Season Effect on Storage Outcome in Honeycrisp and Gala apples

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MSU CA CLINIC - MI

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WSU

- **Honeycrisp**
- **Gala**

2019-2022

2022-2025

Organic Agriculture Research and Extension Initiative

- Same commercial blocks
- Same group of trees (+20)
- Within-canopy sensors (Temp., RH)
- Different postharvest systems
  - Conditioning at harvest
  - CA/RA/DCA + RA (cold-chain scenario)

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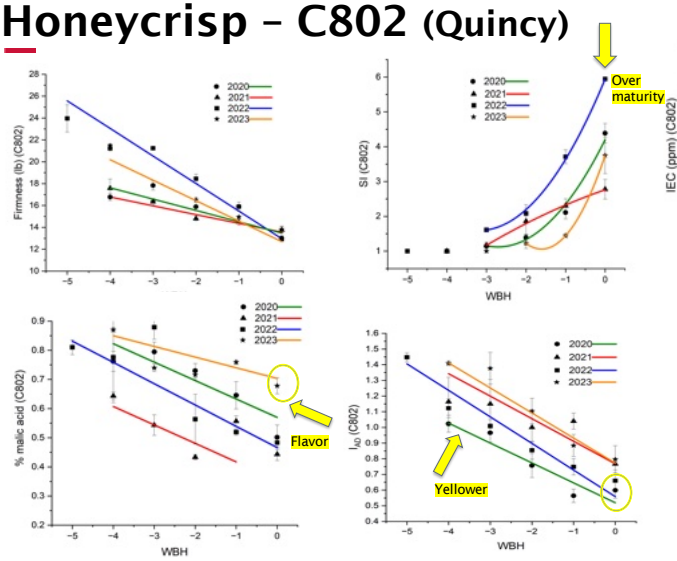
Honeycrisp – C802 (Quincy)



2020 - Smoke at harvest (close to 200 P.M.2.5 in Quincy- Sept)

2021 - Heat wave in June, warm nights

2022 – Cold spring, smaller heat waves closer to harvest, cooler nights

2023 – Warm spring → higher # of cells → denser fruit. Cooler weather at the end

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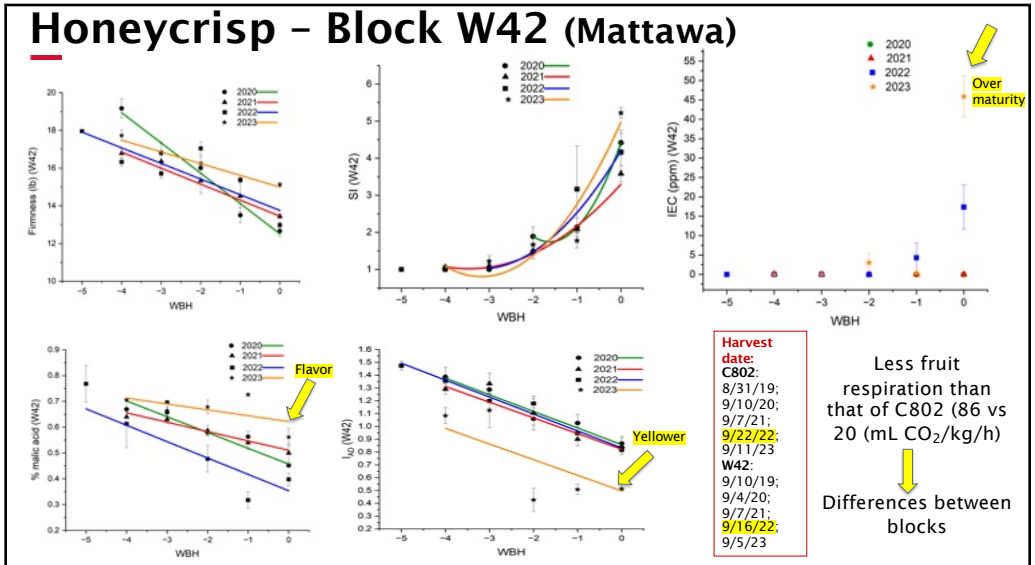
Honeycrisp – Block W42 (Mattawa)



