

# **Gala quality: Review of 2021 harvest season and recommendations for 2022**

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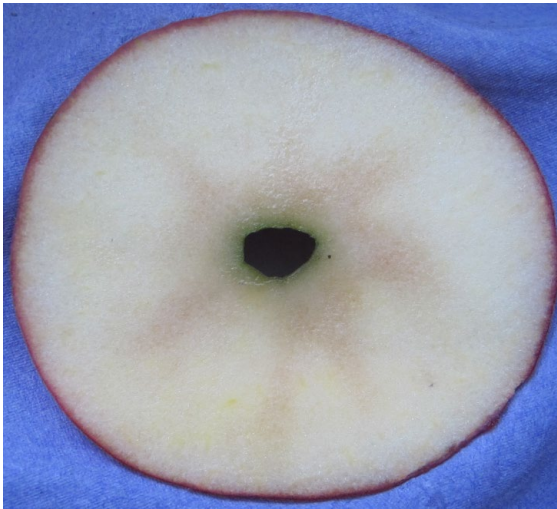
# Acknowledgements for funding of 2021 harvest experiments

- NY Apple Research Development Program
- Valent BioSciences
- Multi-state Hatch funding

And the many wonderful grower and storage cooperators!!!!

# The major storage disorders

Stem end flesh browning



Flesh browning



Core browning



Minor disorders: greasiness, stem end cracking, shriveling, decay

# Three main experiments

1. Effects of ReTain and timing of application
2. Effects of ReTain, oxygen concentration, storage temperature, and delayed CA
3. Regional study of 0.5% oxygen and storage temperature on storage quality

Plus DA reading relationships with disorder incidence

# 1. Effects of ReTain and timing of application

Brookfield strain (commercial farm in Wayne County)

ReTain treatments:

- Trt 1. Untreated control
- Trt 2. ReTain half pouch at 21 dbh
- Trt 3. ReTain half pouch at 21 dbh + 7 dbh
- Trt 4. ReTain half pouch at 21 dbh + 3 dbh
- Trt 5. ReTain full pouch at 7 dbh
- Trt 6. ReTain full pouch at 3 dbh

Objective was to assess effects of later applications to minimize effects on red color development

- Early season resulted in harvest 3, rather than 4, weeks before anticipated harvest.
- Two harvests rather than three harvests

# Experimental details

- Commercially colored fruit only
- 4 sets of replicate trees per treatment
- **No postharvest 1-MCP** because of focus on ReTain results
- Storage temperature – 33°F
- Storage atmosphere – **2% oxygen**/1% carbon dioxide (applied 1 day after harvest following overnight cooling)
- Storage periods – 5 and 9 months plus 7 days at 68F

# At harvest

H1: Sept 14

H2: Sept 21

Control



H1

ReTain



**Trt 2. ReTain half pouch at 21 dbh**

Control



H2

ReTain





# At harvest and after 7 days at 68°F

Trt 1: Control			
Trt 2: ReTain half pouch/A at 21 dbh			
Trt 3: ReTain half pouch/A @ 21 dbh + 7 dbh			
Trt 4: ReTain half pouch/A @ 21 dbh + 3 dbh			
Trt 5: ReTain full pouch/A @ 7 dbh			
Trt 6: ReTain full pouch/A @ 3 dbh			

IEC (ppm)					
TRT	Sept 14			Sept 21	
	D 1	D 7		D 1	D 7
1	3.59 c	57.36 a		4.05 c	45.39 b
2	0.52 c	0.82 c		0.83 c	0.81 c
3	0.21 c	0.59 c		0.48 c	0.52 c
4	0.27 c	0.57 c		0.37 c	0.32 c
5	0.31 c	0.56 c		0.64 c	0.52 c
6	0.32 c	0.49 c		0.60 c	0.36 c

Firmness (lb)					
TRT	Sept 14			Sept 21	
	D 1	D 7		D 1	D 7
1	16.7 abc	14.1 d		15.9 cd	14.3 d
2	18.0 ab	16.7 bc		17.6 abc	16.8 abc
3	18.4 ab	17.5 abc		17.7 abc	17.3 abc
4	18.9 a	18.2 ab		17.5 abc	17.2 abc
5	17.4 abc	17.0 abc		16.7 abc	16.8 abc
6	17.9 abc	17.4 abc		17.0 abc	17.3 abc



High numbers = greener fruit.

Trt 1: Control			
Trt 2: ReTain half pouch/A at 21 dbh			
Trt 3: ReTain half pouch/A @ 21 dbh + 7 dbh			
Trt 4: ReTain half pouch/A @21 dbh + 3 dbh			
Trt 5: ReTain full pouch/A @ 7 dbh			
Trt. 6 ReTain full pouch/A @ 3 dbh			

TRT	SPI		DA reading		SSC (%)		TA (%)	
	Sept 14	Sept 21	Sept 14	Sept 21	Sept 14	Sept 21	Sept 14	Sept 21
1	5.6 ab	6.8 a	0.07 b	0.07 b	12.9 ab	13.6 a	0.476 ab	0.437 ab
2	3.5 bcd	3.1 cd	0.39 a	0.34 a	11.1 d	11.6 cd	0.415 ab	0.408 ab
3	2.8 d	3.1 cd	0.46 a	0.36 a	10.9 d	11.5 cd	0.445 ab	0.423 ab
4	2.7 d	3.2 cd	0.45 a	0.43 a	10.9 d	10.9 d	0.427 ab	0.401 b
5	5.1 abc	6.1 a	0.17 b	0.15 b	12.3 bc	12.8 ab	0.442 ab	0.458 ab
6	5.0 abc	6.4 a	0.11 b	0.08 b	12.8 ab	13.1 ab	0.498 a	0.474 ab

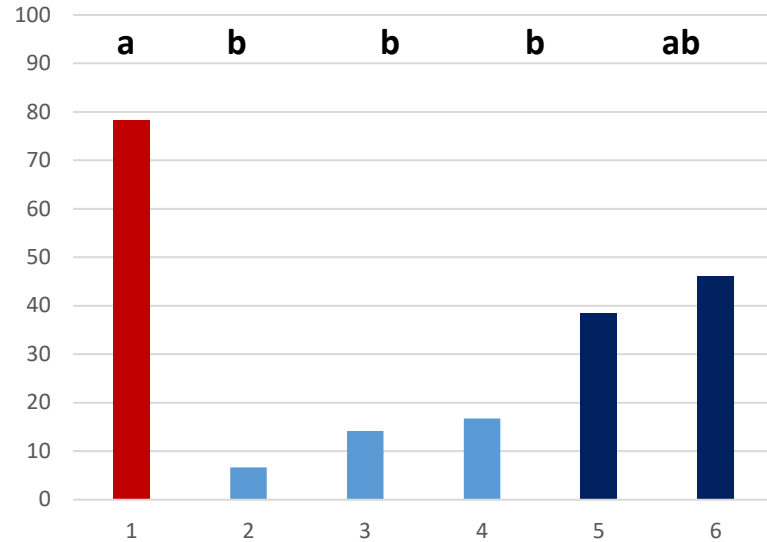
# Storage quality

# SEFB (%)

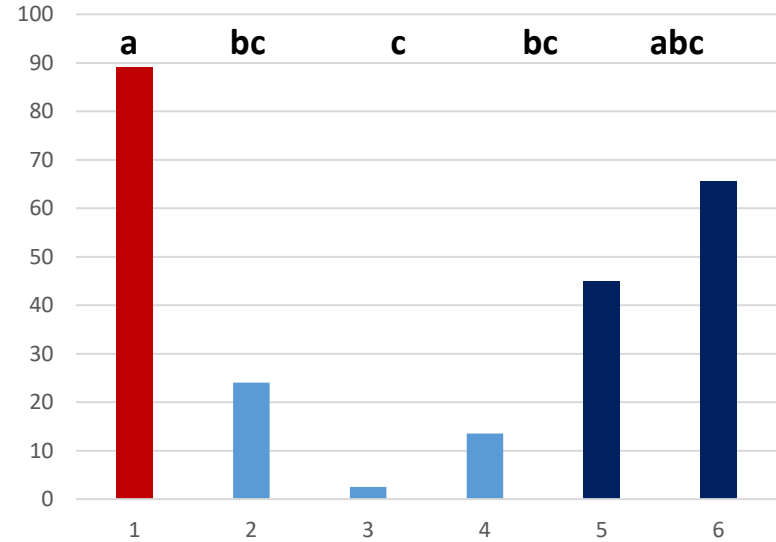
## 5 months + 7 d

Trt 1: Control			
Trt 2: ReTain half pouch/A at 21 dbh			
Trt 3: ReTain half pouch/A @ 21 dbh + 7 dbh			
Trt 4: ReTain half pouch/A @21 dbh + 3 dbh			
Trt 5: ReTain full pouch/A @ 7 dbh			
Trt. 6 ReTain full pouch/A @ 3 dbh			

Sept 14



Sept 21

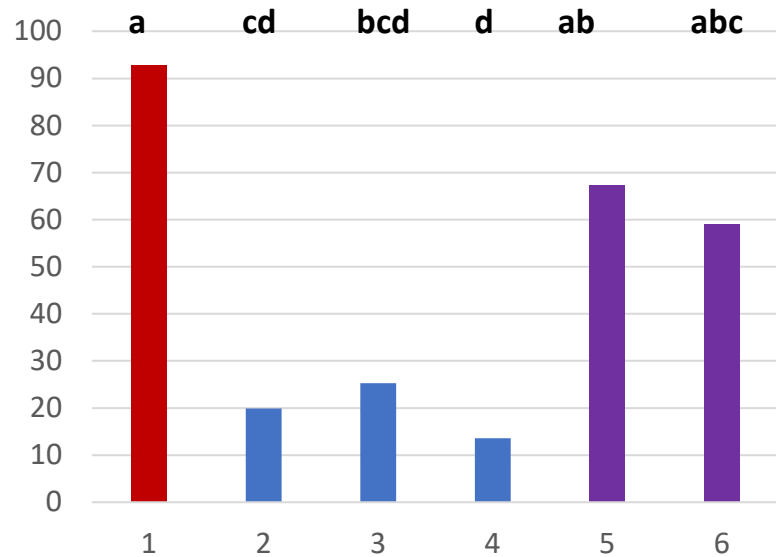


# SEFB (%)

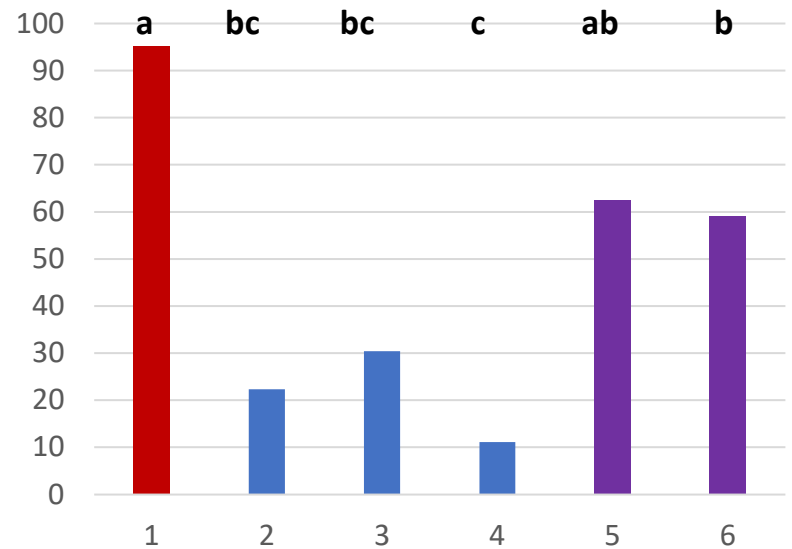
## 9 months + 7 d

Trt 1: Control			
Trt 2: ReTain half pouch/A at 21 dbh			
Trt 3: ReTain half pouch/A @ 21 dbh + 7 dbh			
Trt 4: ReTain half pouch/A @21 dbh + 3 dbh			
Trt 5: ReTain full pouch/A @ 7 dbh			
Trt. 6 ReTain full pouch/A @ 3 dbh			

Sept 14



Sept 21

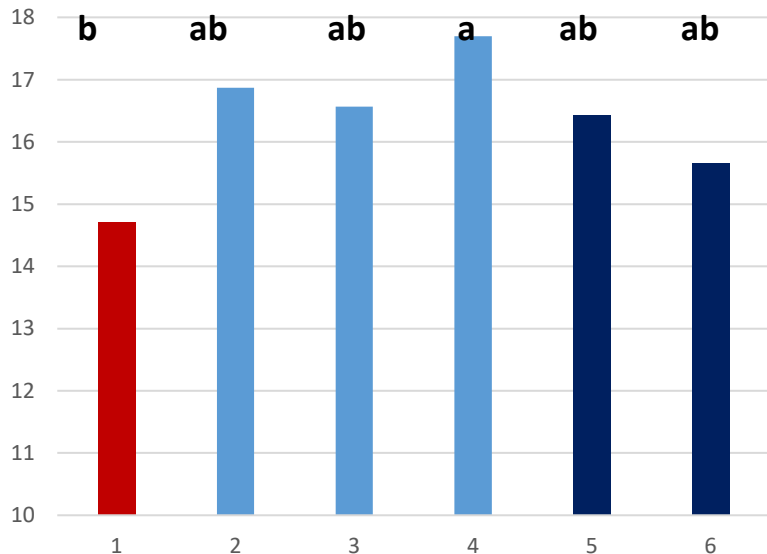


# Flesh firmness (lb) 5 months + 1 d

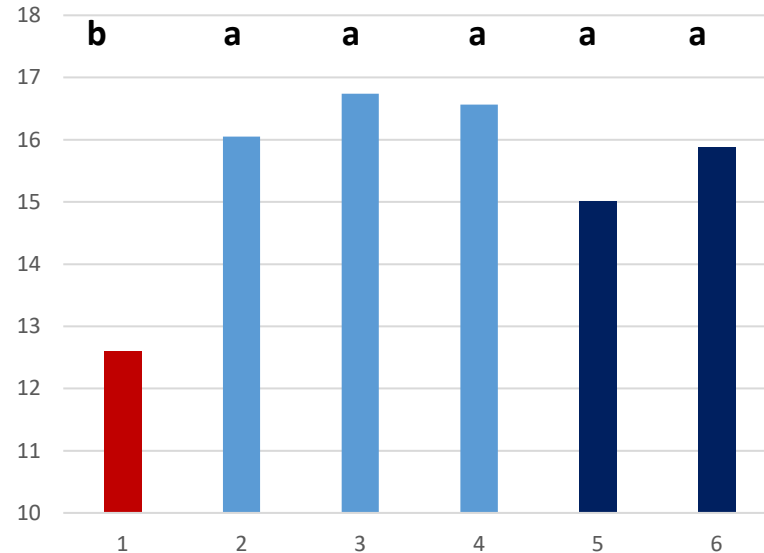
Trt 1: Control			
Trt 2: ReTain half pouch/A at 21 dbh			
Trt 3: ReTain half pouch/A @ 21 dbh + 7 dbh			
Trt 4: ReTain half pouch/A @21 dbh + 3 dbh			
Trt 5: ReTain full pouch/A @ 7 dbh			
Trt. 6 ReTain full pouch/A @ 3 dbh			

