



**5TH INTERNATIONAL
STRAWBERRY CONGRESS**

Thursday

Parallel Session 3: Innovative Technology & Vertical Farming

The background of the slide is a photograph of several ripe, red strawberries with green leafy tops, scattered on a solid blue surface. The strawberries are in various positions, some in sharp focus and others slightly blurred, creating a sense of depth.

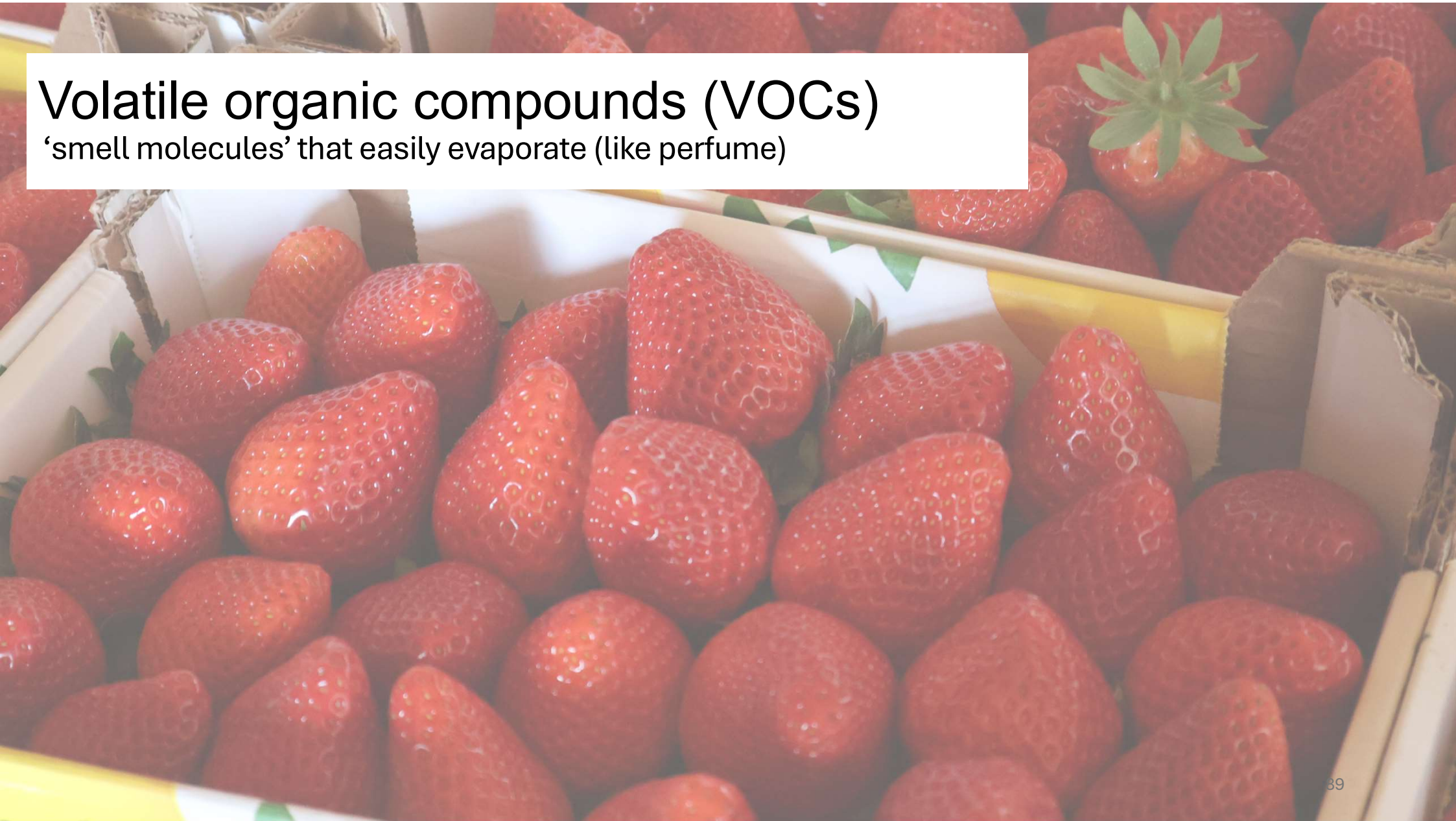
VOC-based monitoring for early detection of mechanical damage and fungal infection in strawberries

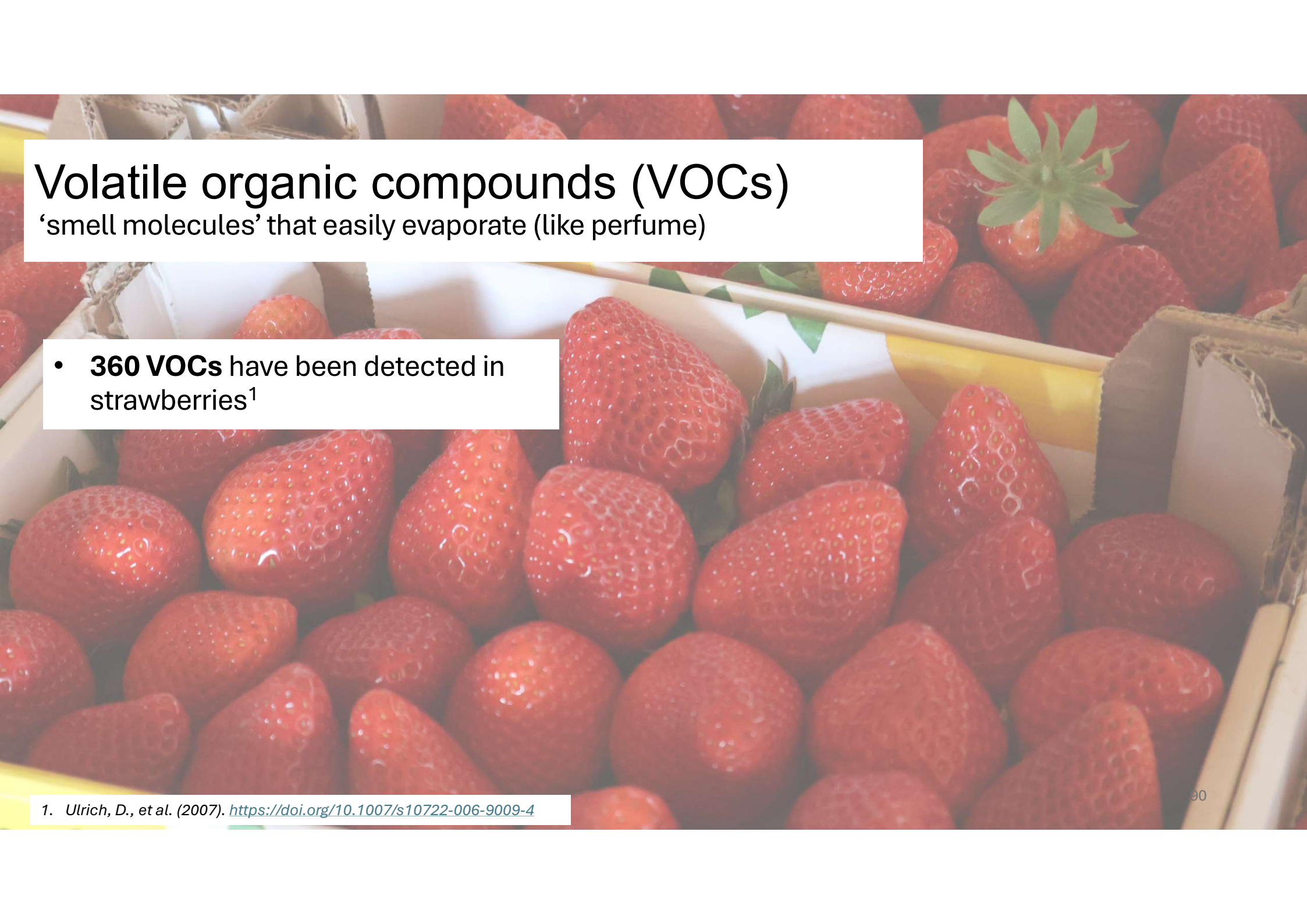
Taylor Person, Miaomiao Yao, Maxence Paillart,
Thijs Defraeye, Rob Schouten



