effect of 1-MCP



Latest results – conditioning, CA/DCA, post storage 1-MCP

CA/DCA storage initiated after 8 days

Conditioning - 50°F for 7 days

1-MCP applied to fruit on day 7 before
storage and/or after storage

Fruit stored for 6 months and evaluated
after 1 and 7 days at 68°F

Treatments

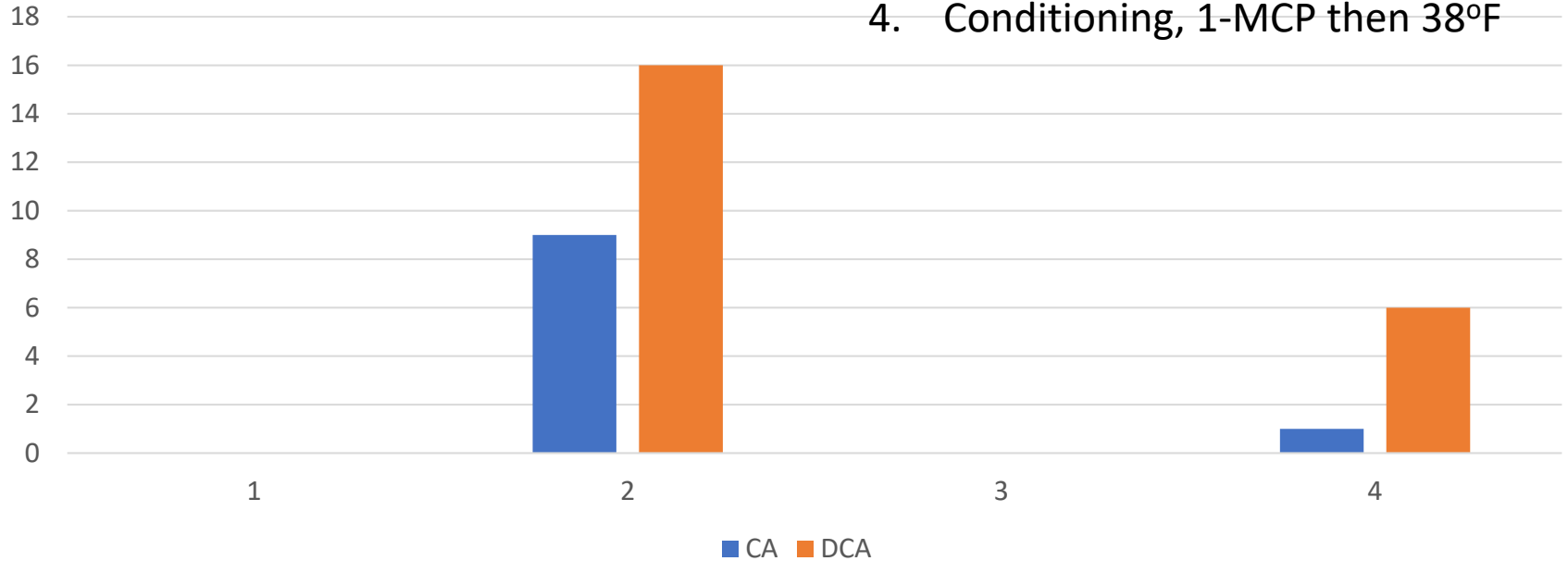
1. 38°F
2. 1-MCP and 38°F
3. Conditioning, then 38°F
4. Conditioning, 1-MCP then 38°F

Post storage 1-MCP effects are similar to those shown here.

HV: Flesh browning (%)

Treatments

1. 38°F
2. 1-MCP and 38°F
3. Conditioning, then 38°F
4. Conditioning, 1-MCP then 38°F