Harvest date:
C802: 8/31/19; 9/10/20; 9/7/21; 9/22/22; 9/11/23
W42: 9/10/19; 9/4/20; 9/7/21; 9/16/22; 9/5/23

Less fruit respiration than that of C802 (86 vs 20 (mL CO_2/kg/h)

→ Differences between blocks

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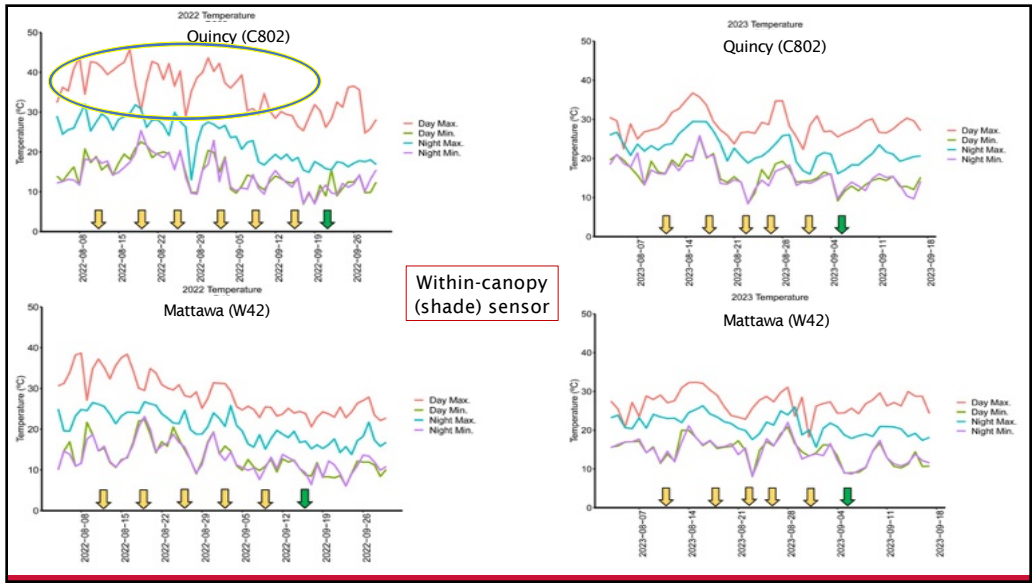
2022 Temperature
Quincy (C802)
Temperature (°C)
Day Max.
Day Min.
Night Max.
Night Min.
2022 Temperature
Mattawa (W42)
Within-canopy (shade) sensor
2023 Temperature
Quincy (C802)
2023 Temperature
Mattawa (W42)

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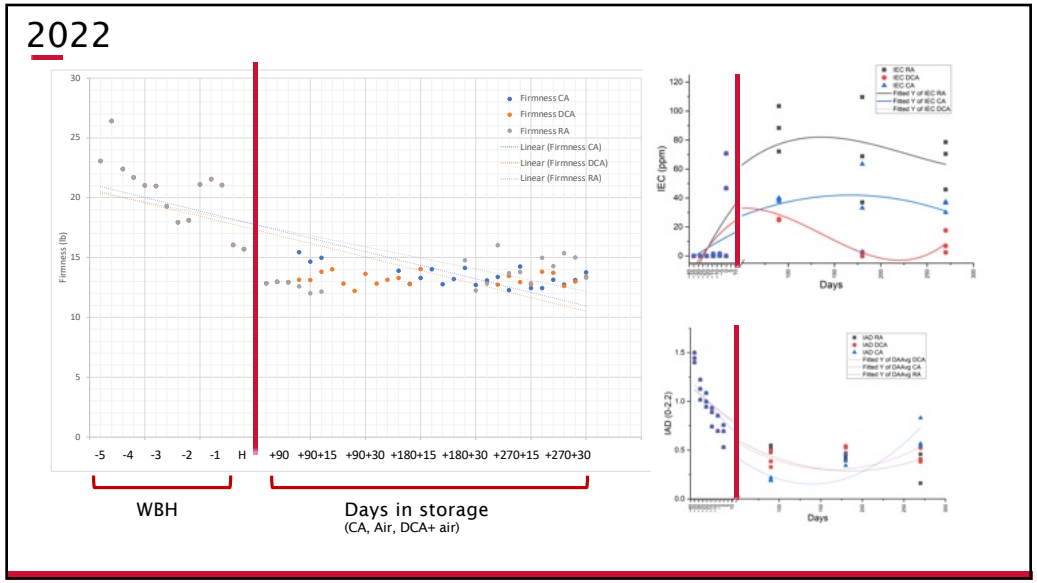
2022
Firmness (lb)
Firmness CA
Firmness DCA
Firmness RA
Linear (Firmness CA)
Linear (Firmness DCA)
Linear (Firmness RA)
-5 -4 -3 -2 -1 H +90 +90+15 +90+30 +180+15 +180+30 +270+15 +270+30
WBH
Days in storage
(CA, Air, DCA+ air)
IEC (ppm)
Days
IAD (0-2.2)
Days