Volatile organic compounds (VOCs)

‘smell molecules’ that easily evaporate (like perfume)





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- **360 VOCs** have been detected in strawberries¹

1. Ulrich, D., et al. (2007). <https://doi.org/10.1007/s10722-006-9009-4>

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- When strawberries mature², are stored³, damaged⁴, or infected with mold⁵, the **abundance and mixture of VOCs can change**.



1. Ulrich, D., et al. (2007). <https://doi.org/10.1007/s10722-006-9009-4>
2. Simkova K., et al. (2024). 10.3390/plants13101419.
3. Li, H., et al. (2021). <https://doi.org/10.1016/j.postharvbio.2021.111719>
4. Cao, Y., et al. (2022). 10.3390/s22020427
5. Zhao, Y., et al. (2023). 10.1016/j.ijfoodmicro.2023.110313

Volatile organic compounds (VOCs)

‘smell molecules’ that easily evaporate (like perfume)

- **360 VOCs** have been detected in strawberries¹
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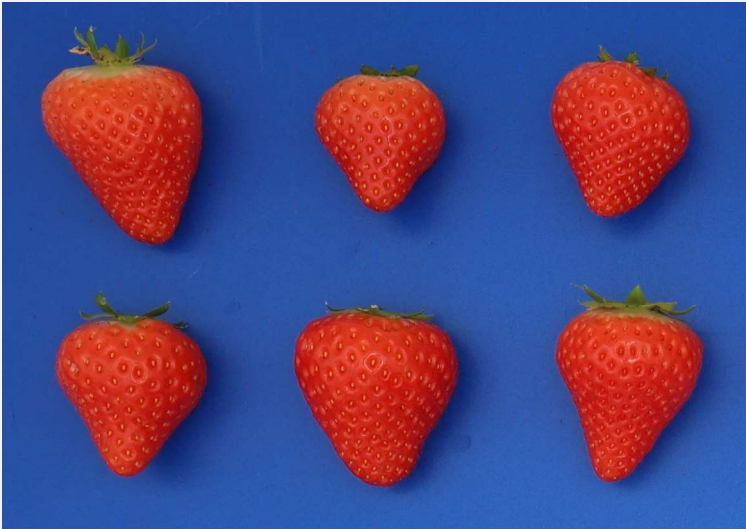


Can we use VOCs as an early indicators of bruise damage and/or risk of fungal infection?

1. Ulrich, D., et al. (2007). <https://doi.org/10.1007/s10722-006-9009-4>
2. Simkova K., et al. (2024). 10.3390/plants13101419.
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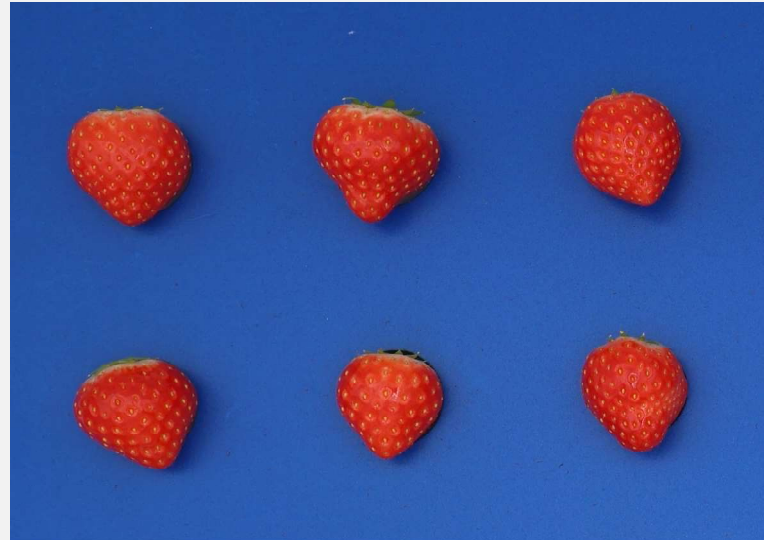
Malling Centenary

- Larger with 10-12 fruit per cuvette (~250g)



Elsanta

- Smaller with 17-24 fruit per cuvette (~250g)



Both suitable for protected cultivation
Short-day (June-bearing)

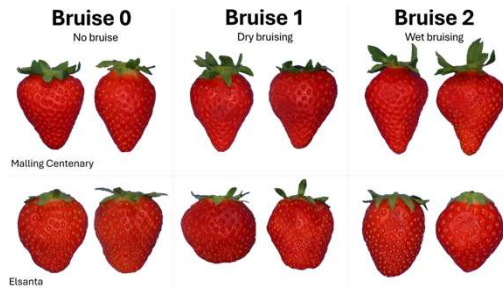
Experimental Procedure

Experimental Procedure



Fruit pickup (8kg / cultivar)
Bruise sorting
Weight
Images

Day 0



Experimental Procedure



5 °C

Malling C.