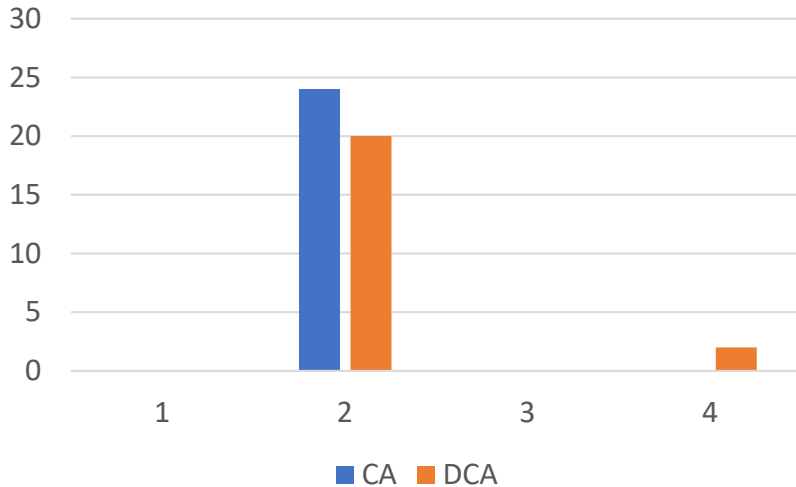


WNY: Flesh browning (%)

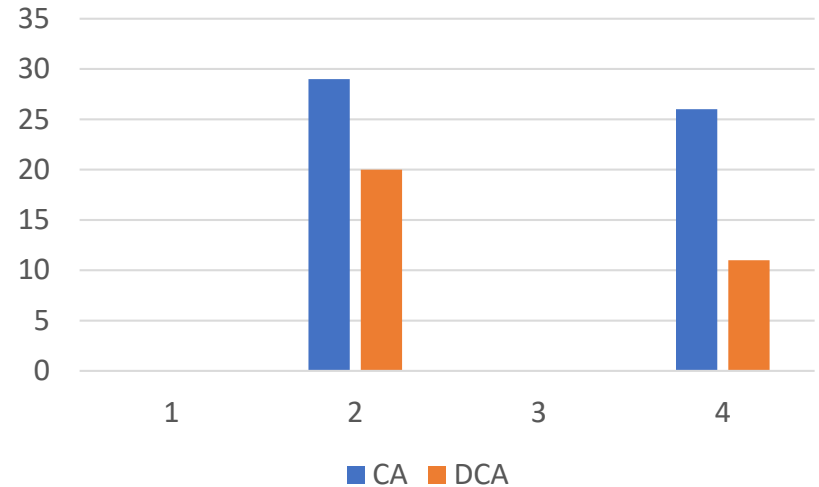
Treatments

1. 38°F
2. 1-MCP and 38°F
3. Conditioning, then 38°F
4. Conditioning, 1-MCP then 38°F