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Honeycrisp 2019-2021 harvests

WSU

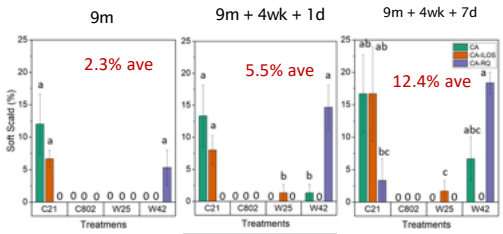
Storage	Initial O_2	Initial CO_2	Final O_2	Final CO_2
CA	3.0 %	0.5 %		
ILOS (10 days)	0.5 %	0.5 %	1.0 %	0.7 %
CA-RQ	3.0 %	0.5 %	6 multistep events to determine LOL	

- All CA/ILOS storage regimes evaluated were suitable for long-term storage of Honeycrisp.
  - Strong effect of cold chain scenario (fruit metabolism) for physiological disorders (ethylene…) and decay
- The overall effect on fruit quality was season and block-dependent.

Bitter Pit (2019-2020)

Block (A)	9m	9m+4k+7d
W42	0.2	20.3 a
W25	0.2	4.2 b
C21	0.0	9.3 ab
C802	1.5	3.3 b
P value	ns	**

Soft Scald (2019-2020)



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Soft Scald (%)						
	6m+4w+1d			6m+4w+7d		
Block	2019/20	2020/21	2021/22	2019/20	2020/21	2021/22
W42	8.0	0.0	0.6	10.6	0.6	0.6
C802	0.4	0.6	0.5	0.6	0.6	0.5
	9m+4w+1d			9m+4w+7d		
W42	6.0	0.4	3.0	9.3	0.8	3.7
C802	2.0	1.3	0.0	3.7	1.3	0.5
Soggy Breakdown (%)						
	6m+4w+1d			6m+4w+7d		
W42	0.0	0.0	0.0	1.7	0.0	0.0
C802	0.0	0.0	0.0	0.0	0.6	0.0
	9m+4w+1d			9m+4w+7d		
W42	0.3	0.0	0.0	1.3	1.3	0.0
C802	0.0	0.0	0.0	0.7	1.3	0.0

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2023-2024

"Benefits of and barriers to dynamic controlled atmosphere (DCA) storage: Analyses needed for technology uptake by the U.S. apple industry"

PI. C. Watkins, Cornell U

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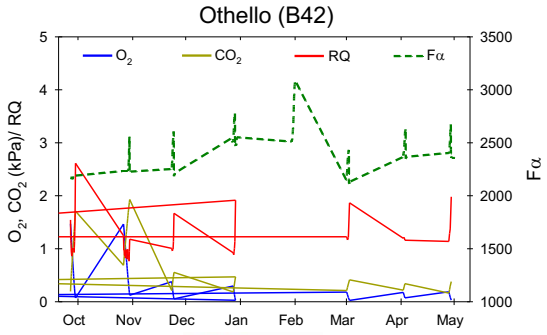
2023-2024 - Honeycrisp



Honeycrisp	LabPod			HW	Setpoint	
Othello-W42	RQ	CO_2	LOL-RQ	LOL-CF	O_2	CO_2
September	1.00	1.26	0.42		2.0	0.7
October	1.18	1.93	0.12	0.34	2.0	0.7
November	1.14	0.48	0.03	0.32	0.4	0.3
December	1.14	0.39	0.08	0.08	0.3	0.3
January	1.23	0.52	0.07	0.22	0.3	0.3
February	1.21	0.30	0.08	0.18	0.2	0.2
March	1.21	0.28	0.12	0.17	0.2	0.2
April	1.37	0.30	0.08	0.14	0.2	0.2