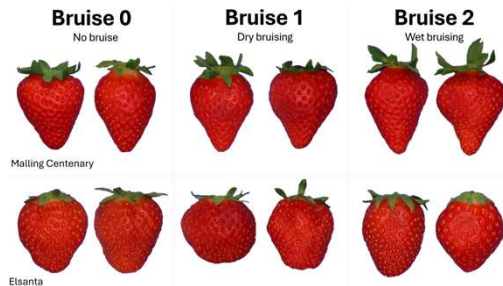
Elsanta

Fruit pickup (8kg / cultivar)
Bruise sorting
Weight
Images

Day 0

Day 14

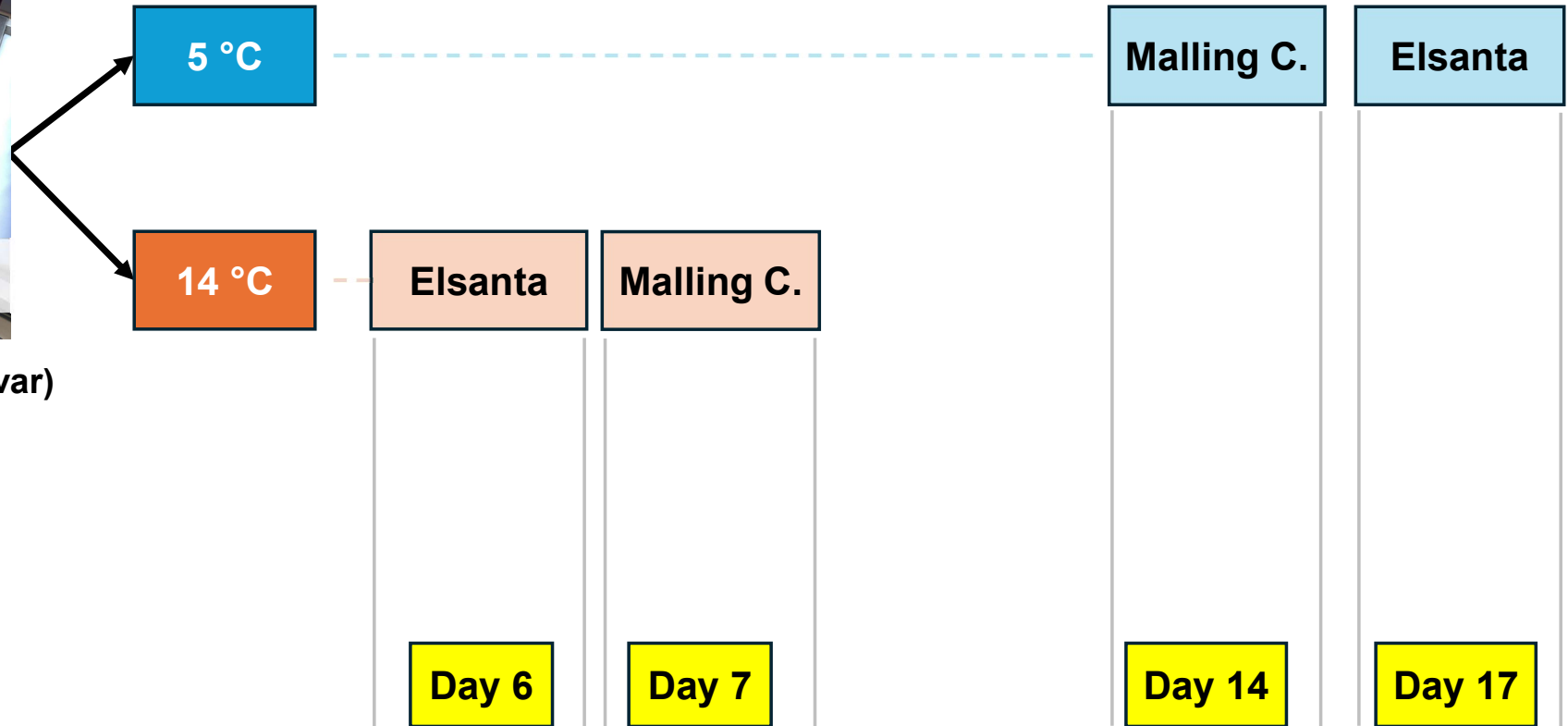
Day 17



Experimental Procedure



Fruit pickup (8kg / cultivar)
Bruise sorting
Weight
Images



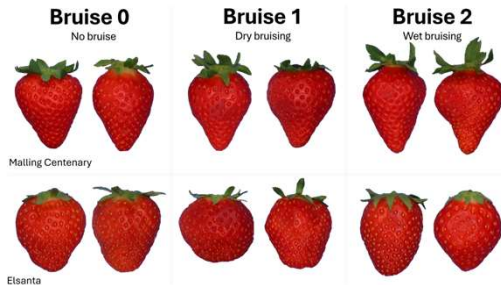
Day 0

Day 6

Day 7

Day 14

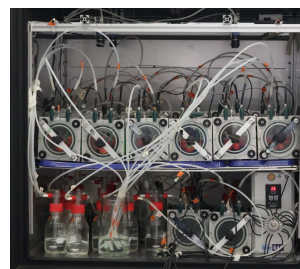
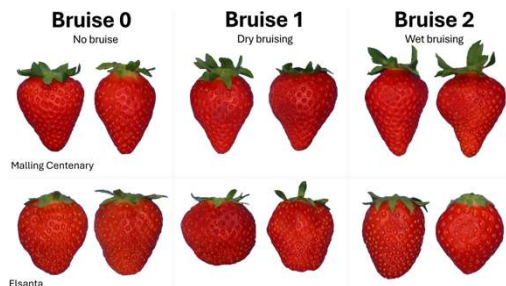
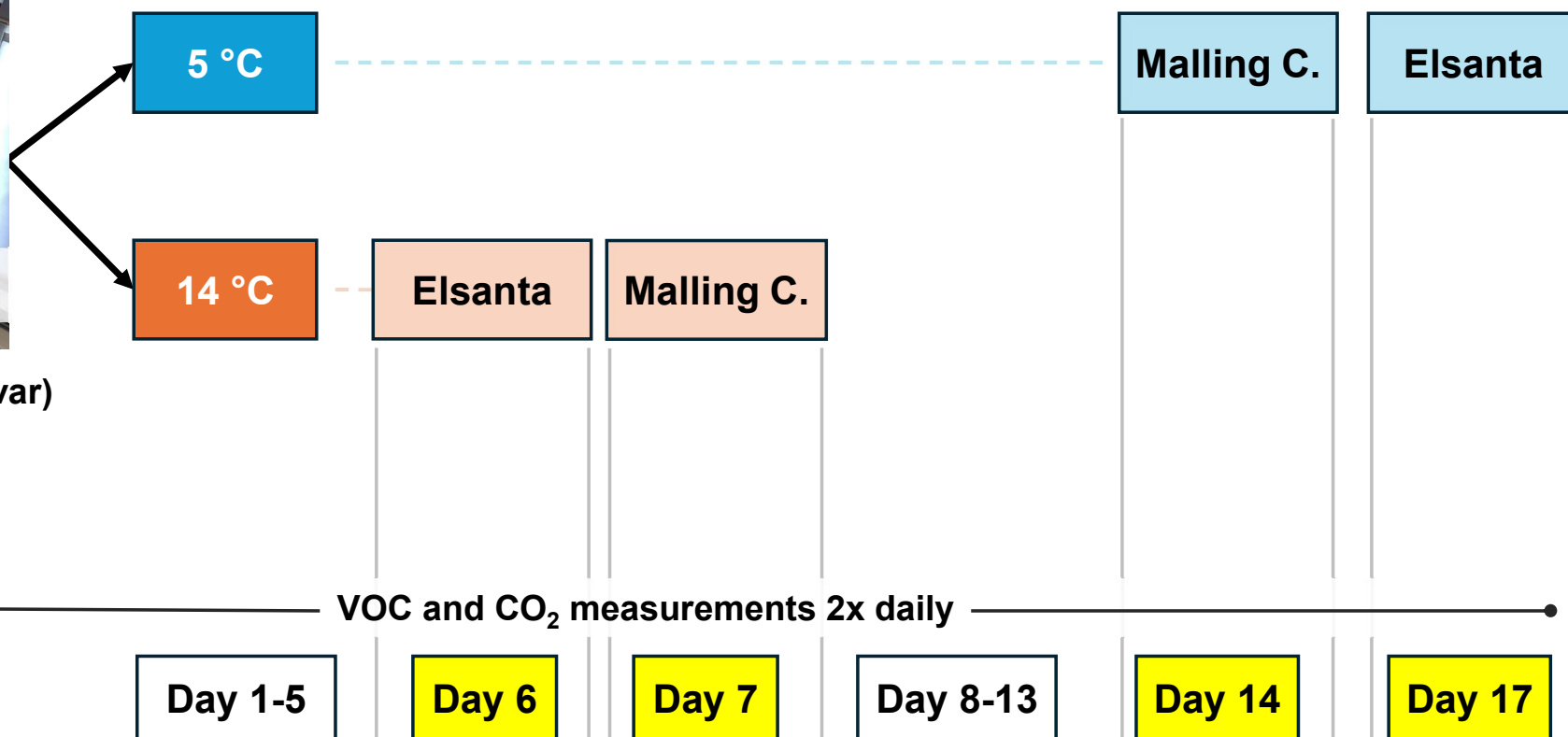
Day 17