H1



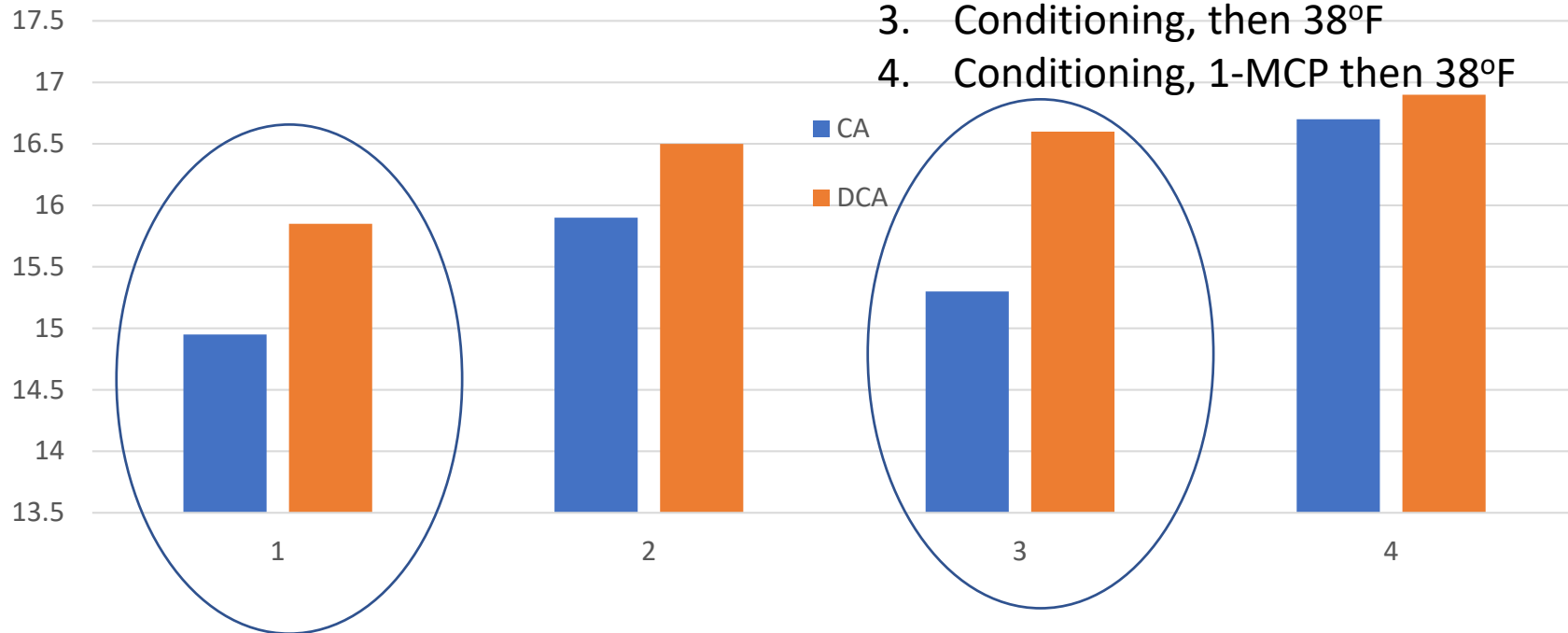
H2



HV: firmness (lb)

Treatments

1. 38°F
2. 1-MCP and 38°F
3. Conditioning, then 38°F
4. Conditioning, 1-MCP then 38°F

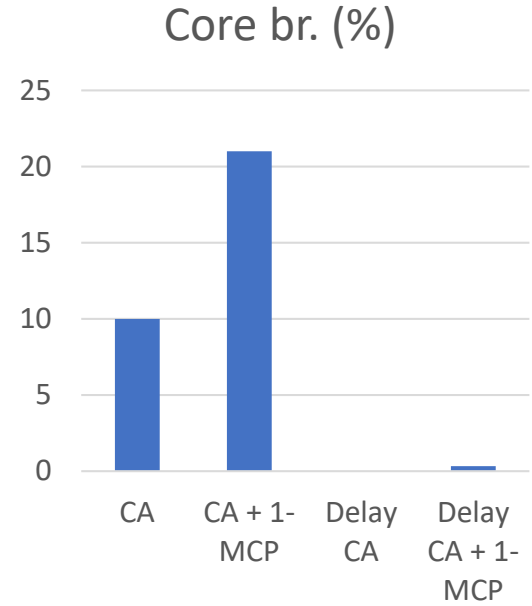
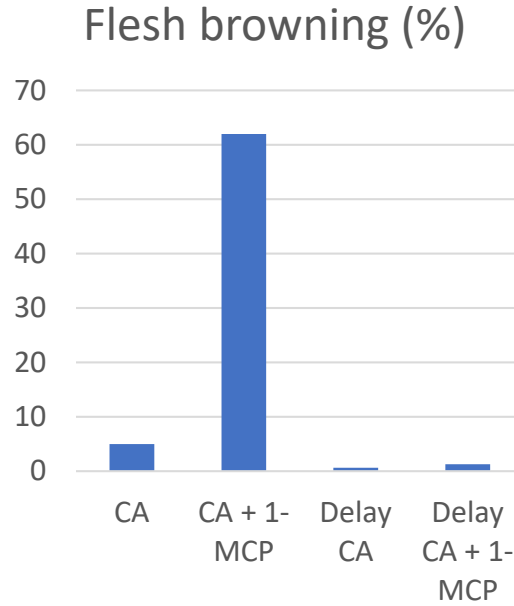
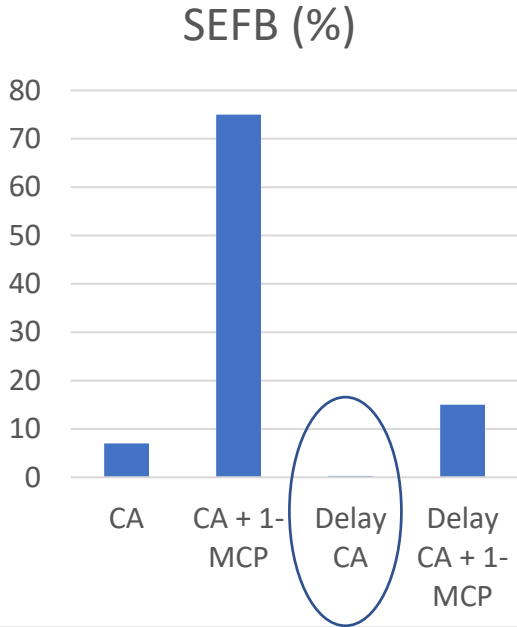