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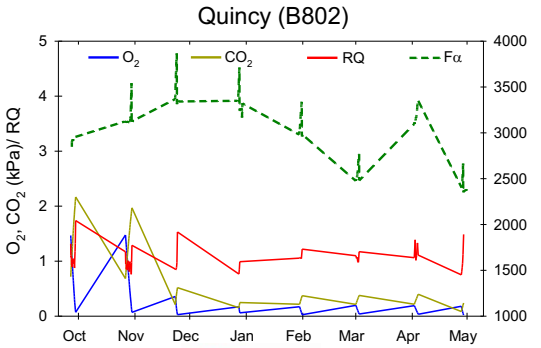
2023-2024



Honeycrisp	LabPod			HW	Setpoint	
Quincy/C802	RQ	CO_2	LOL-RQ	LOL-CF	O_2	CO_2
September	1.01	1.78	0.42		2.0	0.7
October	1.29	1.97	0.07	0.34	2.0	0.7
November	0.97	0.45	0.03	0.30	0.4	0.3
December	0.99	0.25	0.06	0.06	0.2	0.2
January	1.22	0.37	0.03	0.17	0.3	0.3
February	0.98	0.34	0.07	0.19	0.2	0.2
March	1.10	0.32	0.10	0.16	0.2	0.2
April	1.12	0.2	0.05	0.11	0.2	0.2

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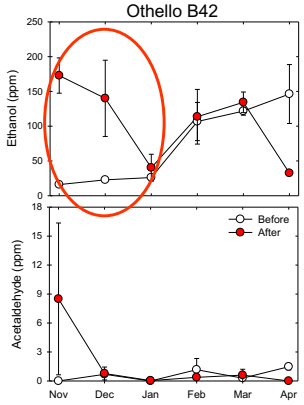
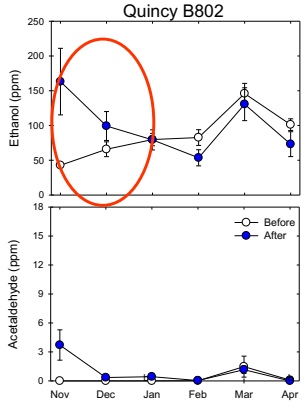
2023-2024

Ethanol and Acetaldehyde before and after LOL determination

Honeycrisp	Setpoint	
Othello-W42	O_2	CO_2
September	2.0	0.7
October	2.0	0.7
November	0.4	0.3
December	0.3	0.3
January	0.3	0.3
February	0.2	0.2
March	0.2	0.2
April	0.2	0.2





Honeycrisp	Setpoint	
Quincy/C802	O_2	CO_2
September	2.0	0.7
October	2.0	0.7
November	0.4	0.3
December	0.2	0.2
January	0.3	0.3
February	0.2	0.2
March	0.2	0.2
April	0.2	0.2

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Harvest Maturity

WSU

GALA

Season	Weight (g)	Background color (1-4)	Red coverage %	I_{AD}	Firmness (Lb)	SS (°Brix)	SI (1-6)	IEC ppm	Malic acid %	Respiration (mL CO_2/kg/h)
2022	163.8	3.8	67.4	0.62	14.2	9.4	1.3	0.00	0.36	28.30
2023	161.8	2.6	68.1	0.47	14.8	13.5	4.8	0.56	0.48	5.75
Sign.[z]	ns	*	ns	ns	*	*	*	*	ns	*

- Harvested on Aug 23, 2023
- Storage duration: 3, 6, and 9 months + 2 weeks in RA storage plus 1 or 7 days 'shelf-life'
- Storage: Air storage at 34°F or 37°F