Experimental Procedure



Fruit pickup (8kg / cultivar)
Bruise sorting
Weight
Images

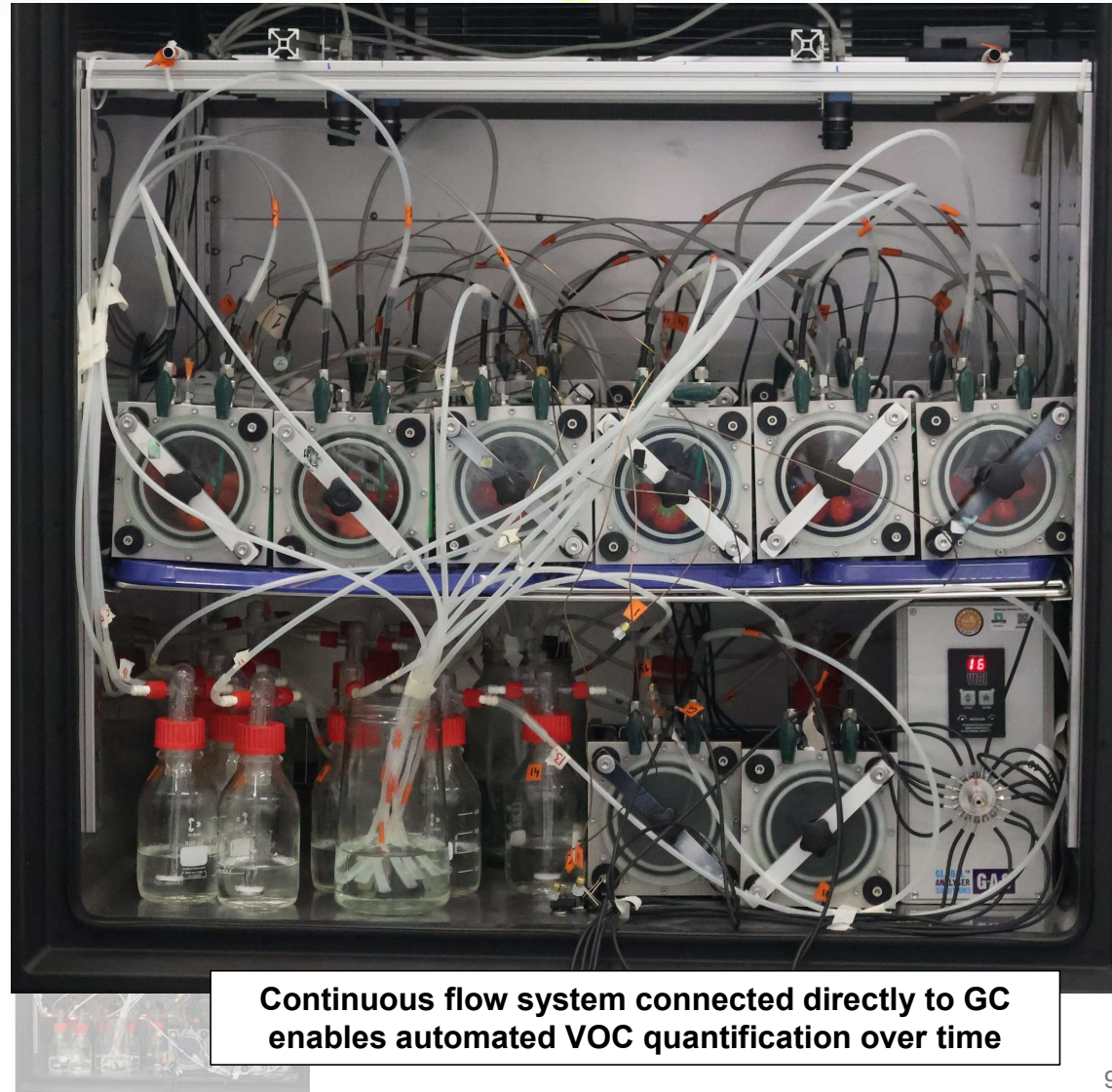
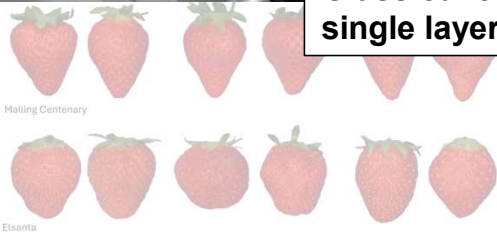


Experimental Pro

Live overhead cameras
(to view fruit without opening the door)