However, longer delay before CA/DCA may be preferred rather than conditioning

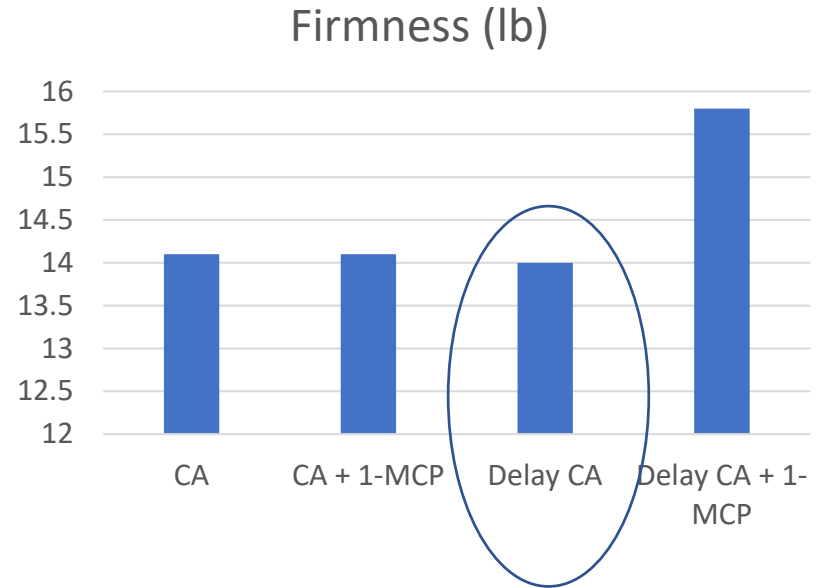
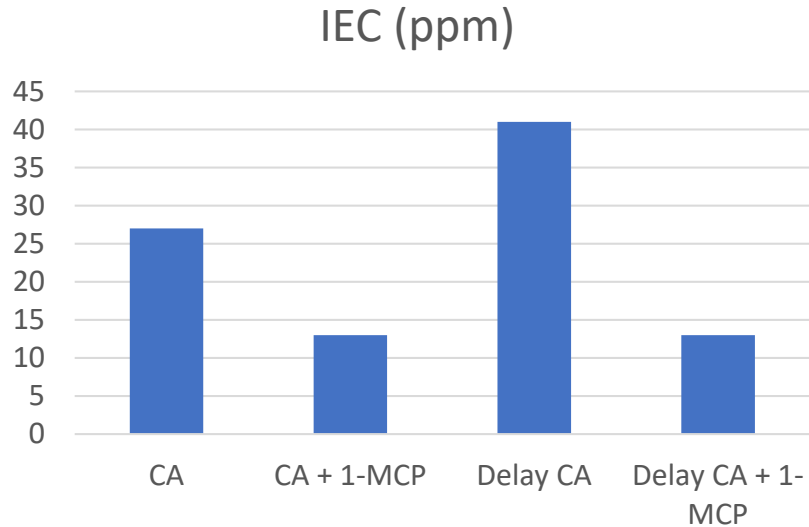
- Easier and less management

But a delay without 1-MCP may be problematic.