H1: 16.3 lb a  
H2: 15.5 lb b

Sept 14

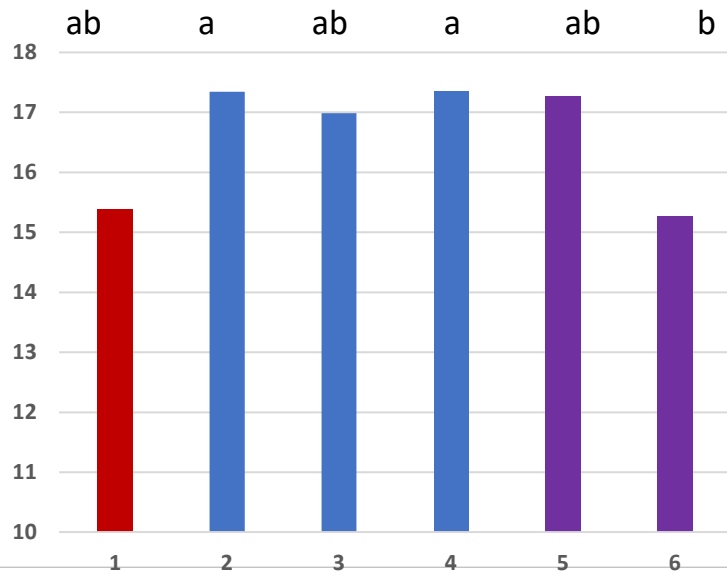


Sept 21



# Flesh firmness (lb) 5 months + 7 d

Sept 14

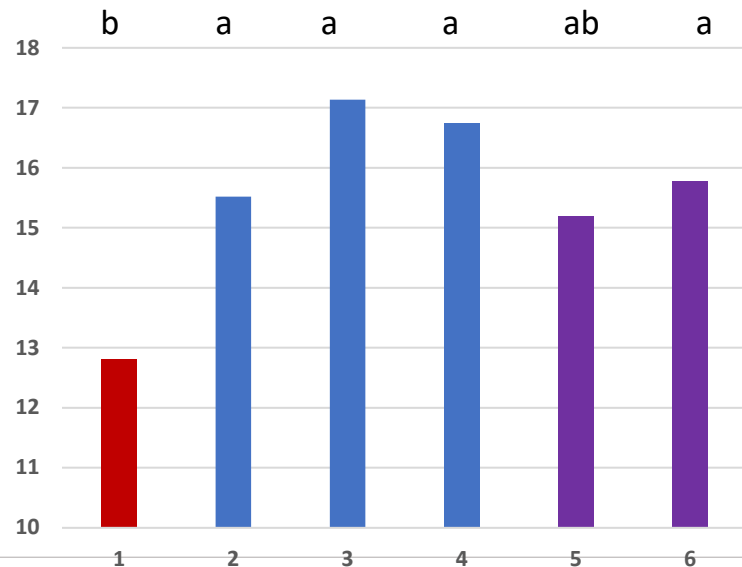


Trt 1: Control			
Trt 2: ReTain half pouch/A at 21 dbh			
Trt 3: ReTain half pouch/A @ 21 dbh + 7 dbh			
Trt 4: ReTain half pouch/A @21 dbh + 3 dbh			
Trt 5: ReTain full pouch/A @ 7 dbh			
Trt. 6 ReTain full pouch/A @ 3 dbh			

H1: 16.6 lb a

H2: 15.5 lb b

Sept 21



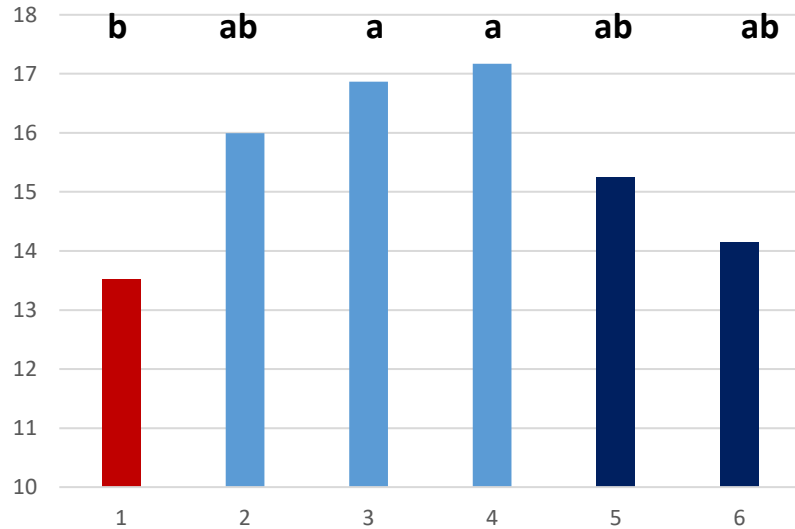
# Flesh firmness (lb)

## 9 months + 1 d

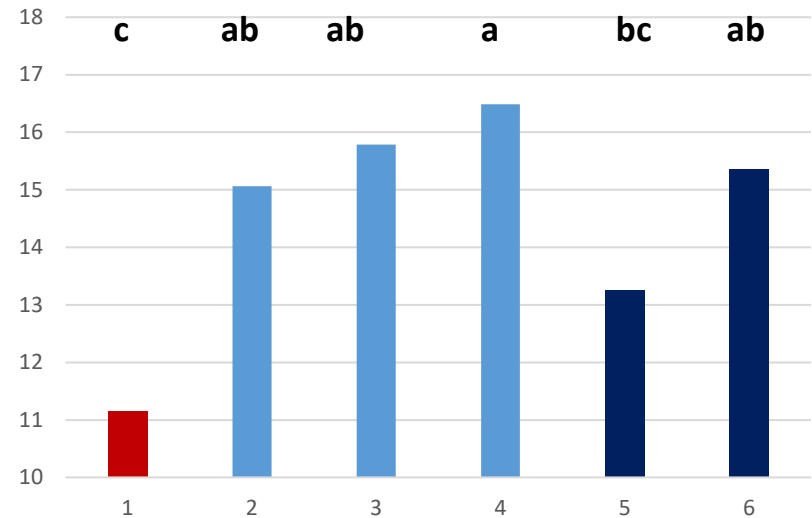
Trt 1: Control			
Trt 2: ReTain half pouch/A at 21 dbh			
Trt 3: ReTain half pouch/A @ 21 dbh + 7 dbh			
Trt 4: ReTain half pouch/A @ 21 dbh + 3 dbh			
Trt 5: ReTain full pouch/A @ 7 dbh			
Trt 6: ReTain full pouch/A @ 3 dbh			

H1: 15.5 lb a  
H2: 14.5 lb b

Sept 14



Sept 21

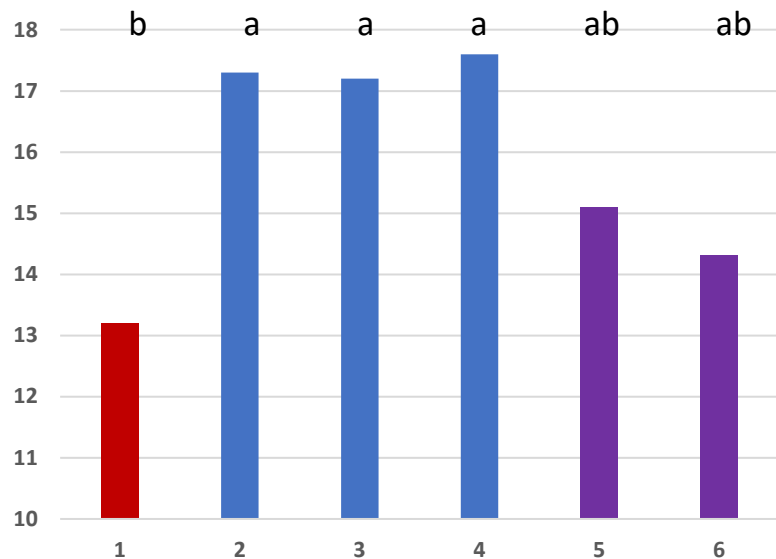




# Flesh firmness (lb)

## 9 months + 7 d

Sept 14

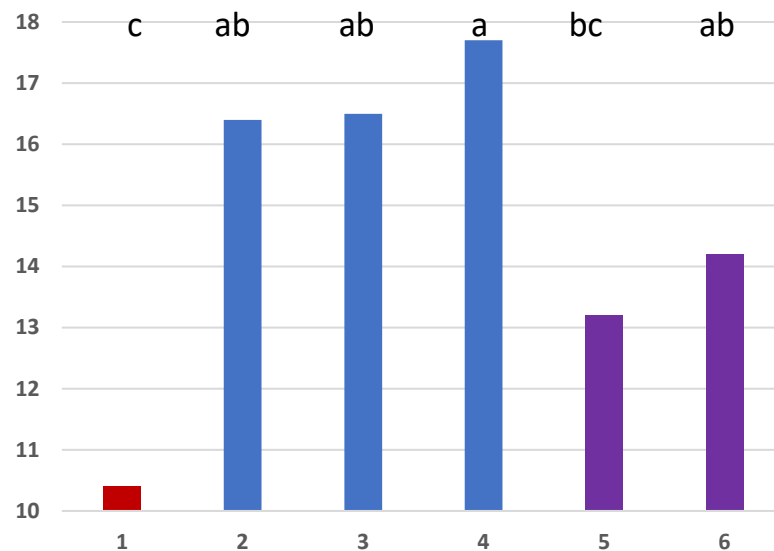


Trt 1: Control			
Trt 2: ReTain half pouch/A at 21 dbh			
Trt 3: ReTain half pouch/A @ 21 dbh + 7 dbh			
Trt 4: ReTain half pouch/A @21 dbh + 3 dbh			
Trt 5: ReTain full pouch/A @ 7 dbh			
Trt. 6 ReTain full pouch/A @ 3 dbh			

H1: 15.8 lb a

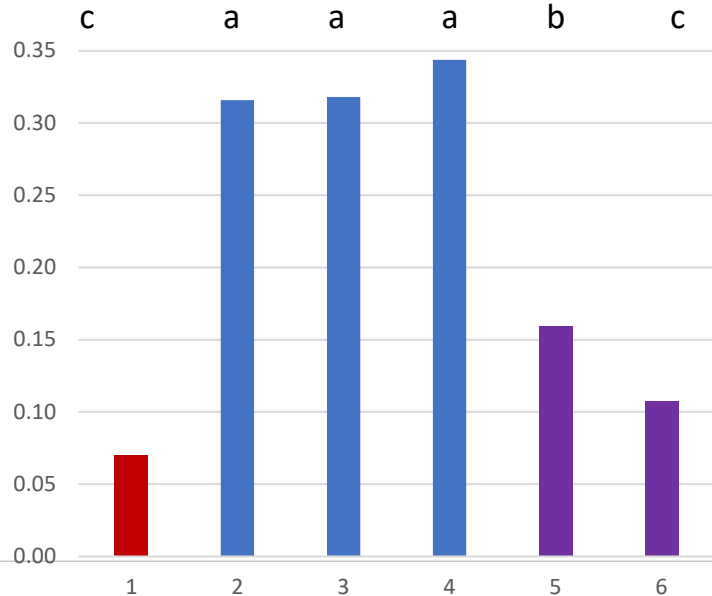
H2: 14.7 lb b

Sept 21



# I<sub>AD</sub> value 5 months + 7 d

Sept 14

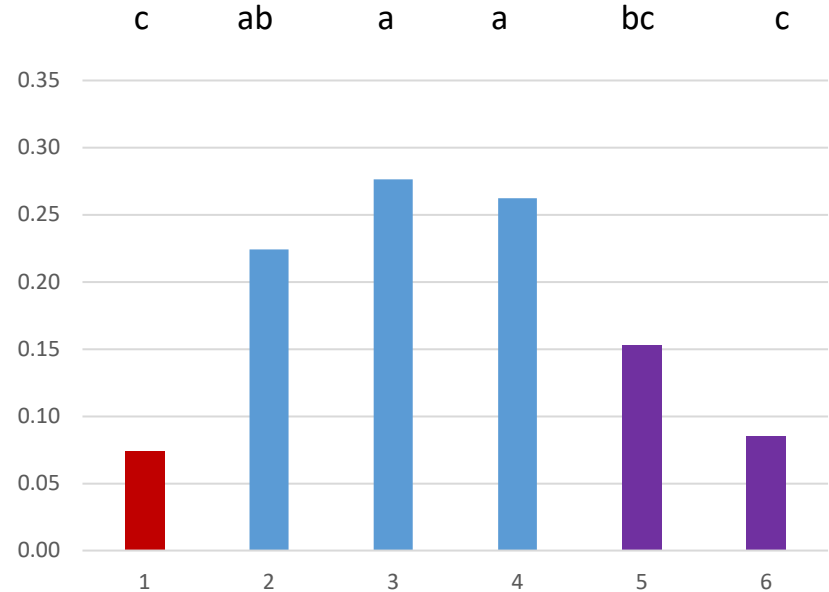


Trt 1: Control			
Trt 2: ReTain half pouch/A at 21 dbh			
Trt 3: ReTain half pouch/A @ 21 dbh + 7 dbh			
Trt 4: ReTain half pouch/A @21 dbh + 3 dbh			
Trt 5: ReTain full pouch/A @ 7 dbh			
Trt 6 ReTain full pouch/A @ 3 dbh			