Glass cuvettes with
single layer of fruit

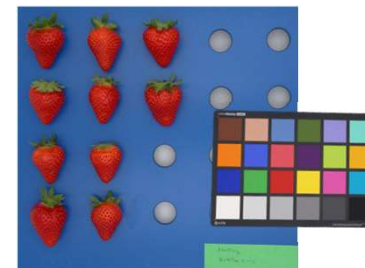
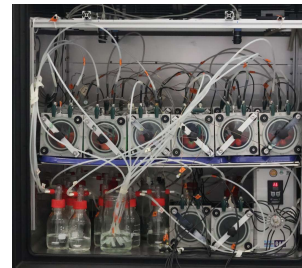
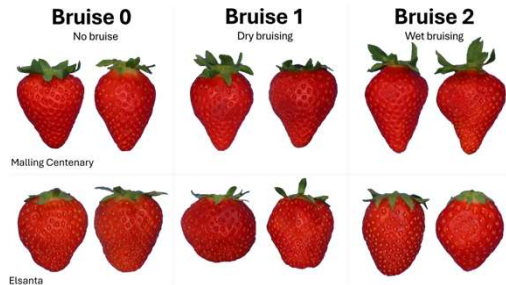
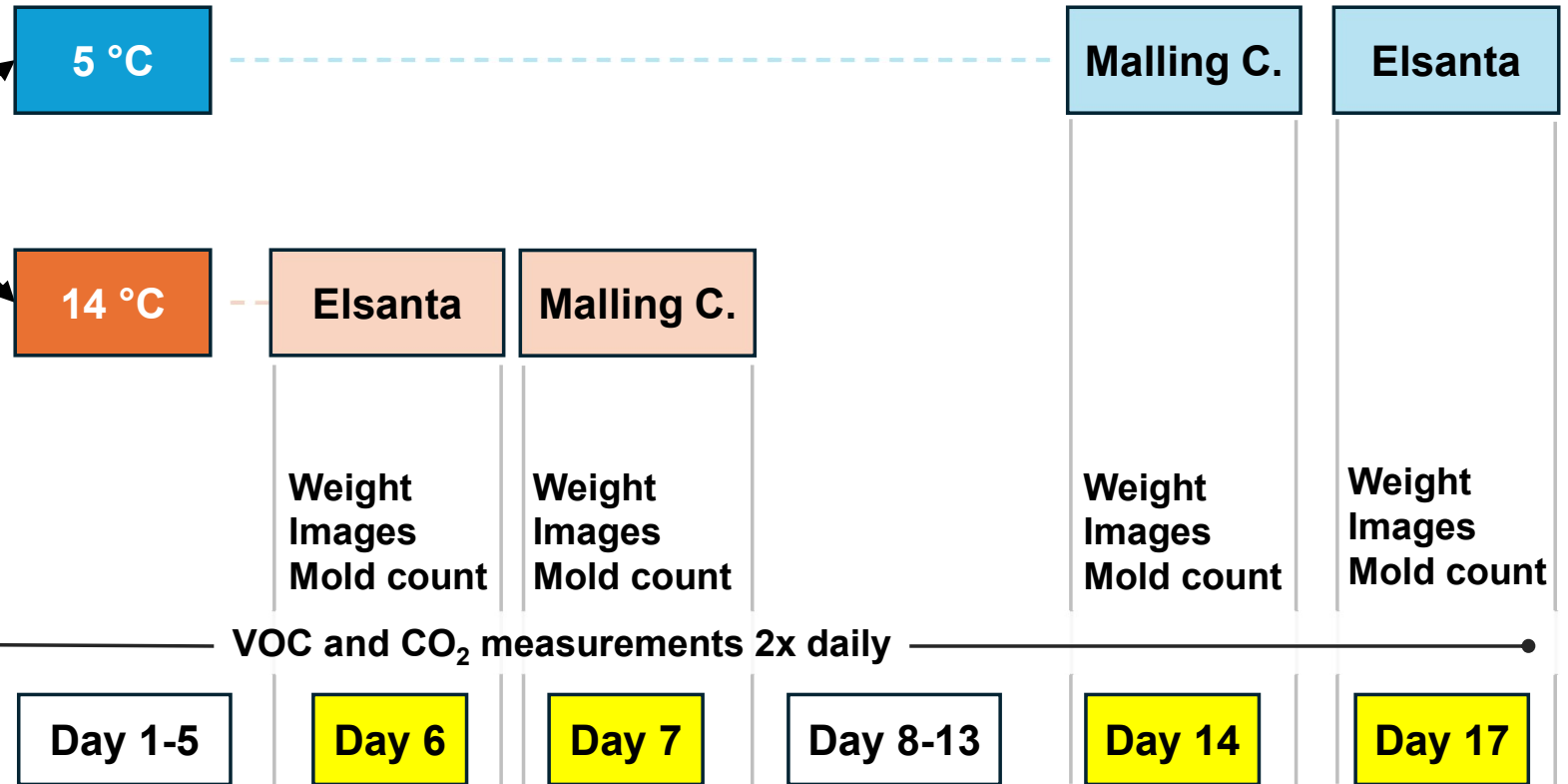


Continuous flow system connected directly to GC
enables automated VOC quantification over time