CA/delayed CA - 6 month storage + 7d



CA/delayed CA - 6 month storage + 7d



NY1 – CA storage

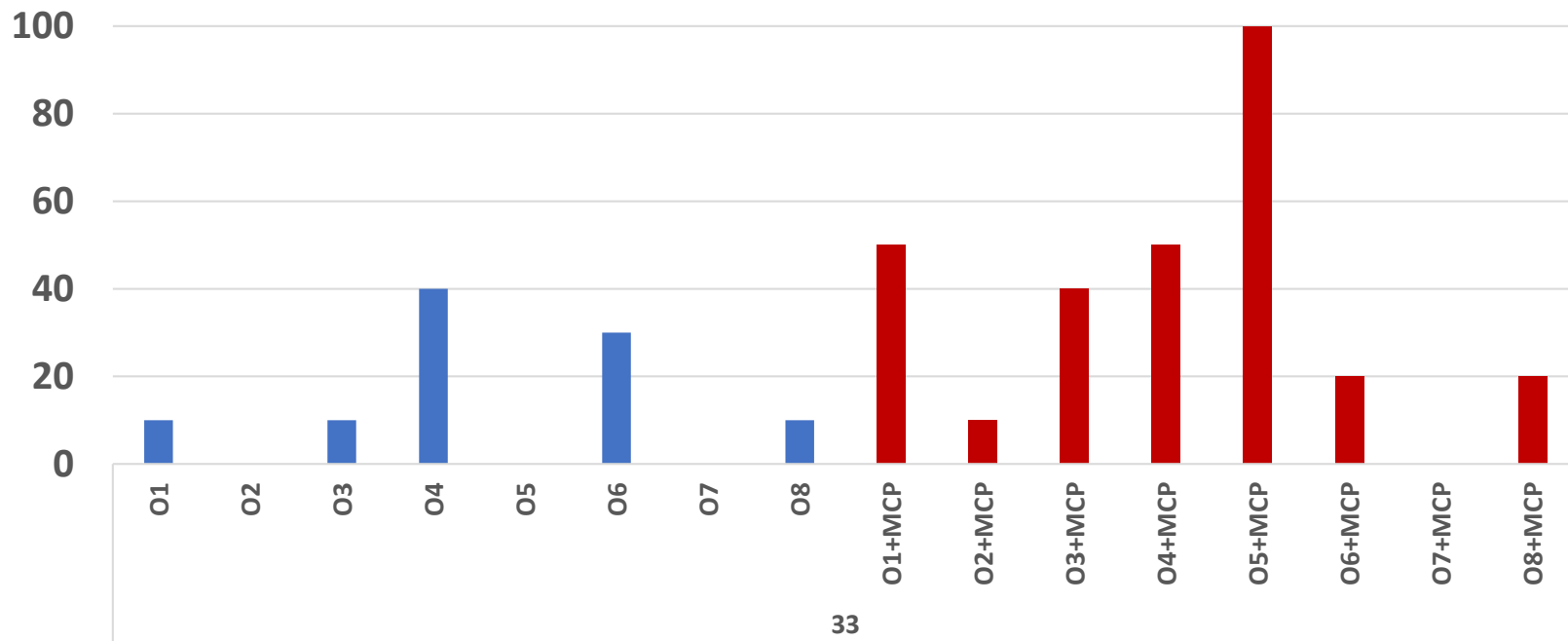
- 38°F
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- DCA has potential to provide 1-MCP-like benefits

QUESTIONS?