H1: 0.22 a

H2: 0.18 b

Sept 21



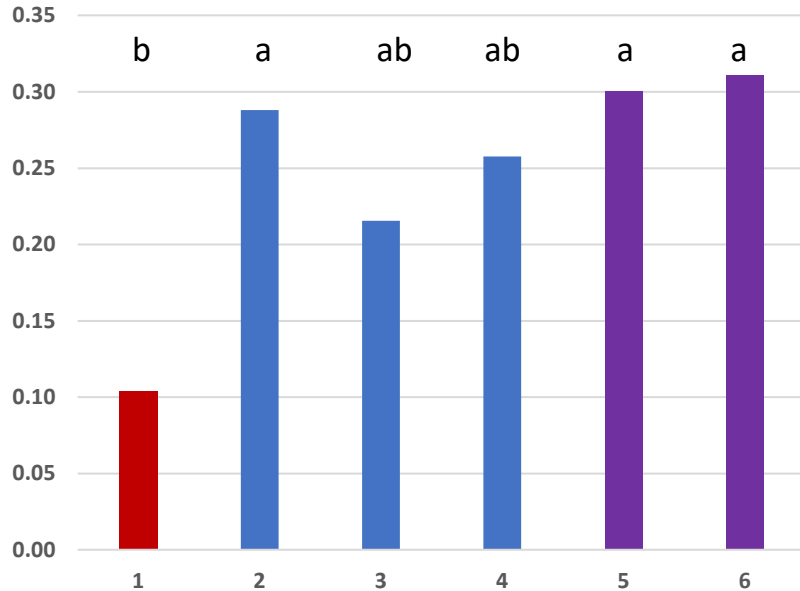
# I<sub>AD</sub> value 9 months + 7 d

Trt 1: Control			
Trt 2: ReTain half pouch/A at 21 dbh			
Trt 3: ReTain half pouch/A @ 21 dbh + 7 dbh			
Trt 4: ReTain half pouch/A @21 dbh + 3 dbh			
Trt 5: ReTain full pouch/A @ 7 dbh			
Trt 6 ReTain full pouch/A @ 3 dbh			

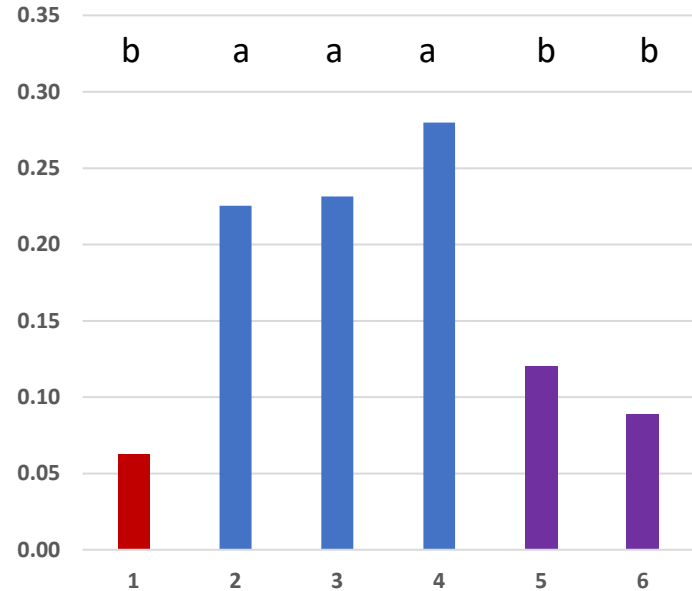
H1: 0.24 a

H2: 0.17 b

Sept 14

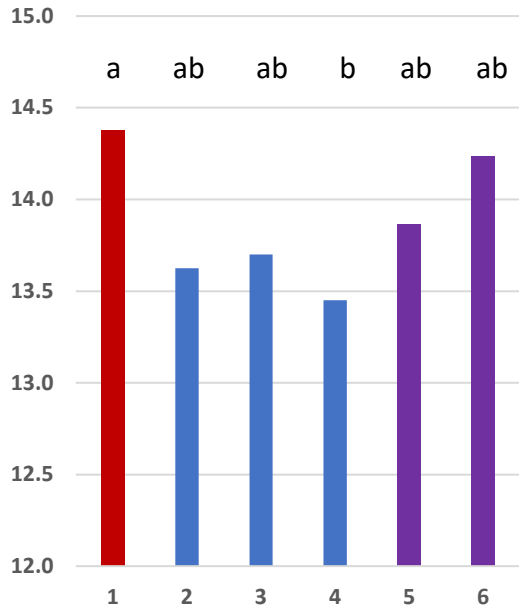


Sept 21

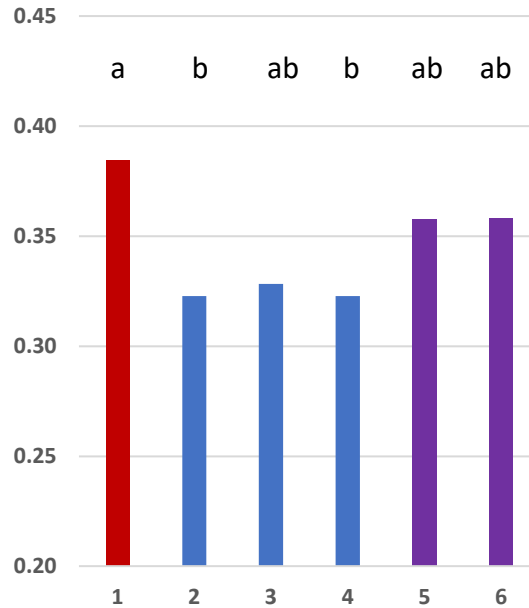


# 5 months - Harvest dates combined

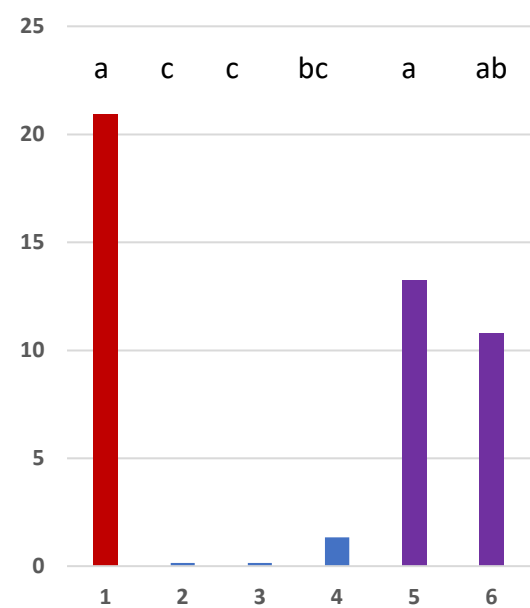
SSC (%)



TA (%)

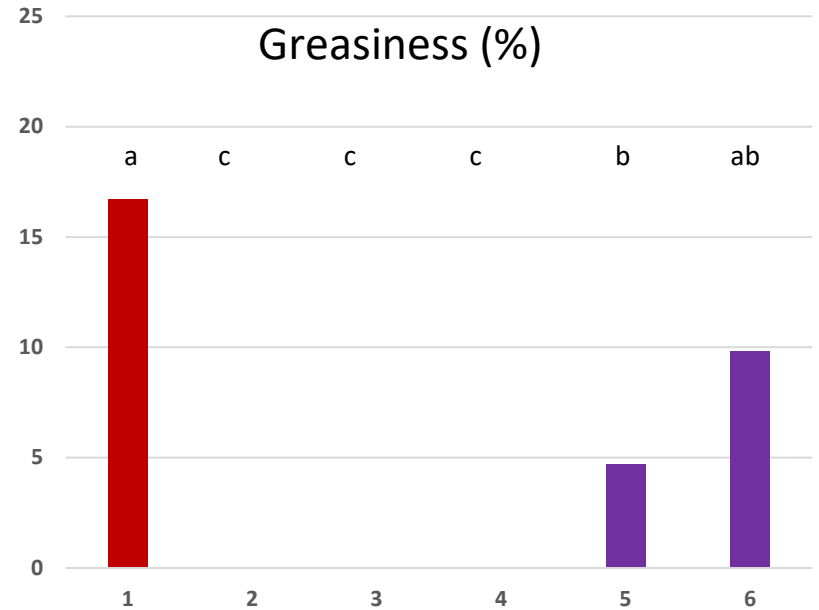


Greasiness (%)

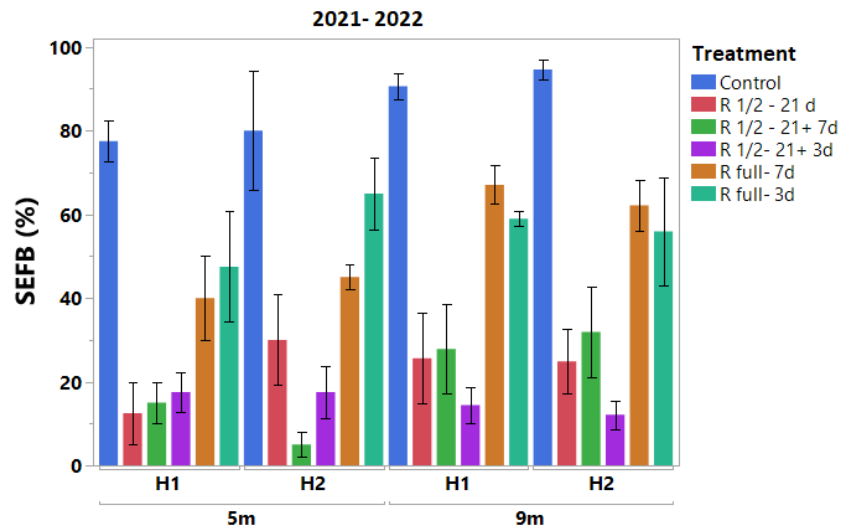
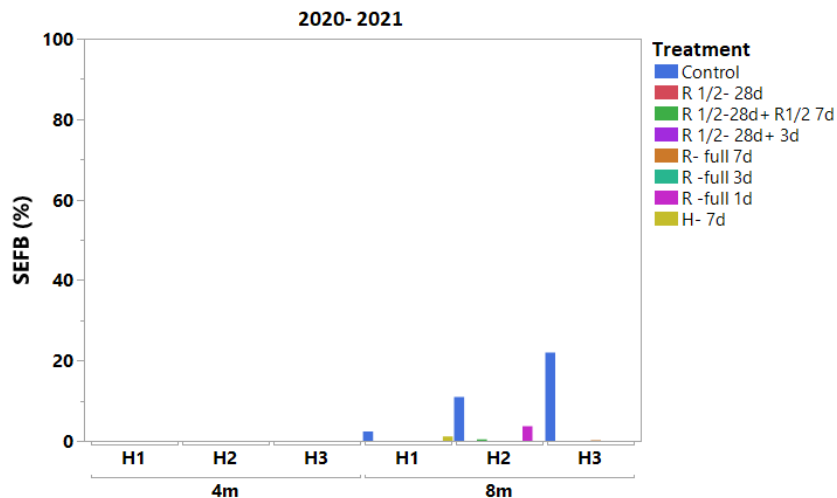


# 9 months

No treatment effects on SSC, TA



# Brief comparison with last year



# Summary for expt 1

## **At harvest**

ReTain effects similar regardless of application timing for IEC (lower than control) and flesh firmness (higher than control).

But effects of late Retain on SPI, loss of green color, and inhibition of yellowing less than earlier application.

# Summary for expt 1

## After storage

SEFB – inhibition of browning greater with earlier than late application at 6 and 9 months.

Flesh firmness similar for all ReTain timings and all greater than the control at 6 months. However, benefit decreases over storage time and shelf life.

Loss of green color affected greatly by treatment timing at harvest 2 compared with harvest 1.



# Conclusions

**USE OF PGRS IS STRONGLY  
RECOMMENDED!**

**A significant weapon against SEFB as  
well as post-storage benefits on  
firmness.**

## 2. Effects of ReTain, oxygen concentration, storage temperature, and delayed CA

Brookfield strain (commercial farm in Wayne County)

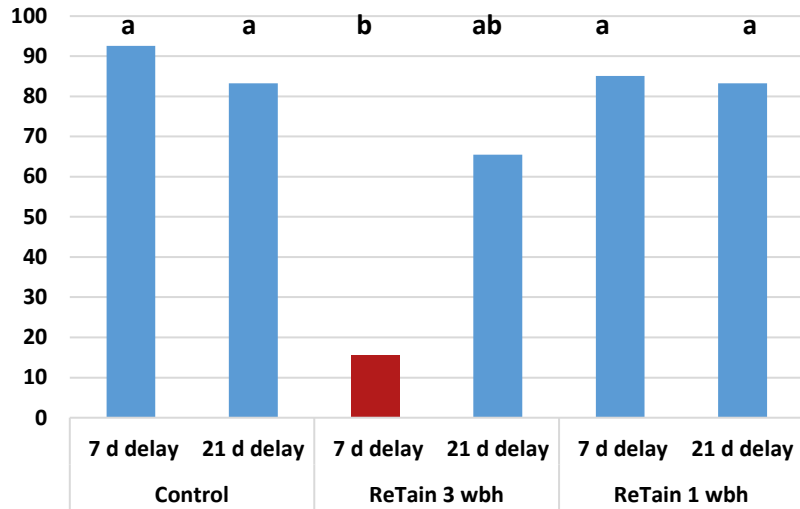
ReTain treatments:

- Trt 1. Untreated control
- Trt 2. ReTain half pouch at 21 dbh
- Trt 3. ReTain full pouch at 7 dbh

- All fruit treated with **1-MCP** after overnight cooling
- 2% oxygen compared with 0.5% oxygen (1% carbon dioxide)
- 33°F compared with 38°F
- Delay 7 d and 21 d after cooling and storage
- 4 replicates