Experimental Procedure



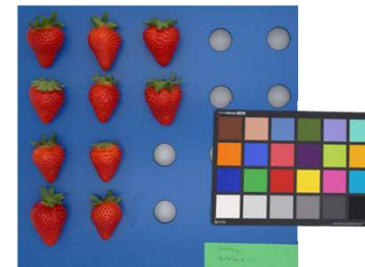
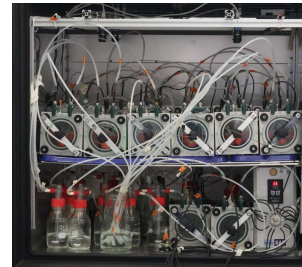
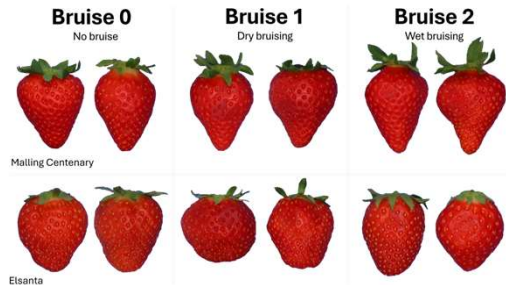
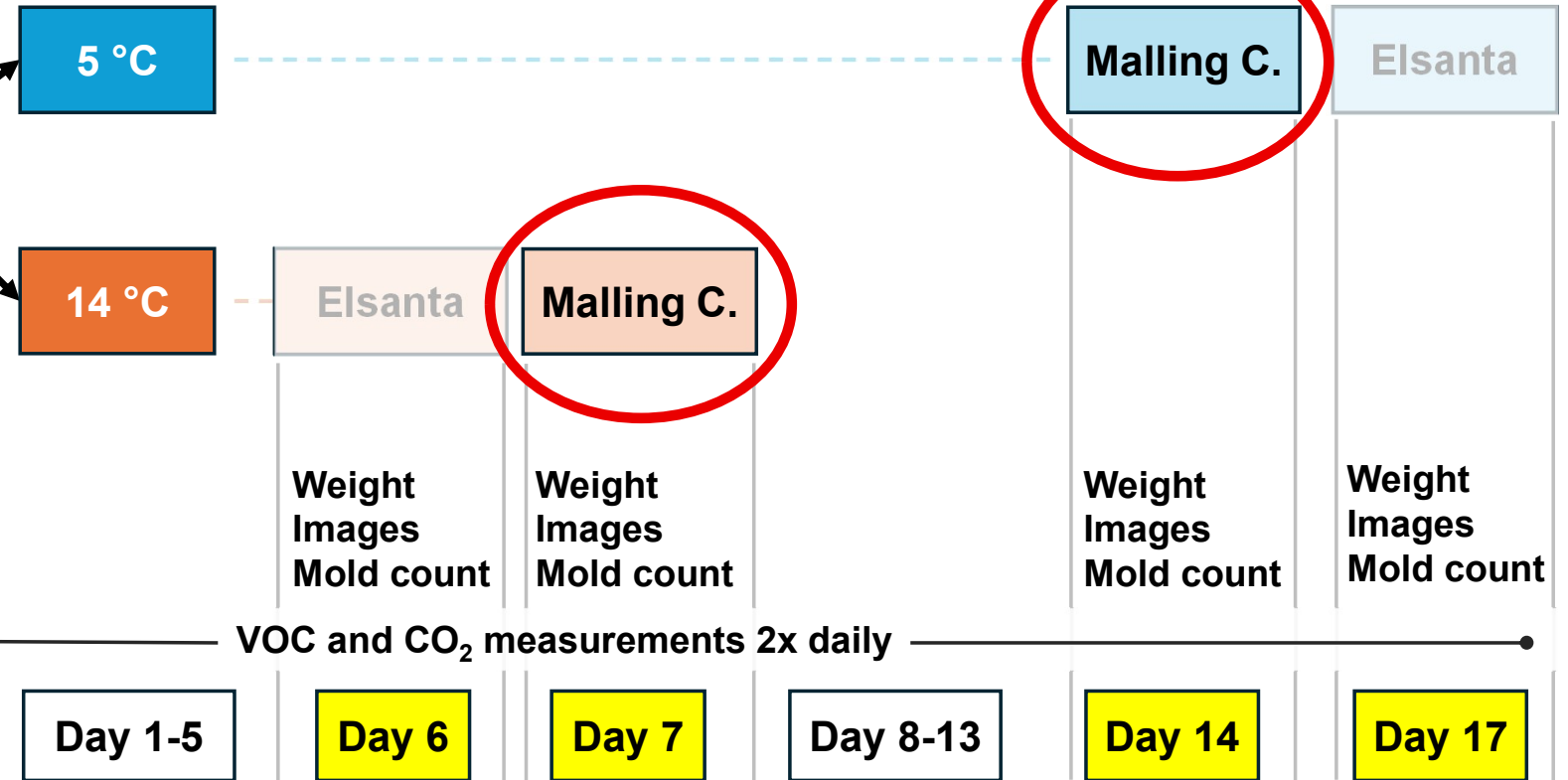
Fruit pickup (8kg / cultivar)
Bruise sorting
Weight
Images



Experimental Procedure



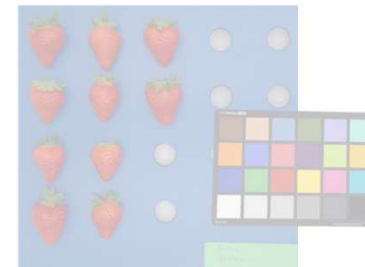
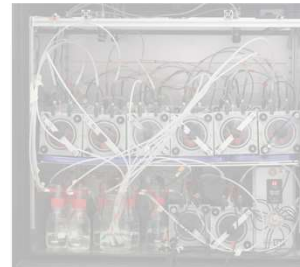
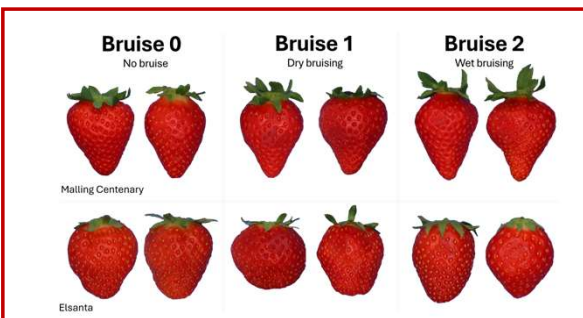
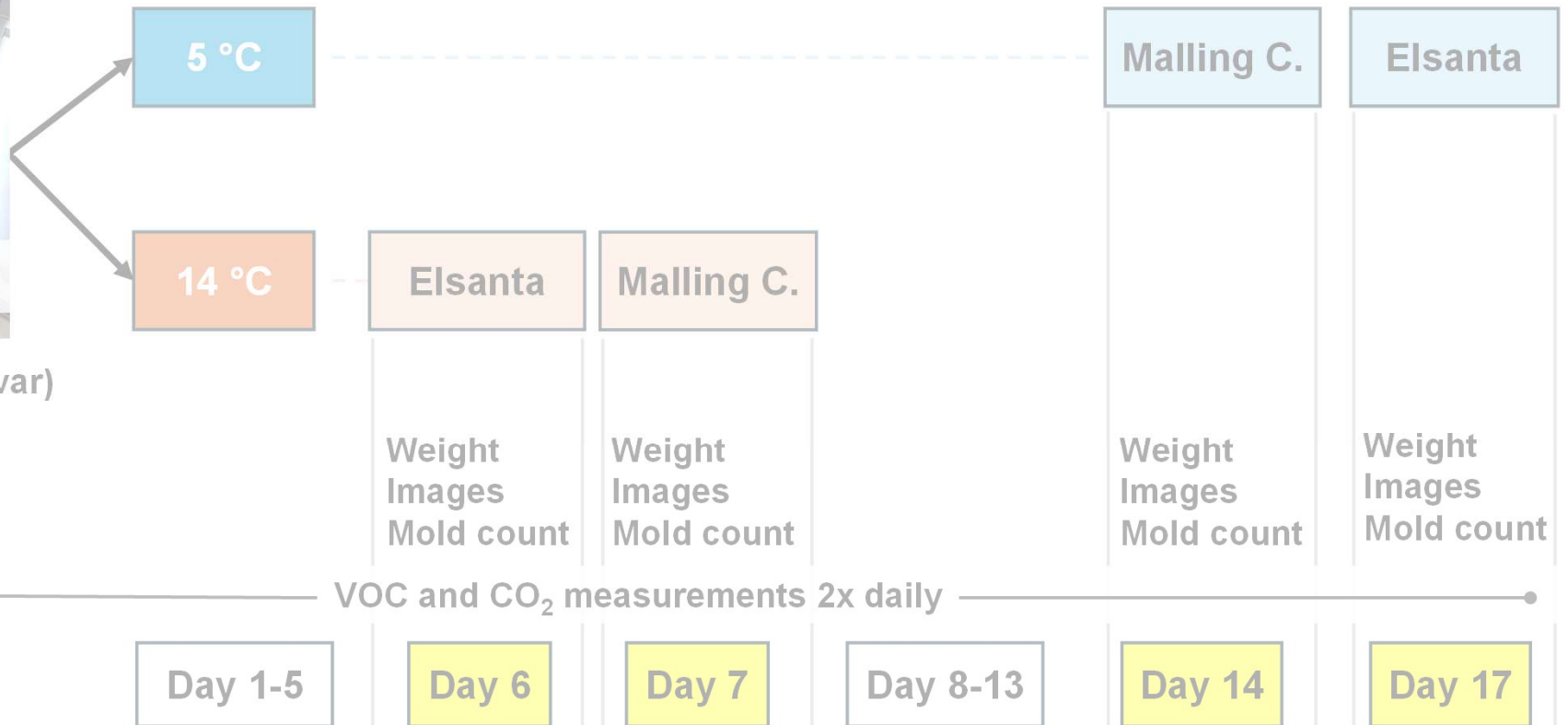
Fruit pickup (8kg / cultivar)
Bruise sorting
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Experimental Procedure