  CA storage (2% O_2, 0.5% CO_2) at 34°F or 37°F

  DCA storage (0.15% O_2, 0.3% CO_2) at 34°F or 37°F

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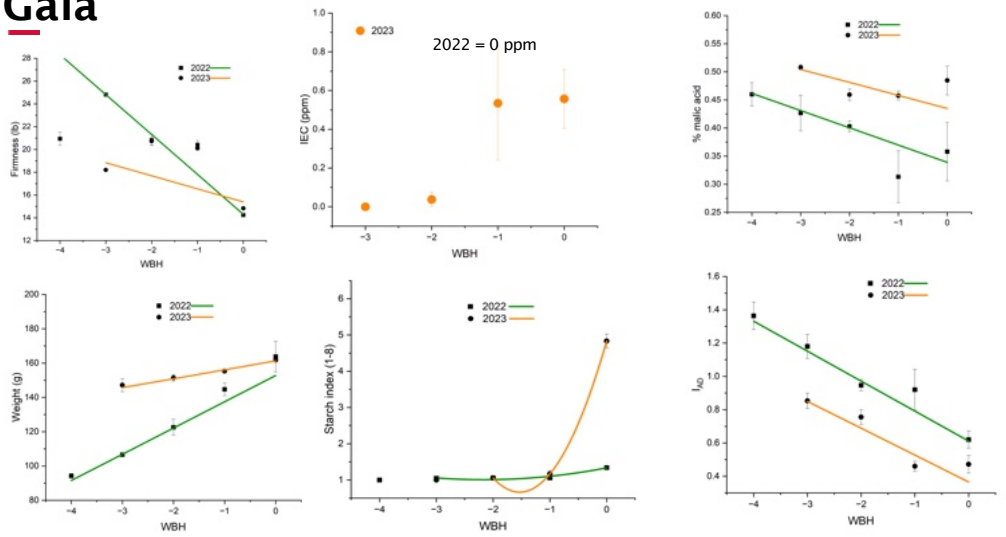
Gala



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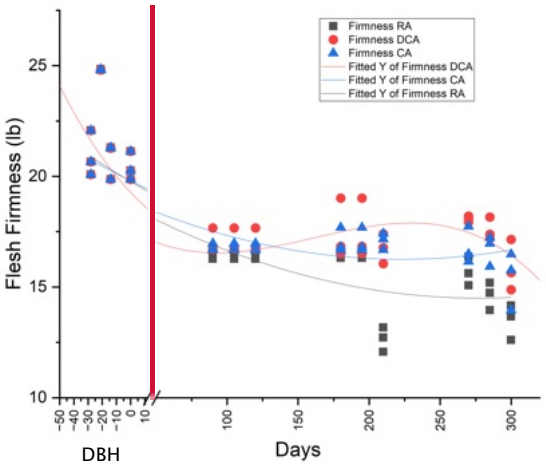
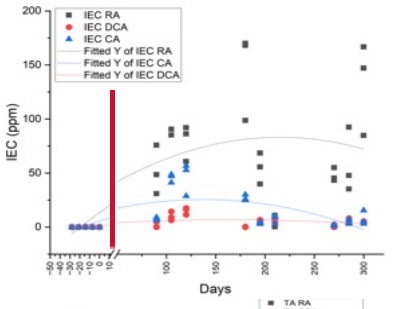
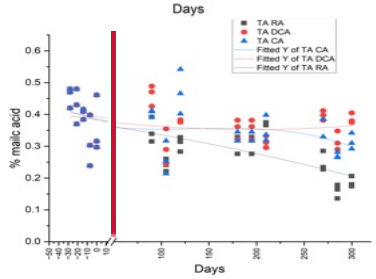
2022-2023







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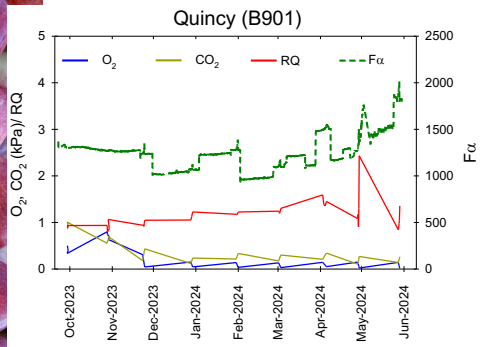
2023-2024