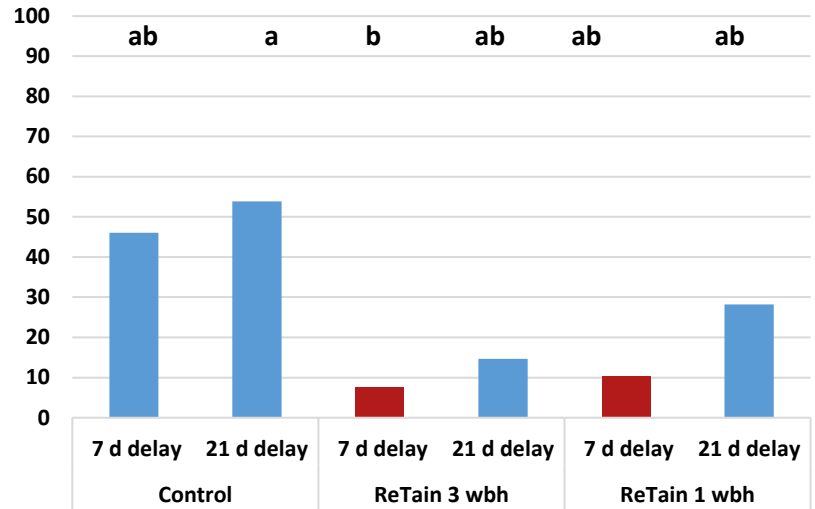
# SEFB (%): 33°F - 6 months + 7 days

2 % oxygen



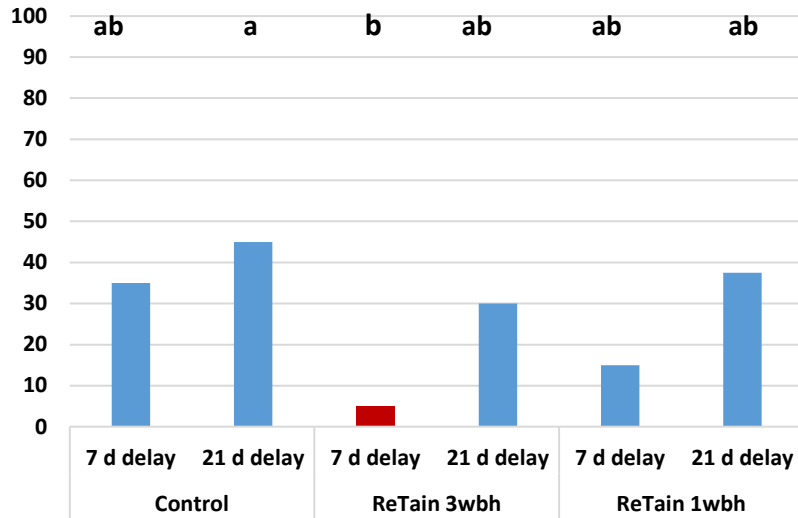
0.5 % oxygen

2%: 73 a  
0.5%: 25 b

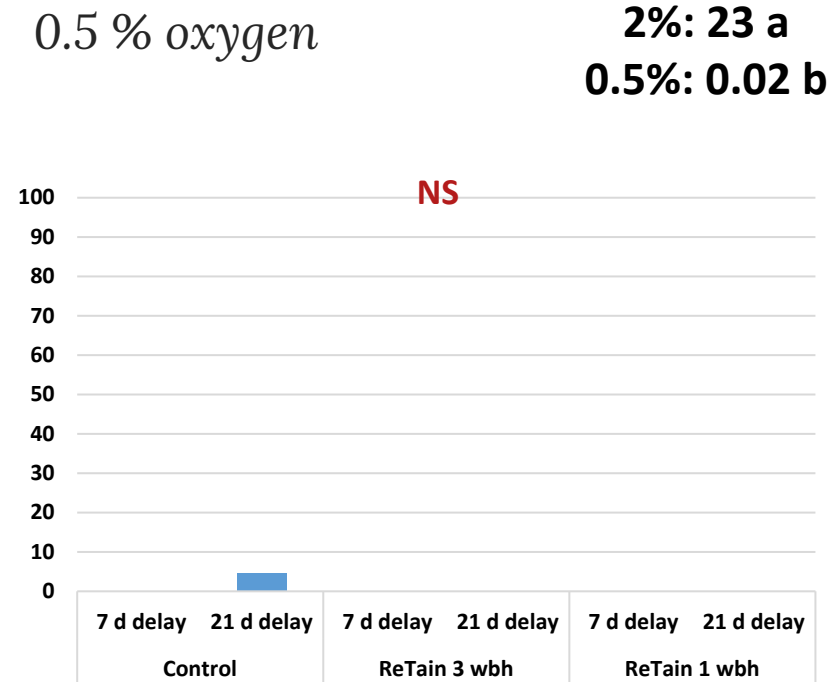


# SEFB (%): 38°F - 6 months + 7 days

2 % oxygen



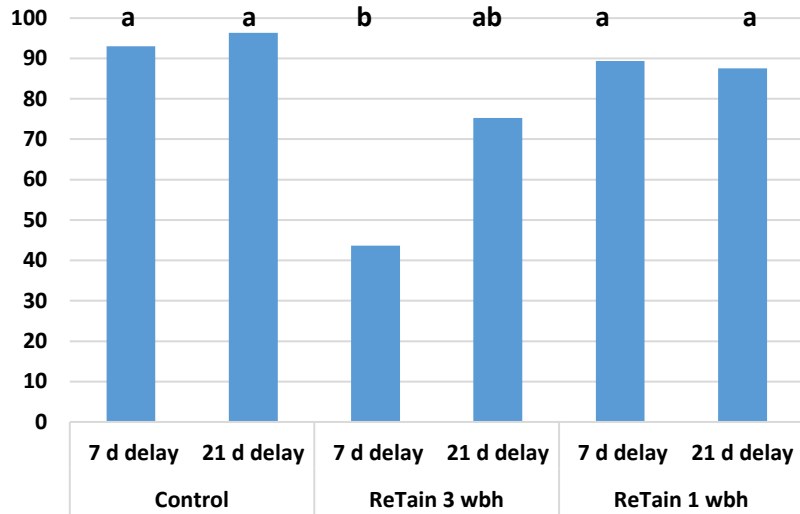
0.5 % oxygen



2%: 23 a  
0.5%: 0.02 b

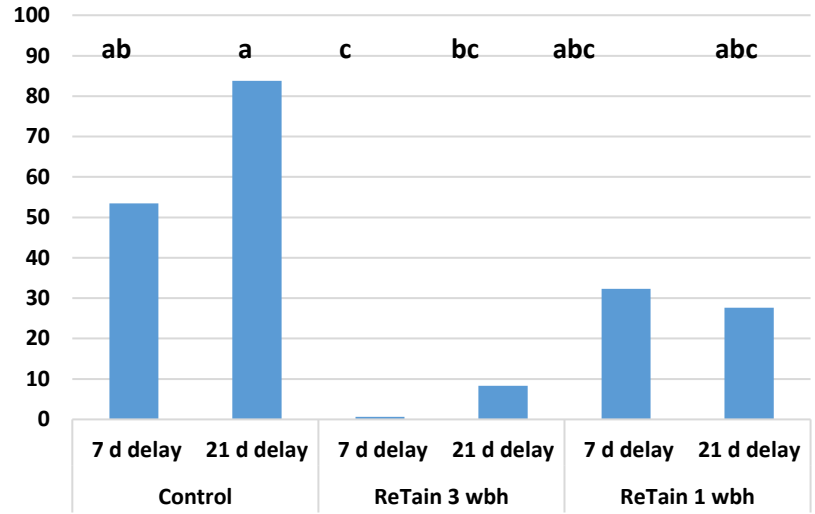
# SEFB (%): 33°F - 9 months + 7 days

2 % oxygen



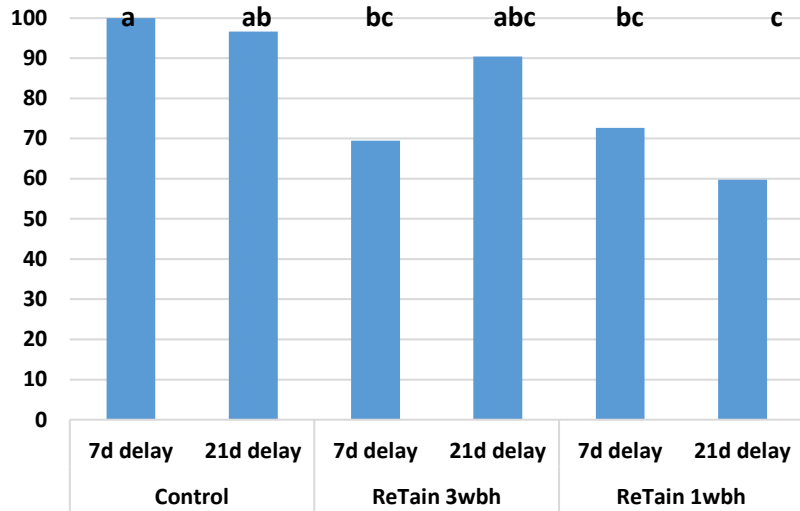
0.5 % oxygen

2%: 83 a  
0.5%: 30 b



# SEFB (%): 38°F - 9 months + 7 days

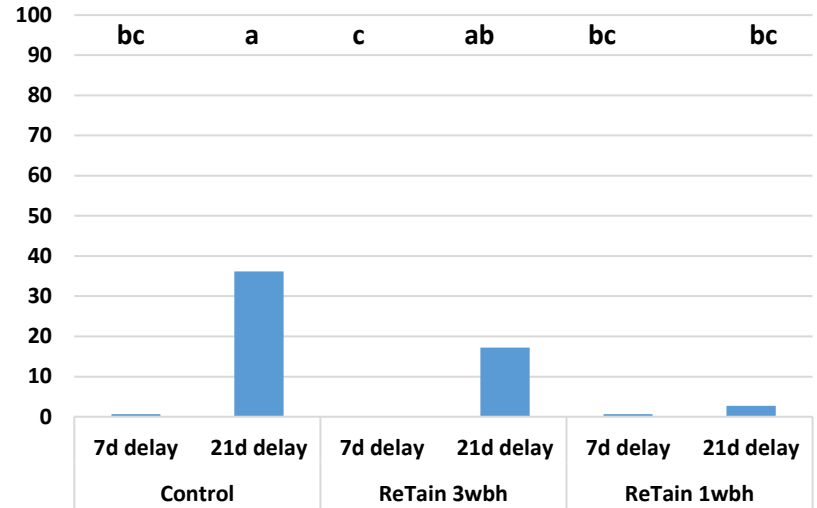
2 % oxygen



0.5 % oxygen

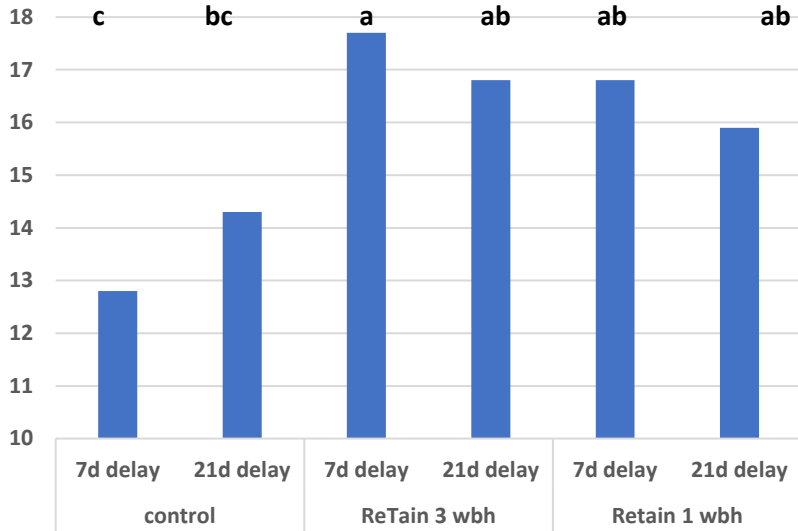
2%: 87 a

0.5%: 5 b



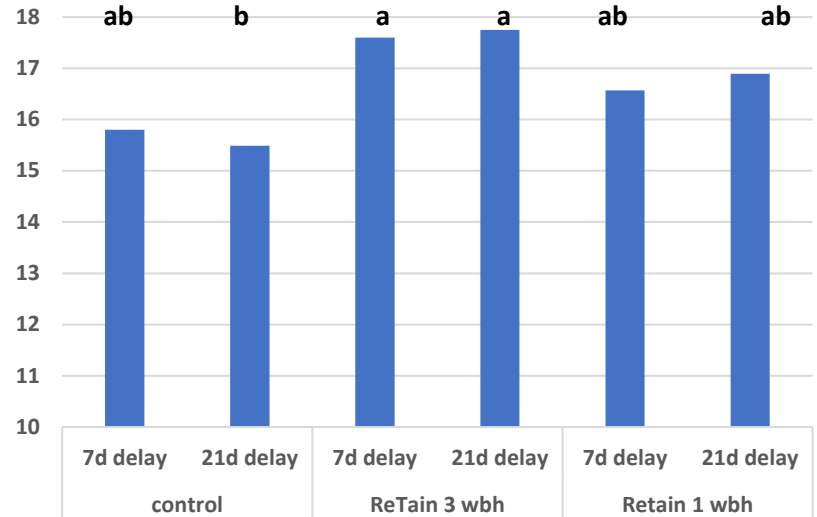
# Firmness (lb): 33°F - 6 months + 7 days