Fruit pickup (8kg / cultivar)
Bruise sorting
Weight
Images



Bruise 0

No bruise

Bruise 1

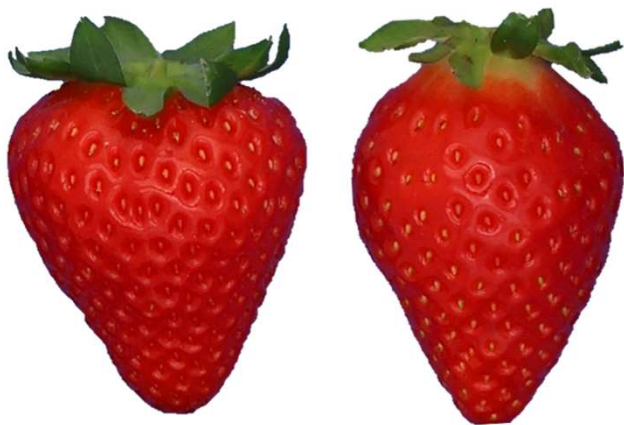
Dry bruising

Bruise 2

Wet bruising

Bruise 0

No bruise



Malling Centenary

Bruise 1

Dry bruising

Bruise 2

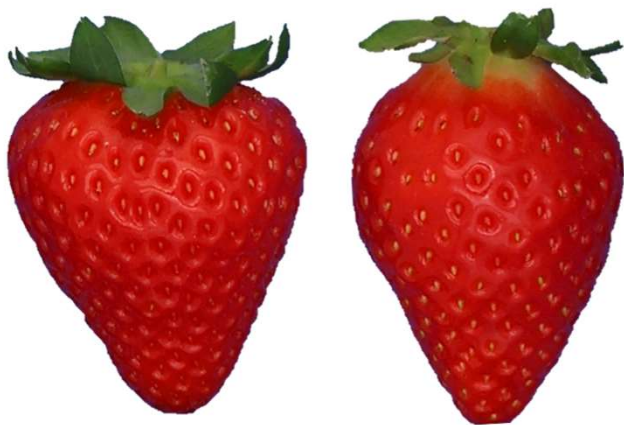
Wet bruising



Elsanta

Bruise 0

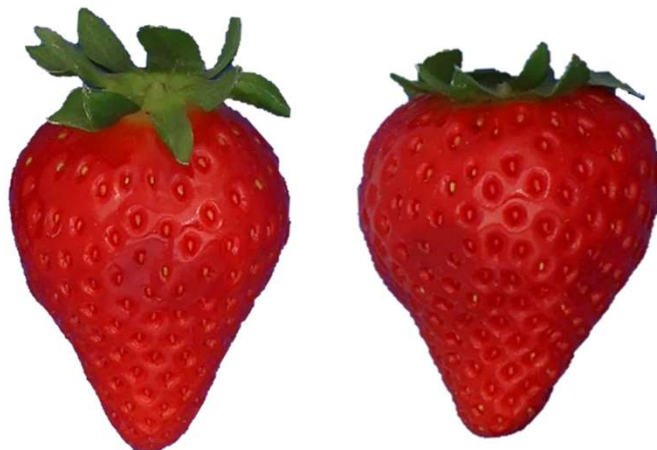
No bruise



Malling Centenary

Bruise 1

Dry bruising



Bruise 2

Wet bruising

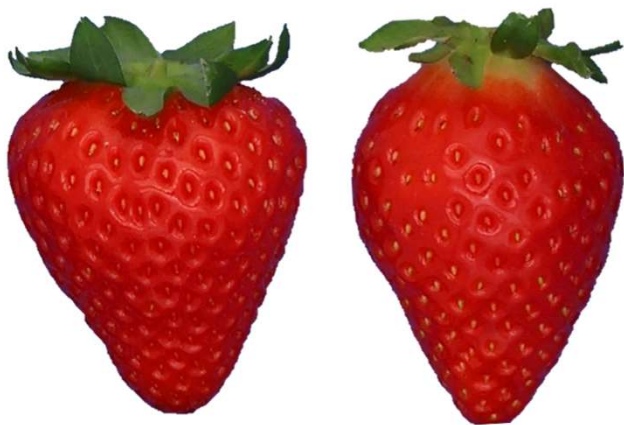


Elsanta



Bruise 0

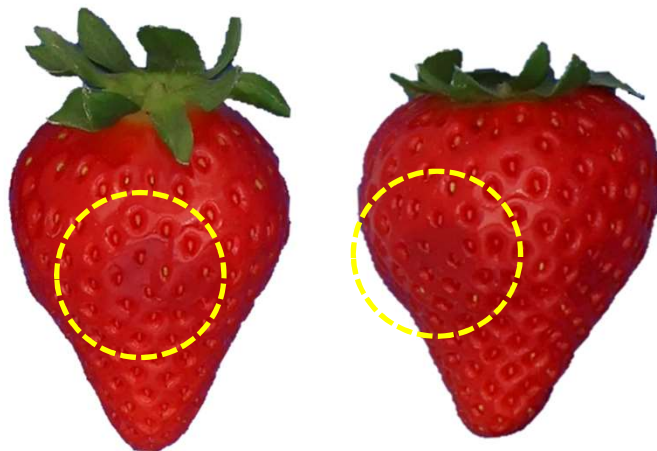
No bruise