Gala	SafePod				Setpoint	
Quincy	RQ	CO_2	LOL-RQ	LOL-CF	O_2	CO_2
October	1.07	0.70	0.64		1.7	1.0
November	1.05	0.43	0.04	0.10	0.3	0.3
December	1.13	0.17	0.10	0.15	0.15	0.3
January	1.22	0.34	0.04	0.14	0.15	0.3
February	1.30	0.30	0.03	0.13	0.15	0.3
March	1.36	0.30	0.08	0.05	0.15	0.3
April	1.30	0.21	0.05	0.09	0.15	0.3
May	1.04	0.23	0.05	0.15		

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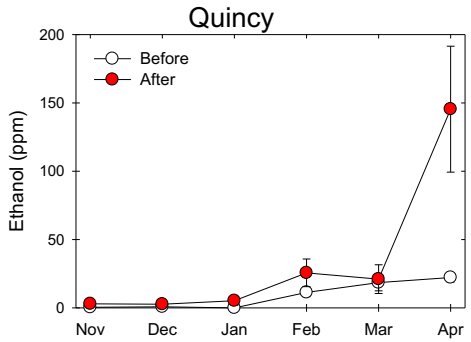
2023-2024

Ethanol concentrations of 'Gala' apples under DCA conditions before and after LOL determination



Gala	Setpoint	
Quincy Pod 6	O_2	CO_2
September	1.70	1.0
October	1.70	1.0
November	0.30	0.3
December	0.15	0.3
January	0.15	0.3
February	0.15	0.3
March	0.15	0.3
April	0.15	0.3

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Final Remarks

- All CA/ILOS storage regimes (2019-2021) evaluated were suitable for long-term storage of Honeycrisp. The overall effect on fruit quality was season-dependent.
  - The supply chain will determine the overall benefit of low O_2 storage on apples.
  - Preharvest management and seasonal climatic conditions explained block differences (nutrition, disease pressure, etc.), particularly in decay incidence and physiological disorders development during the storage period.
- Fruit's CO_2 sensitivity driven by seasonal weather. How?

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Acknowledgments

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Funding
Washington Tree Fruit Research Commission

Collaborators
Stemilt Growers
Zirkle Fruit
…..

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THANK YOU!

POSTHARVEST SYSTEMS

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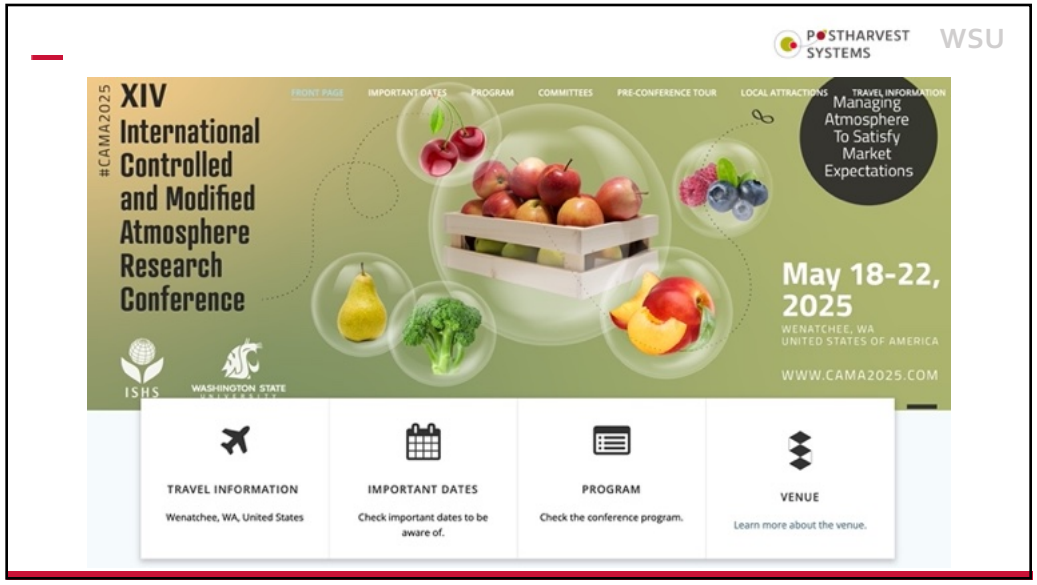

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