2 % oxygen



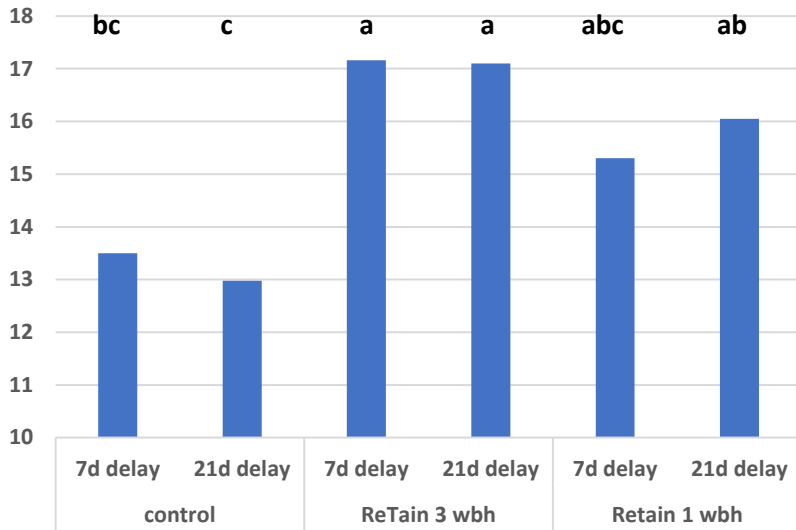
0.5 % oxygen

2%: 15.7 lb  
0.5%: 16.7 lb



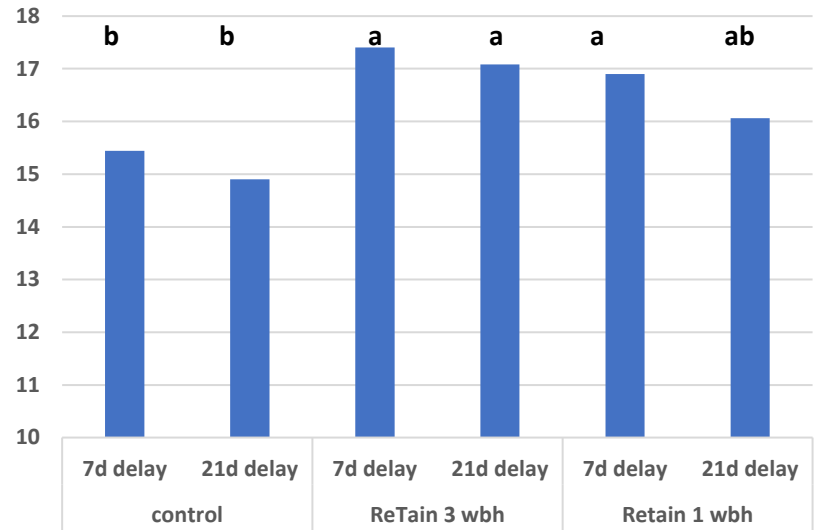
# Firmness (lb): 38°F - 6 months + 7 days

2 % oxygen



0.5 % oxygen

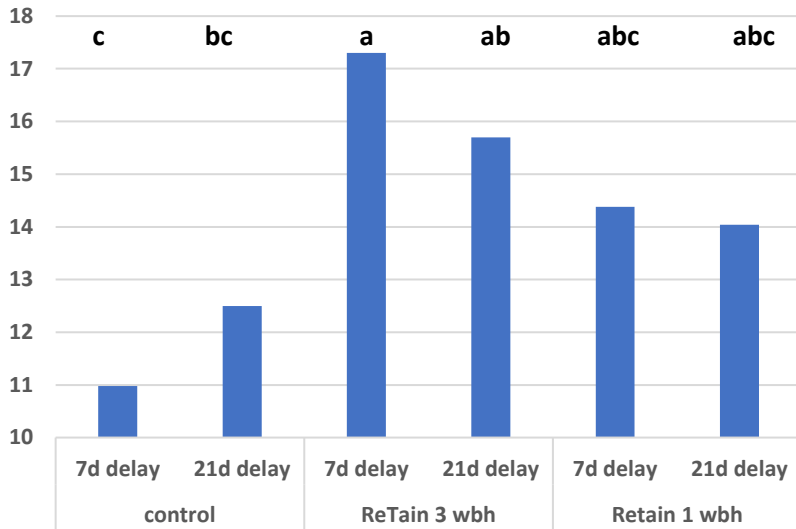
2%: 15.3 lb b  
0.5%: 16.3 lb a





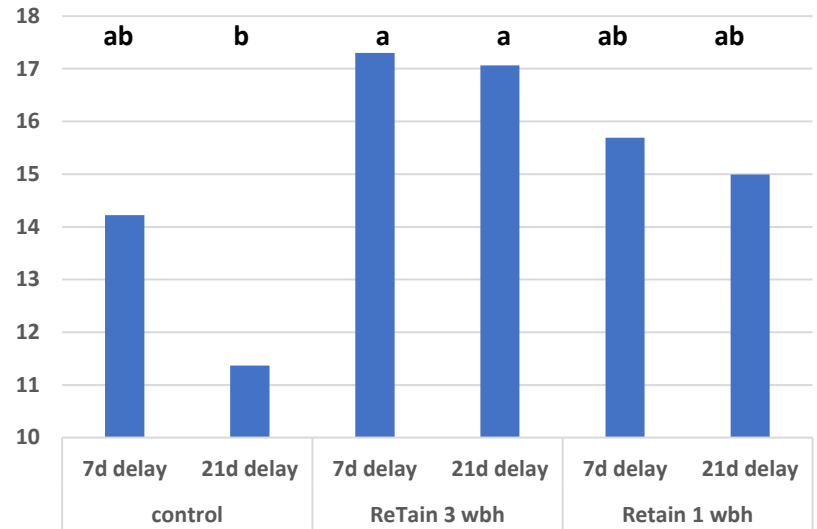
# Firmness (lb): 33°F - 9 months + 7 days

2 % oxygen



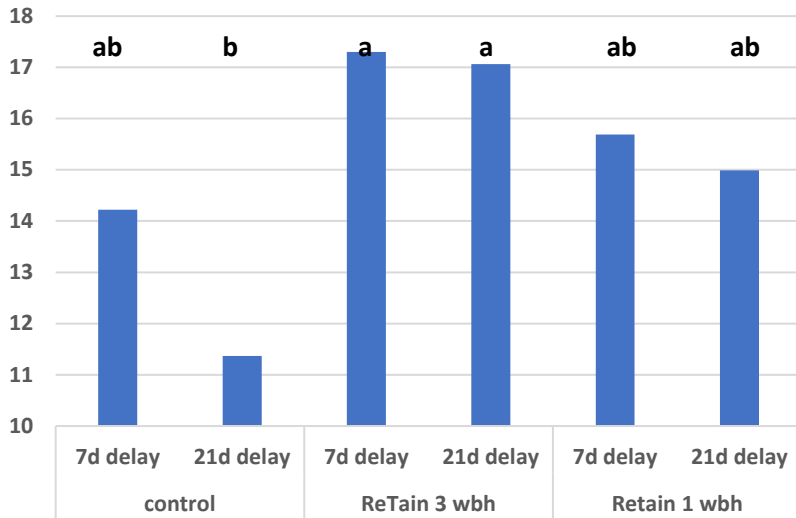
0.5 % oxygen

2%: 14.2 lb  
0.5%: 15.1 lb



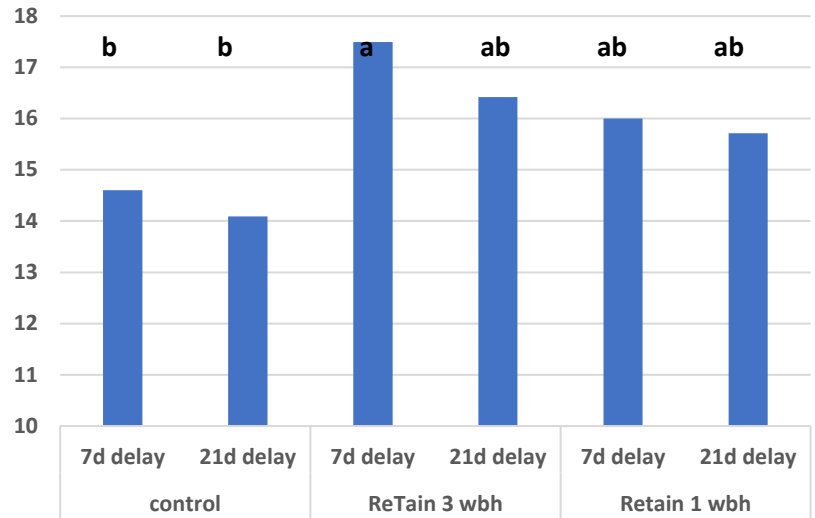
# Firmness (lb): 38°F - 9 months + 7 days

2 % oxygen



0.5 % oxygen

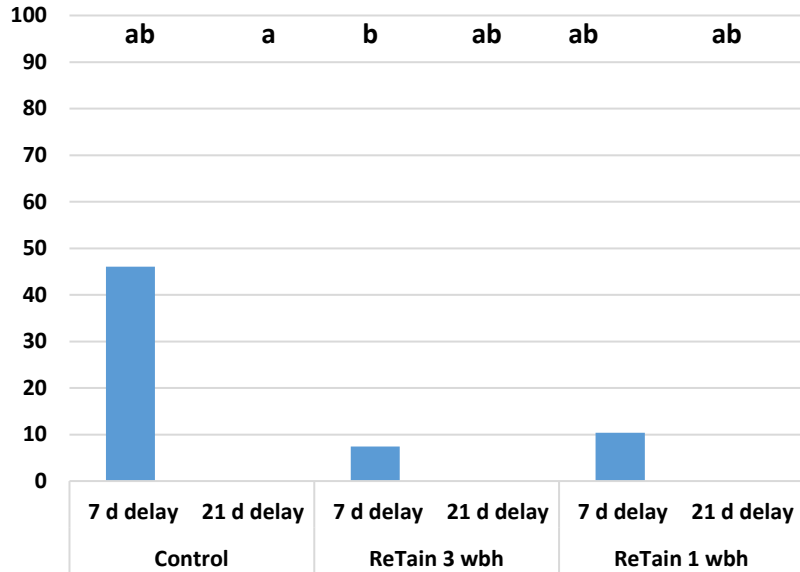
2%: 13.0 lb b  
0.5%: 15.7 lb a



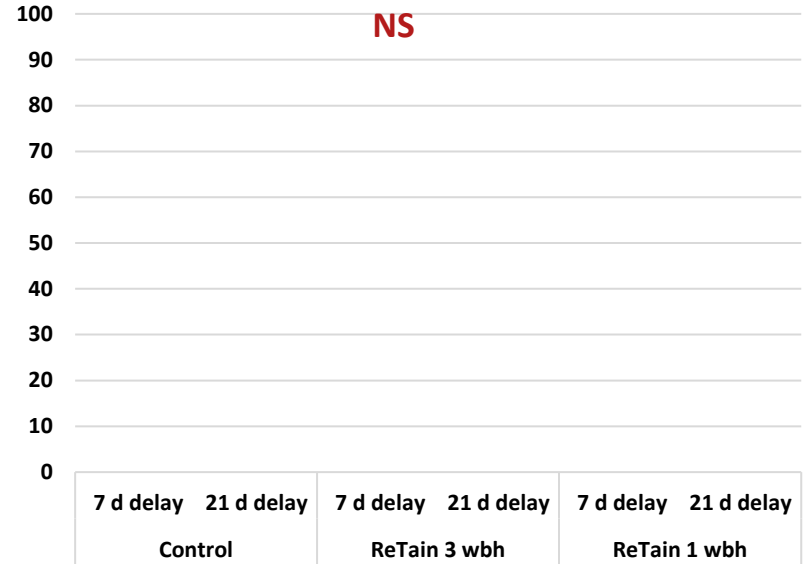
# Comparisons of temperatures

# SEFB (%) at 0.5 % oxygen – 6 months

33°F

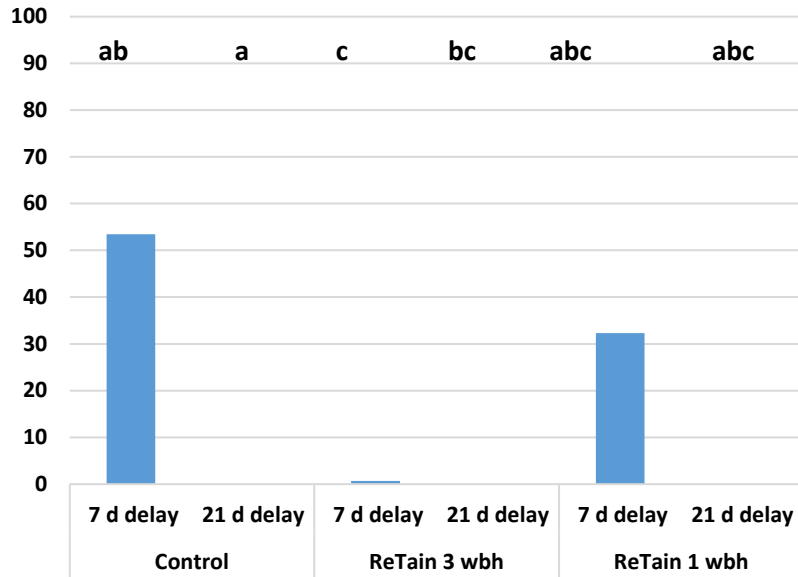


38°F

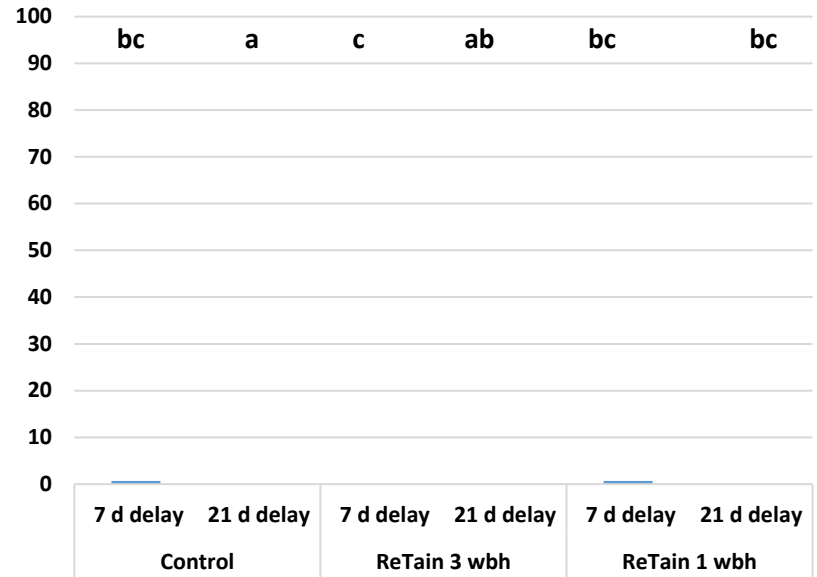


# SEFB (%) at 0.5 % oxygen – 9 months

33°F



38°F



# Summary for expt 2

- Delays between harvest and CA storage are detrimental and do not mimic 'conditioning.'
- Up to 7 day delay and storage at 2% oxygen and 1% carbon dioxide maintained low SEFB if storage temperature was 38°F (not 33°F) for 6 but not 9 months.