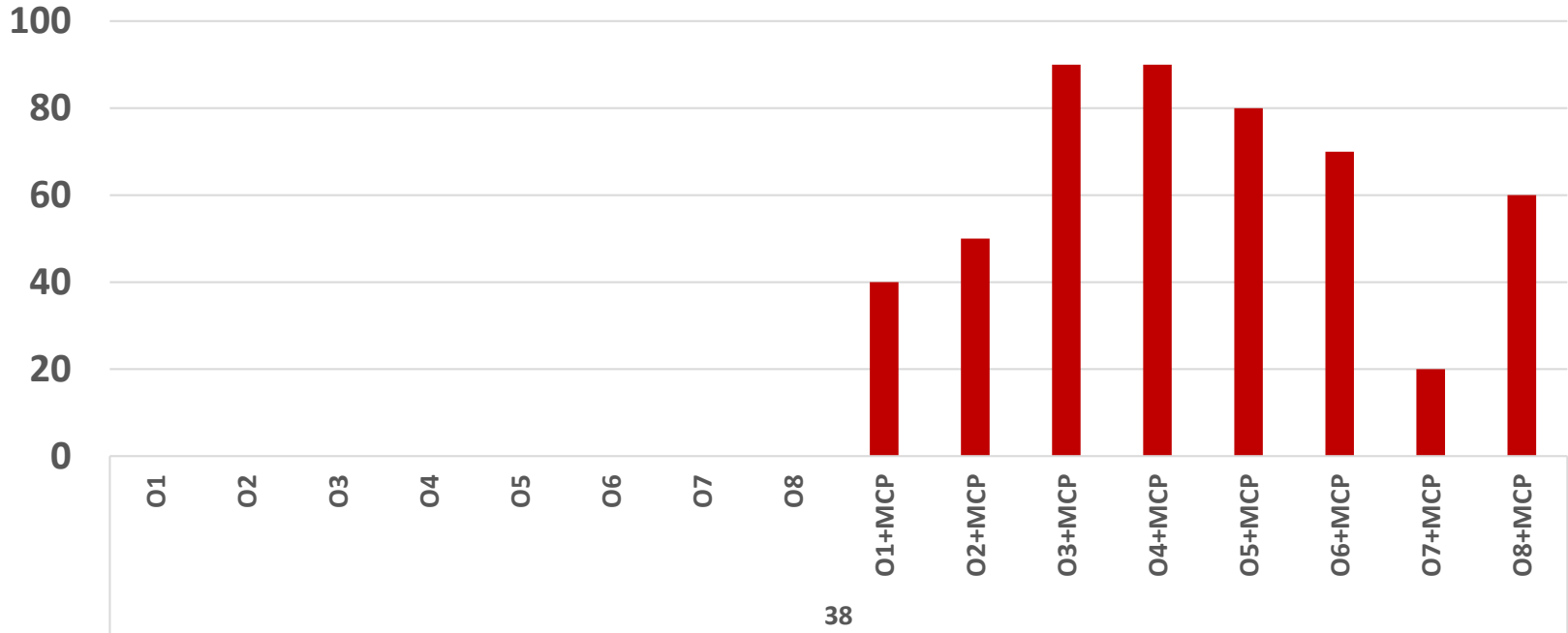


‘Evercrisp’

Core Browning (%) 33°F



Core Browning (%) 38°F



Take home messages (based on limited work)

- Greasiness was delayed at 33°F compared with 38°F and 1-MCP treatment also delayed the greasiness compared with untreated fruit.
- 1-MCP treatment increased CB development at two storage temperatures.
- Current storage recommendation is 38°F without 1-MCP

Firmness/eating quality good, but greasiness?

Interesting 2021 result

*Fruit from 2 orchard blocks harvested 10/26 and 10/30
(2020) and stored at KM Davies until 2/5/2021*

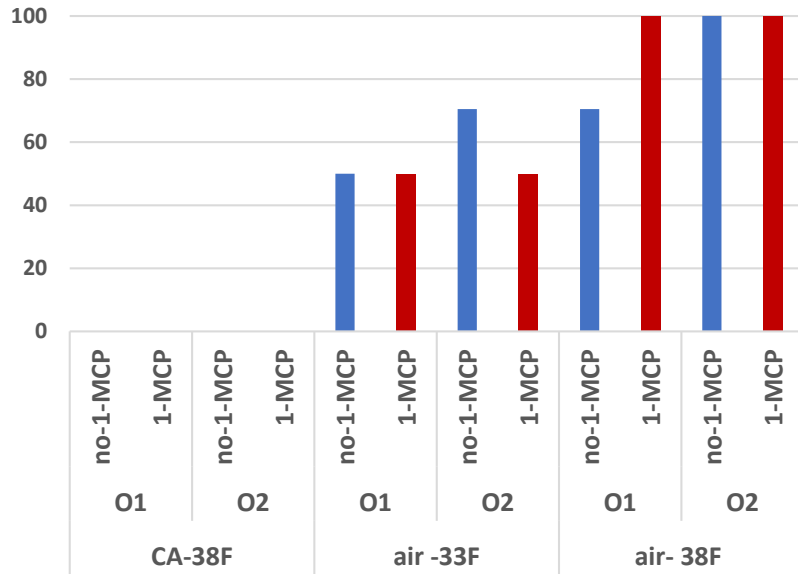
Then stored at Cornell for 5 months at:

1. 33°F in air
2. 38°F in air
3. 38°F in CA

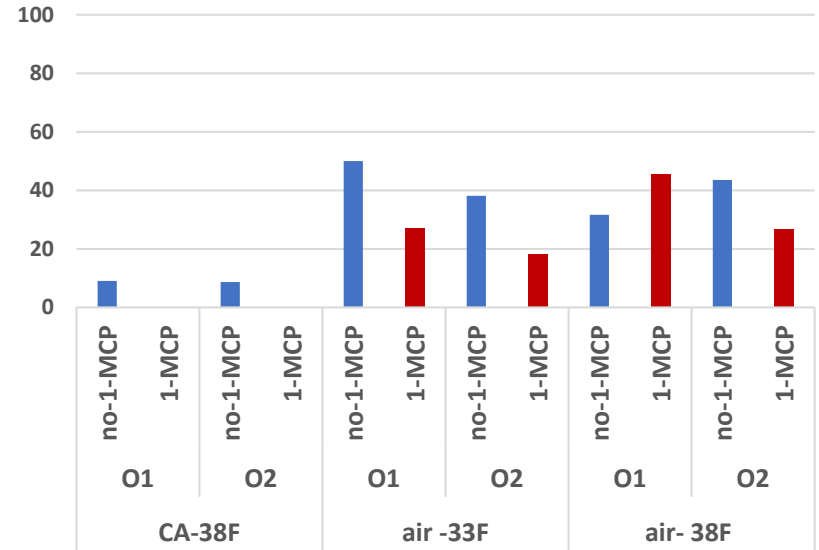


Moved from commercial storage on, and then stored for 5 months: Greasiness (%)

1 d at 68°F

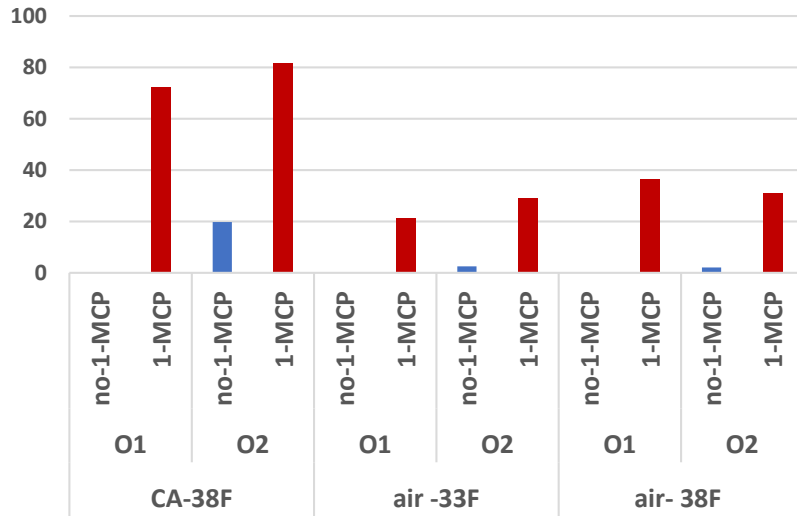


7 d at 68°F

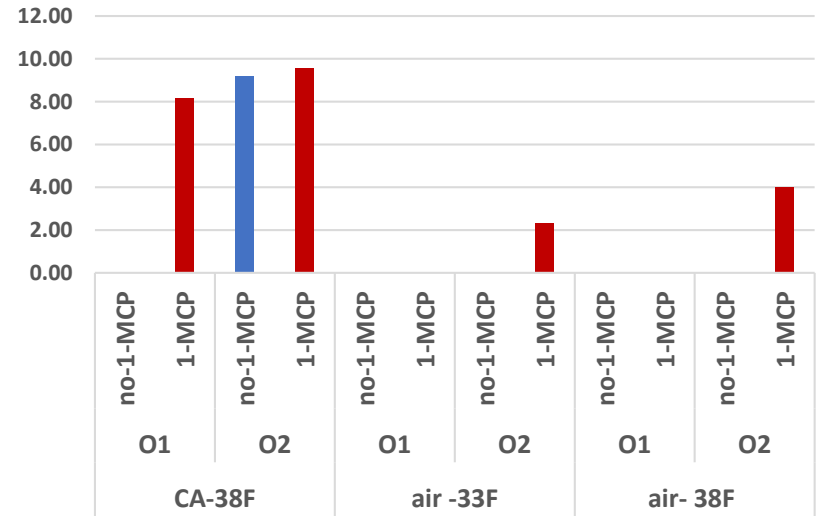


Moved from commercial storage on, and then stored for 5 months, plus 7 d at 68F

Core browning (%)



Watercore breakdown (%)



Take home

- 38°F is recommended storage temperature
- 1-MCP is not recommended.
- Work to manage CA and effects on greasiness is needed.

QUESTIONS?



'NY2' RubyFrost

Summary

- DPA or 1-MCP needed for control of superficial scald
- 1-MCP effects on disorders not significant
- Conditioning effects on disorders not significant, but softer fruit
- DCA provides control of physiological disorders and sometimes fruit quality, with no negative effects detected.

QUESTIONS?