# Summary for expt 2

- Flesh browning development greatly decreased by 0.5% oxygen and 1% carbon dioxide at 33°F and to a greater extent at 38°F.
- No 'cost' in terms of firmness at 38°F compared with 33°F. [including after 7 day shelf life (68°F) – all fruit treated with 1-MCP.]

# Summary for expt 2

**USE OF PGRS IS STRONGLY  
RECOMMENDED!**

**38°F rather than 33°F**

**0.5% oxygen/1% carbon dioxide when  
achievable**

**2% oxygen/1% carbon dioxide has  
relatively limited storage potential**

**Each factor is additive – maturity, ReTain,  
oxygen, 38°F storage temperature**



### **3. Regional study of 0.5% oxygen and storage temperature on storage quality**

- HV (8/27), WNY west (9/9), WNY east (9/13), Champlain (9/17)
- 6 blocks in each region x 4 replicates
- All fruit treated with 1-MCP
- 0.5% oxygen initiated 7 d after harvest and cooling
- 33°F and 38°F
- 8 months storage

# Preharvest treatments

Orch. Block	HV (8/26)		WNY - west		WNY - east		Champlain	
	Strain	PGR	Strain	PGR	Strain	PGR	Strain	PGR
1	Ultima	½ R, 2 wk	Galaxy	No	Brookfield	H	Pacific	3/4 R
2	Buckeye	½ R, 2 wk	Royal	No	Brookfield	H	Brookfield	3/4 R
3	Buckeye	½ R, 2 wk	Galaxy	R	Brookfield	R	Ultima	H
4	Brookfield	½ R, 2 wk	Brookfield	R	Brookfield	H	Ultima	H
5	Ultima	½ R, 2 wk	Imperial	R	Brookfield	H	Pacific	½ R
6	Brookfield	½ R, 2 wk	Brookfield	R	Brookfield	H	Brookfield	½ R

# SPI

# I<sub>AD</sub> value

HV	WNY-W	WNY-E	CH		HV	WNY-W	WNY-E	CH
3.6b	6.0a	6.5a	3.3c		0.87ab	0.31d	0.16b	0.50a
3.5b	5.5ab	5.3bc	3.3c		0.94a	0.20d	0.26b	0.25cd
3.9b	3.5cd	4.9c	4.1bc		0.98a	0.50c	0.42a	0.35bc
5.4a	2.8d	6.1ab	5.3ab		0.67b	0.91	0.22b	0.17
2.7c	4.3bc	6.6a	5.9a		1.01a	0.64	0.23b	0.45ab
4.0b	3.5cd	6.5a	5.9a		0.97a	0.72	0.19b	0.57a

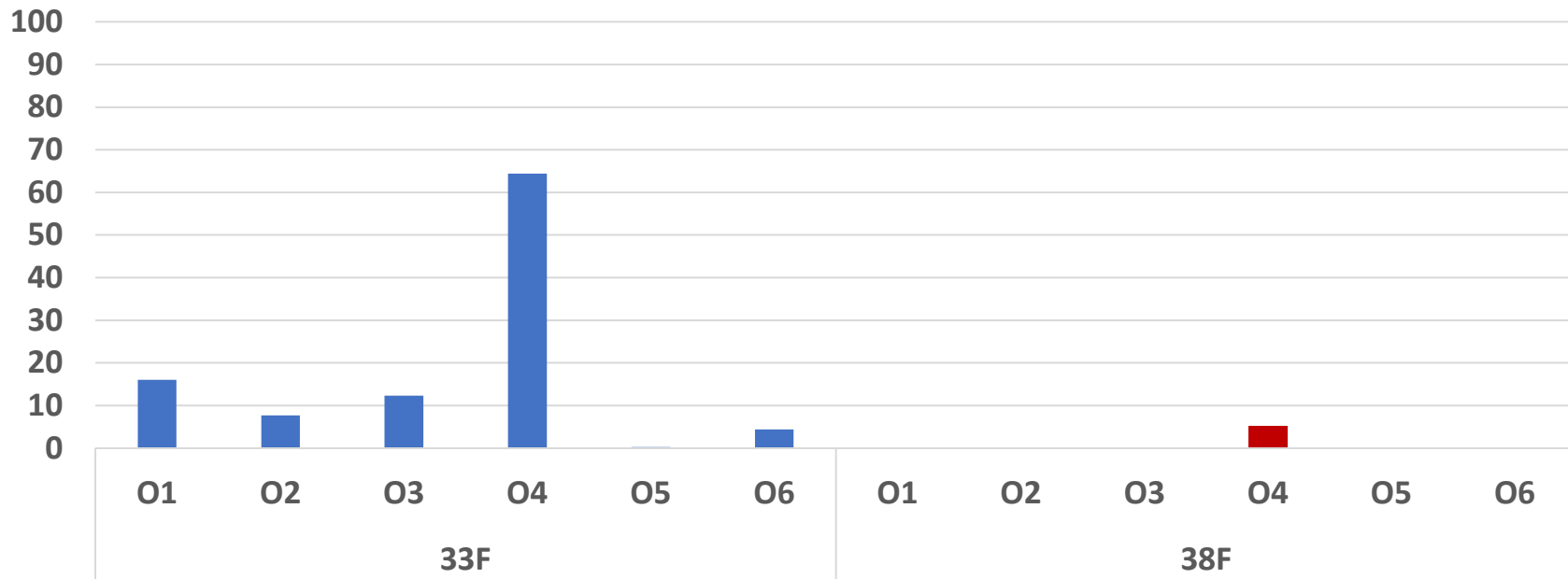
# Firmness (lb)

HV	WNY-W	WNY-E	CH
18.9a	15.4d	15.2d	17.9a
18.2ab	16.1cd	16.5cd	18.8a
18.1ab	16.9bc	16.0bc	18.0a
16.7c	18.3a	14.7a	18.7a
18.5ab	17.6ab	14.4ab	15.2b
17.5bc	18.4a	15.4a	16.0b

**After storage for 8  
months**

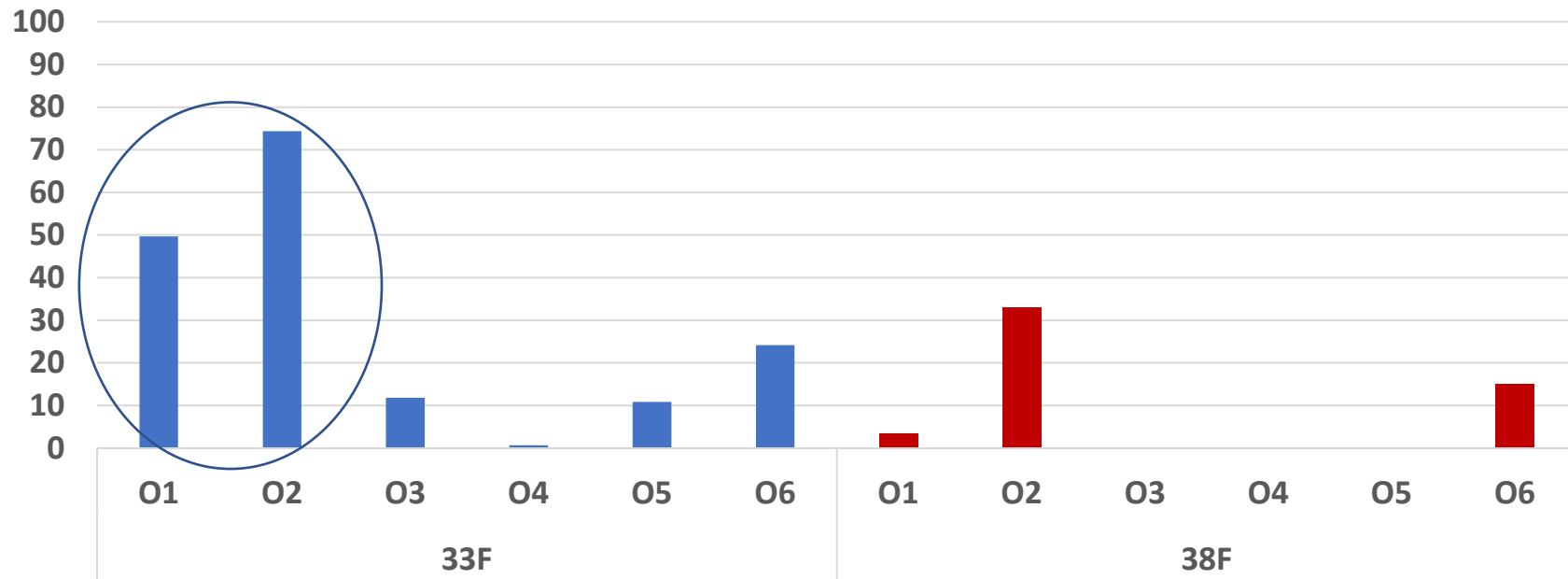
# SEFB (%)

## Hudson Valley



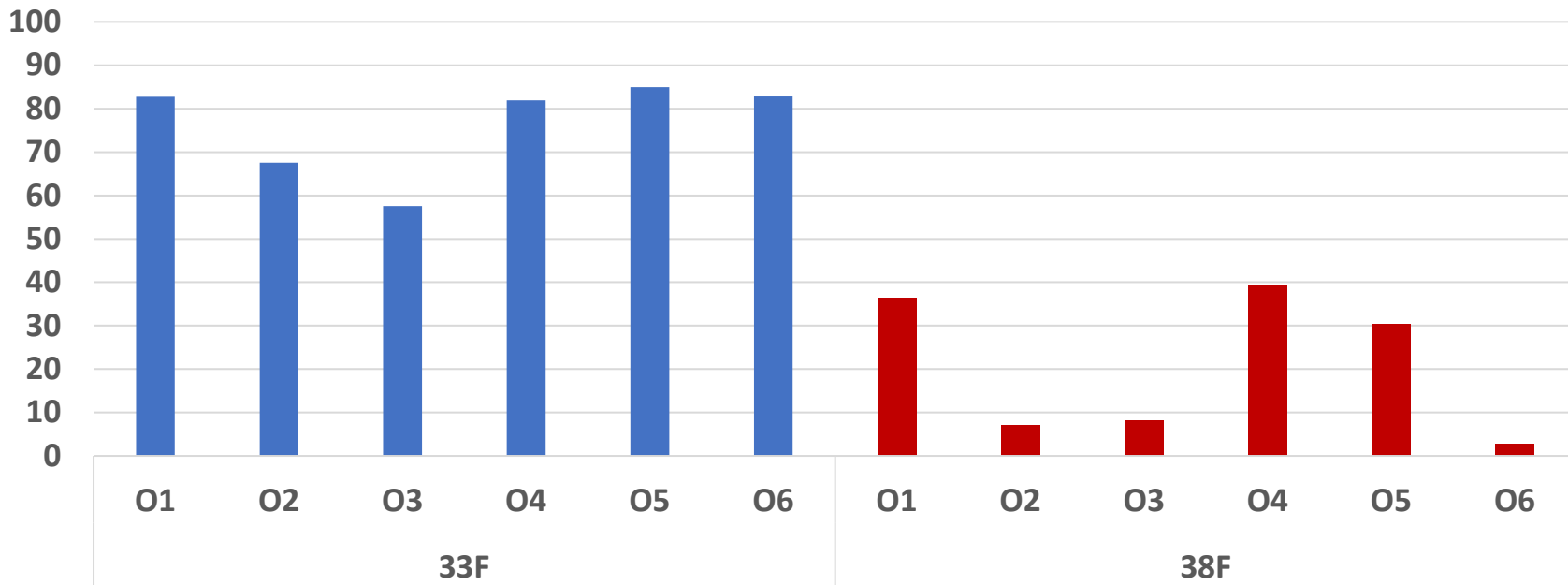
# SEFB (%)

## WNY west



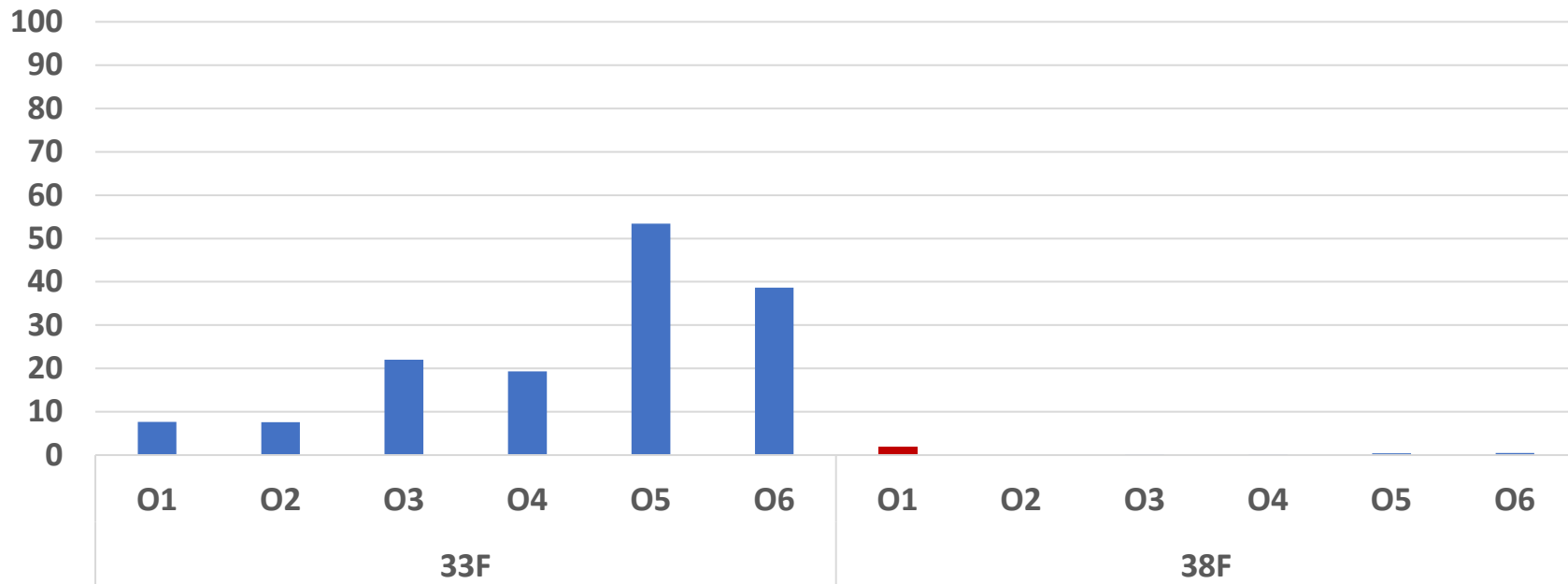
# FB (%)

## WNY east



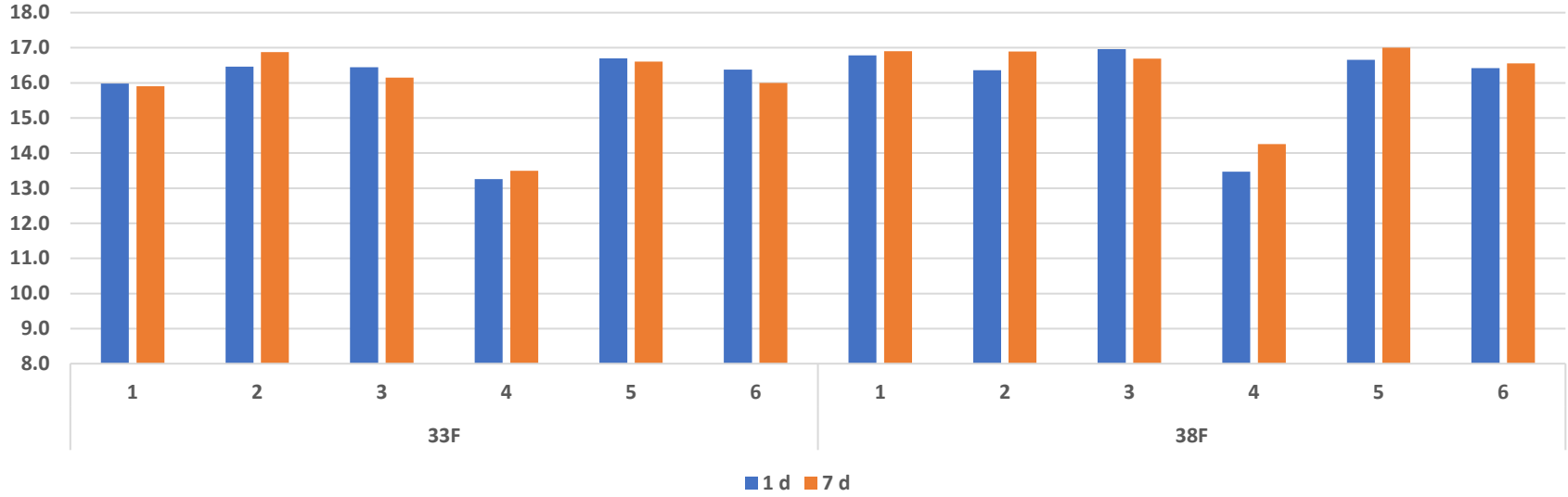


# SEFB (%) Champlain



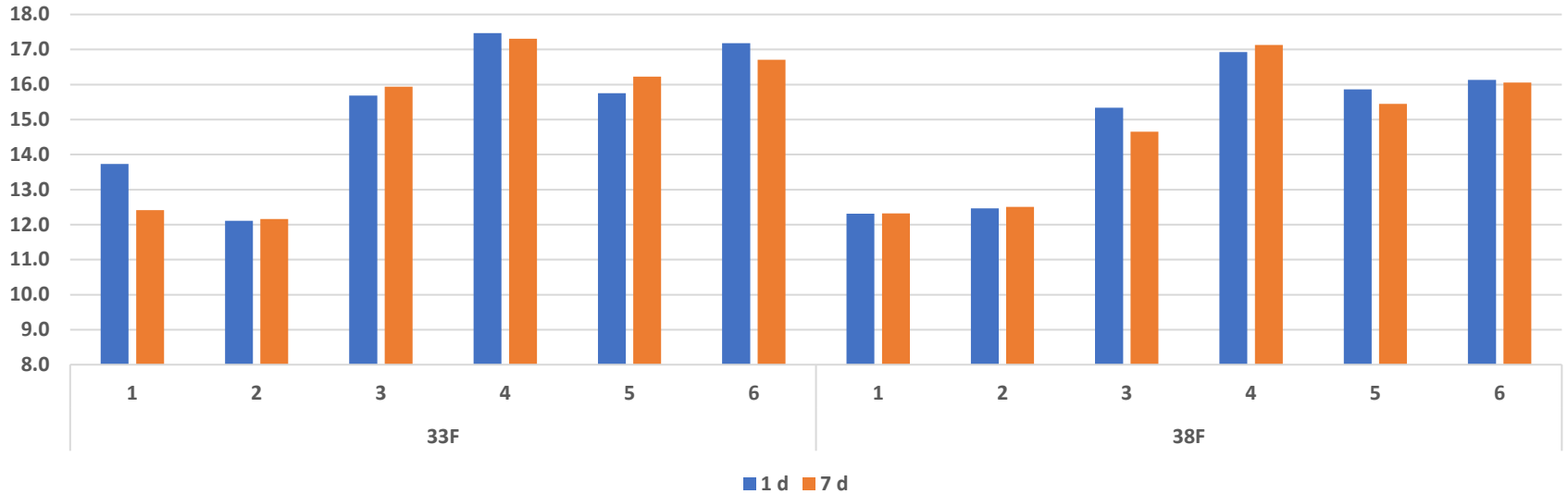
33F	1 d	15.9
38F		16.1
33F	7 d	15.8b
38F		16.4a

# HV: Firmness (lb)



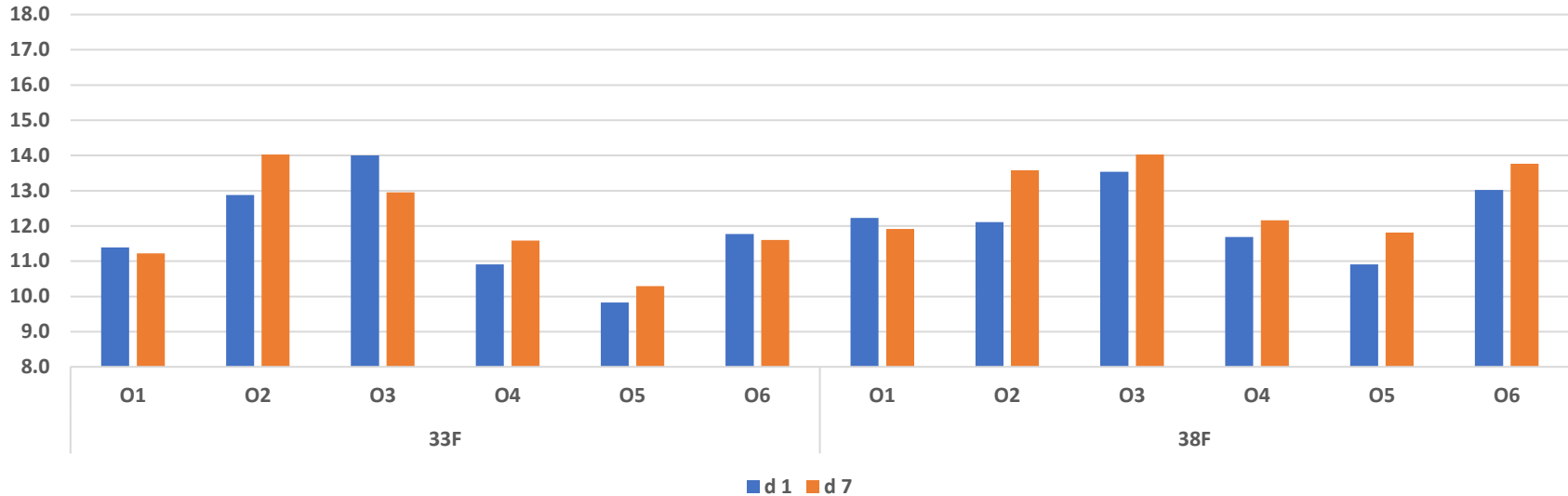
# WNY-W: Firmness (lb)

33F	1 d	15.3a
38F		14.8b
33F	7 d	15.1a
38F		14.7b



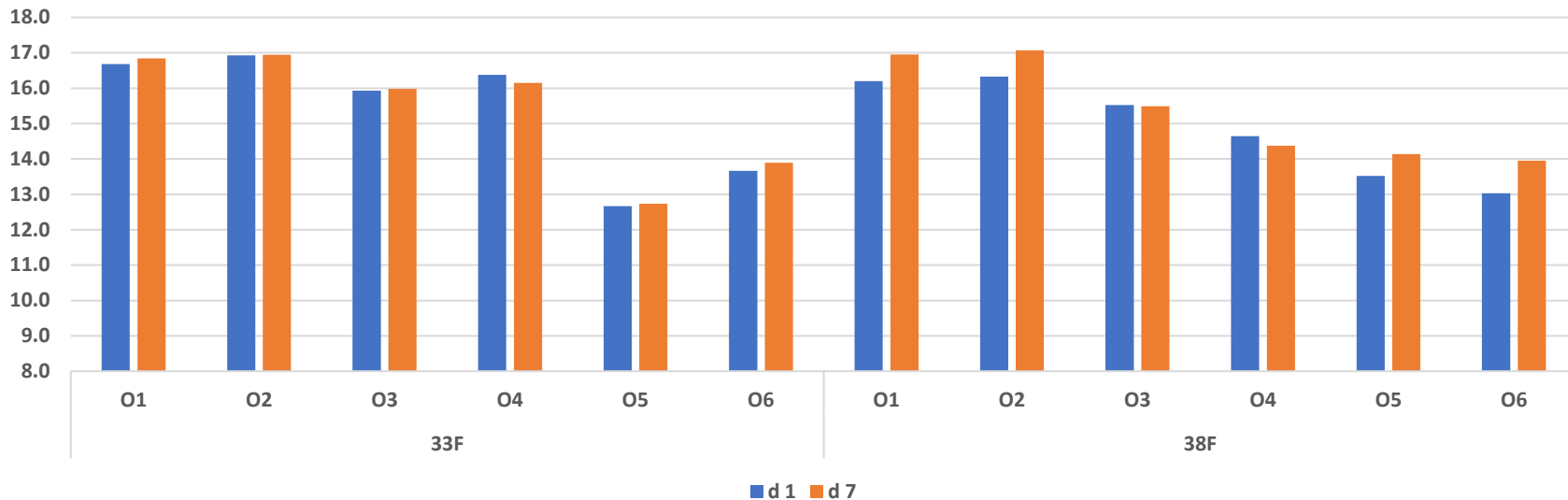
# WNY-E: Firmness (lb)

33F	1 d	11.8
38F		12.1
33F	7 d	11.9b
38F		12.9a



# Champlain: Firmness (lb)

33F	1 d	15.4b
38F		14.9a
33F	7 d	15.4
38F		15.3



# Relationship with mineral?

33F because of highest incidences.

Overall significant but weak correlation with K.

Variable in specific regions, with strongest in Champlain:

- Positively with N, B, P, P/Ca, P+Mg/Ca
- Negatively with Mn, Mg, Mg/Ca

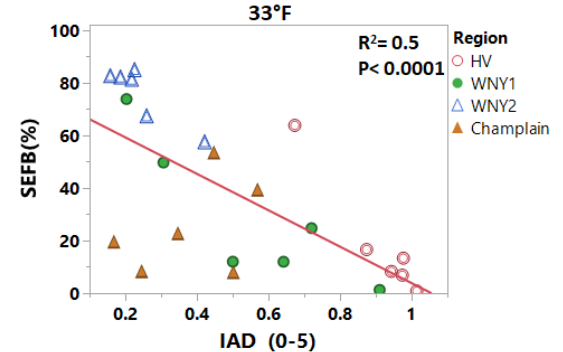
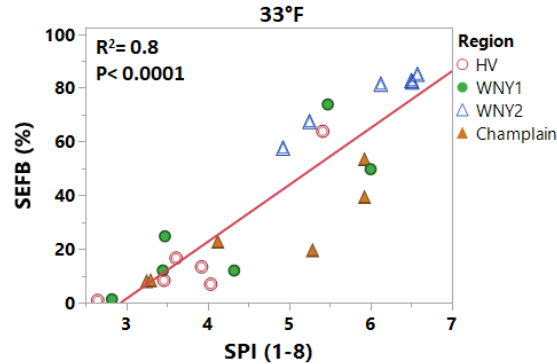
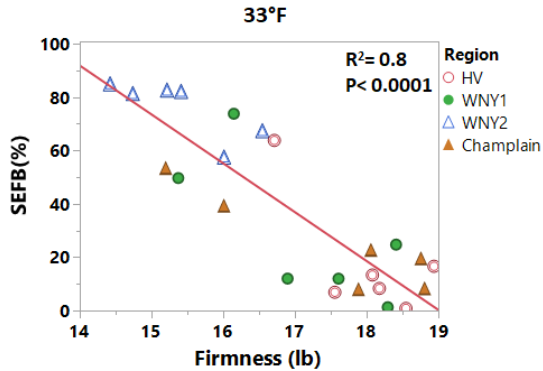
	R	P value
C (%)	-0.0754	0.4654
N (%)	0.0758	0.4631
P	-0.1749	0.0883
K	-0.2558	0.0119
Mg	-0.1883	0.0661
Ca	0.1597	0.12
P/Ca	-0.0922	0.3766
K/Ca	-0.0985	0.3451
Mg/Ca	-0.0896	0.3903
(P+K)/Ca	-0.098	0.3476
(P+Mg)/Ca	-0.0919	0.3784
(K+Mg)/Ca	-0.0982	0.3466
(P+K+Mg)/ca	-0.0977	0.3488

# Relationship with fruit maturity?

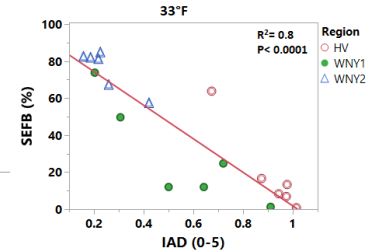
Regression coefficient higher at 33F than at 38F because of more FB.

	33°F		38°F		
	R <sup>2</sup>	P value	R <sup>2</sup>	P value	
<b>IEC</b>		<b>0.4</b> 0.0005		<b>0.2</b> 0.04	
<b>Firmness</b>		<b>0.8</b> <.0001		<b>0.4</b> 0.001	
<b>SSC</b>		0.01	0.284	0.006	0.71
<b>TA</b>		0.003	0.06	0.002	0.84
<b>SPI</b>		<b>0.8</b> <.0001		<b>0.3</b> 0.005	
<b>IAD</b>		<b>0.5</b> 0.0002		<b>0.3</b> 0.009	
<b>L*(D65)</b>		0.04	1.03	0.06	0.26
<b>a*(D65)</b>		<b>0.3</b> 0.007		0.09	0.14
<b>b*(D65)</b>		<b>0.3</b> 0.003		0.14	0.07
<b>Fruit weight</b>		0.137	0.1836	0.001	0.849

# Correlations for Firmness, SPI and I<sub>AD</sub> value – 33°F

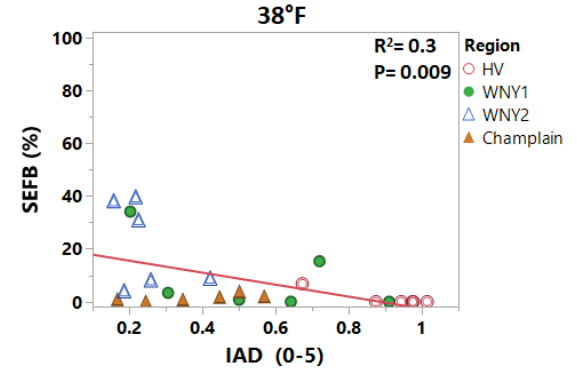
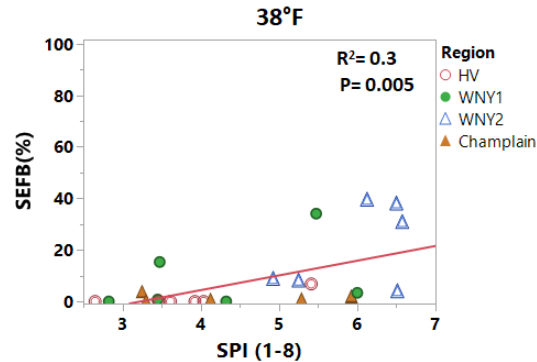
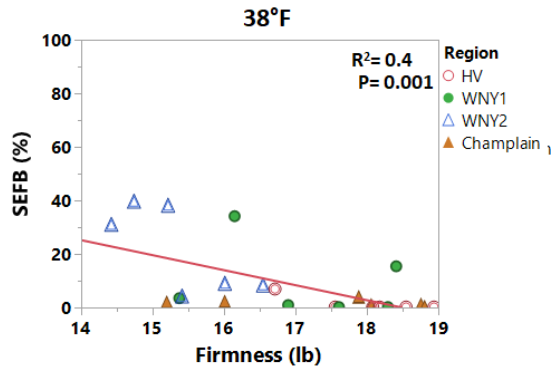


WNY1 = west; WNY2 = east.





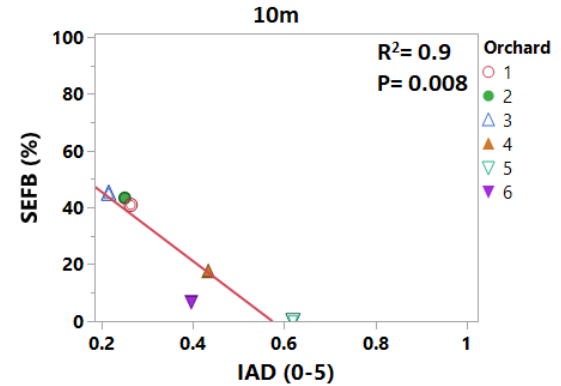
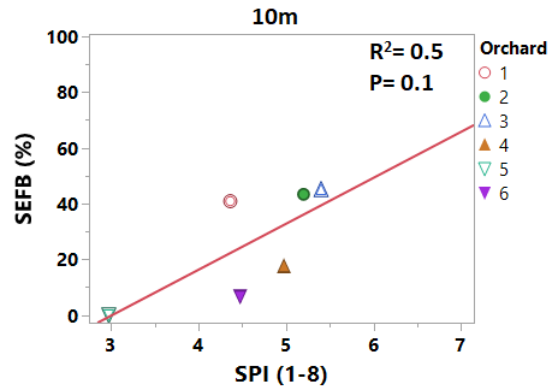
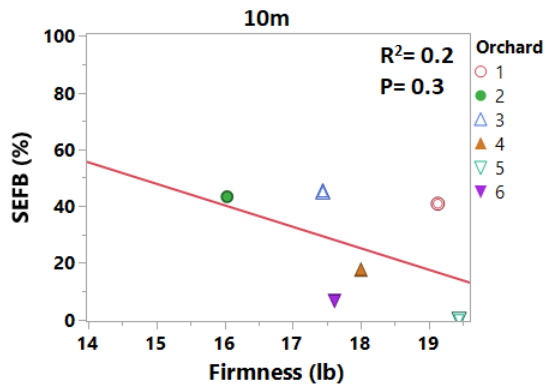
# Correlations for fruit storage at 38°F are less clear cut because of lower % disorder.



# Harvest incidences to minimize risk (using 33°F)

- SPI less than 4
- $I_{AD}$  values greater than 0.4-0.5
- Firmness greater than 17 lb.

# Comparing with 2020 harvest: WNY – 10 months – 33°F



A bit more variation

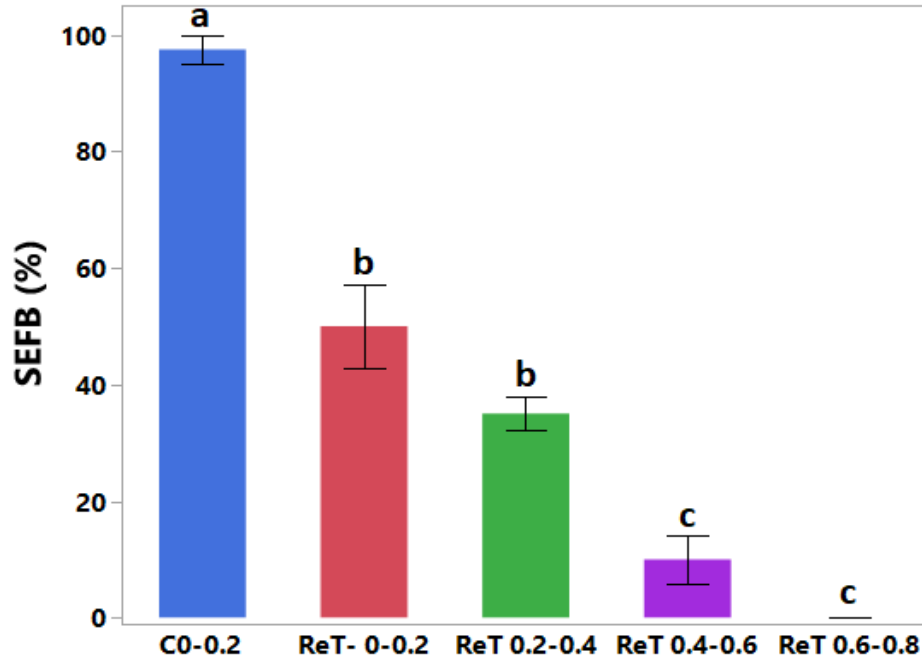
# Summary for expt 3

- PGR effects reinforced but variations.
- No strong mineral relationships
- SPI clearly an indicator.
- $I_{AD}$  values are indicators but within regions.
- 0.5% oxygen at 38F is a strong recommendation for late storing Gala apples.
- Temperature effects on firmness seem small
  - Note softer fruit associated with browning in many cases.

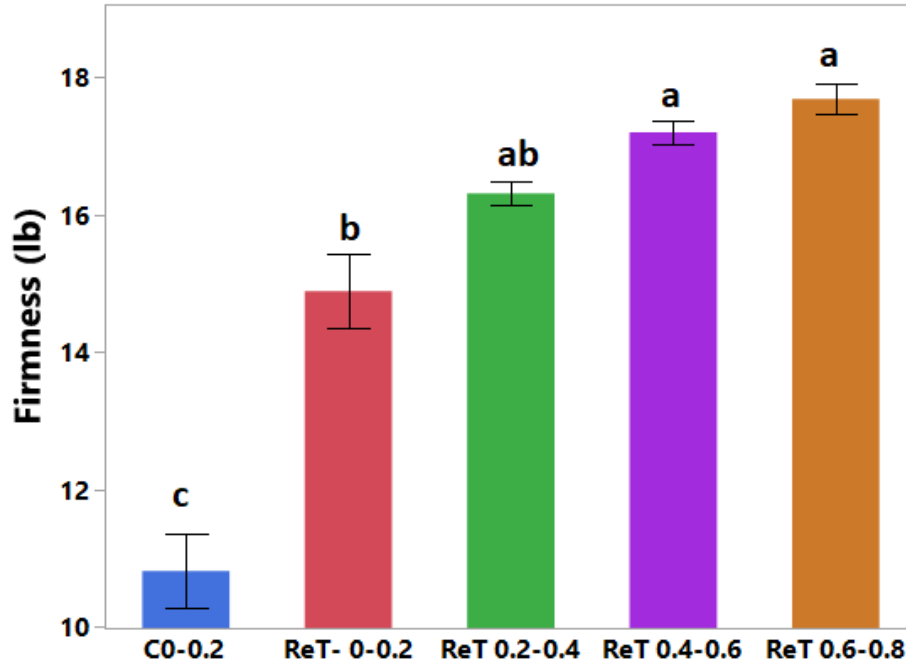
# Additional experiment

- Trees stripped and split into available DA index categories.
- Description: untreated fruit or fruit from T2 (ReTain 3 wbh) from H1 were classified at harvest by DA meter based on 0.2 difference.
- Storage: 5 months + 7d in CA 2% O<sub>2</sub>/ 1% CO<sub>2</sub> at 33°F

# SEFB (%) 5m+ d7



# Firmness (lb) 5m+ d7





# Major conclusions and recommendations



# Strongly recommended

- PGR use – with appropriate timing.
- Harvest indices based on SPI and  $I_{AD}$  values.
- 1-MCP treatment.
- Early harvest for long-term storage (even though size is sacrificed).
- 1-2% oxygen and 1% carbon dioxide for standard CA.
- 0.5% oxygen and 1% carbon dioxide if facilities allow.
- 38°F storage temperature.



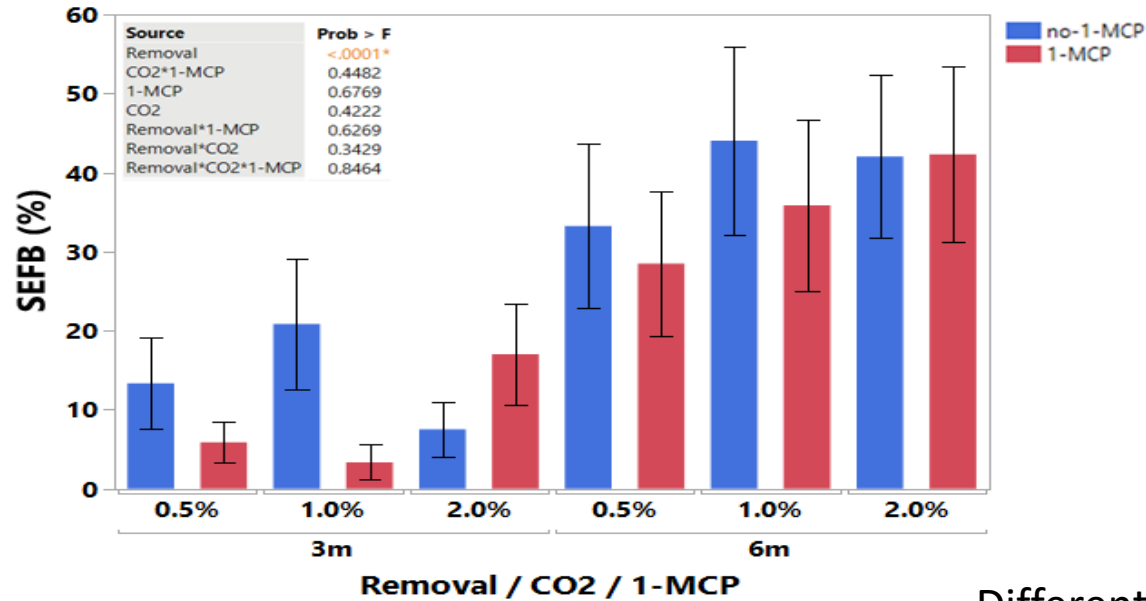
Questions?

What do we need to  
build confidence in  
our findings?

# Questions

- Does 1-MCP make SEFB worse?
- How important is the carbon dioxide concentration?
- Have you ever seen injury in Gala fruit that you believe is caused by carbon dioxide?

# No and 'no' and no



Different % CO<sub>2</sub> at 2% O<sub>2</sub>

# Questions

- Do I need to use DCA equipment?
- What type of DCA equipment do you recommend?
- What about even lower oxygen, e.g., 0.4% say at 38°F?

# Questions

- What fruit can I store at 33°F?
- What about lower chilling injury risk in the warmer regions? Does that apply to SEFB?
- Hey – if 38F is good, what about 36? What about 42?
  
- What maturity should I harvest Gala?
- Is 1-MCP necessary with low oxygen?
  
  
- What varieties respond best to DCA use?

# Questions from Chat box?