Malling Centenary

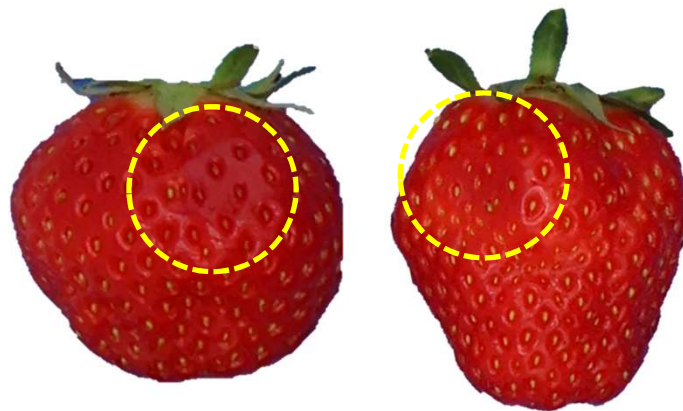
Bruise 1

Dry bruising



Bruise 2

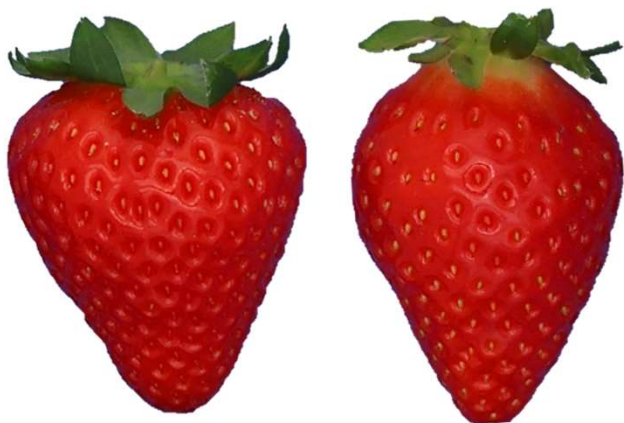
Wet bruising



Elsanta

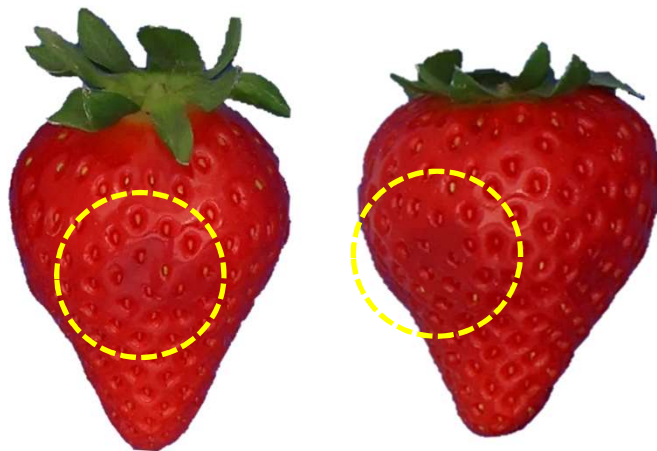
Bruise 0

No bruise



Bruise 1

Dry bruising

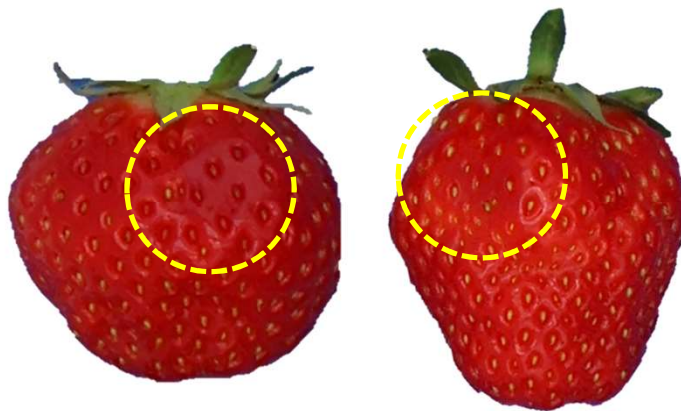


Bruise 2

Wet bruising



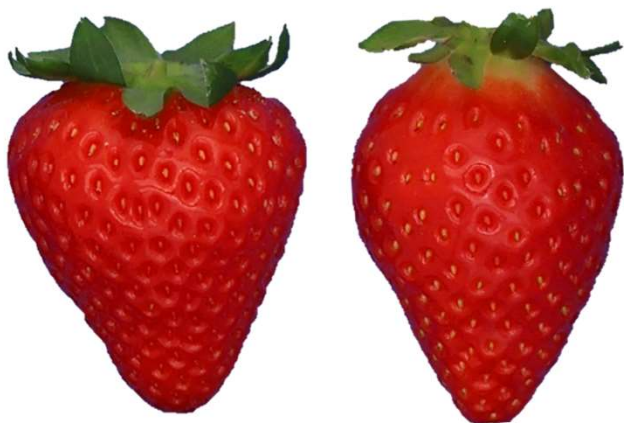
Malling Centenary



Elsanta

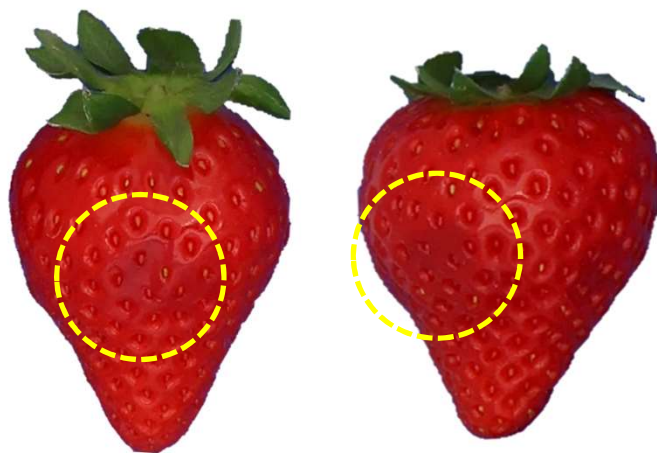
Bruise 0

No bruise



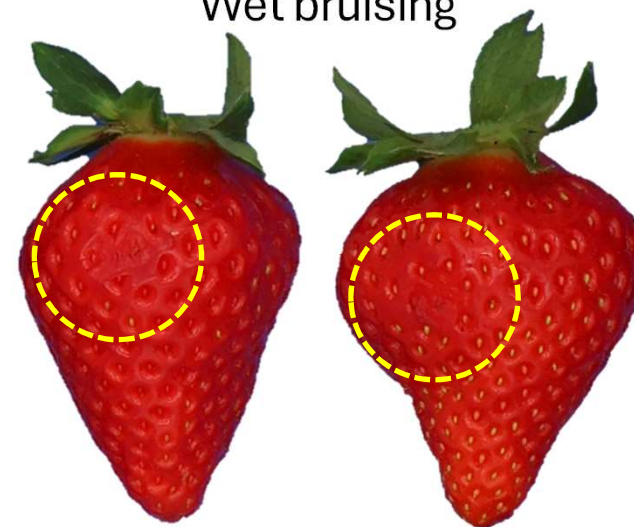
Bruise 1

Dry bruising

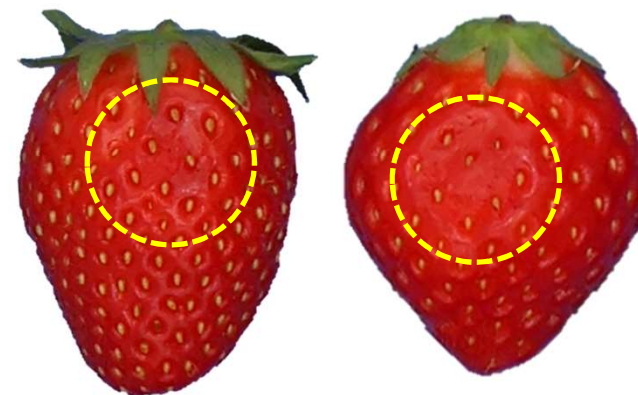
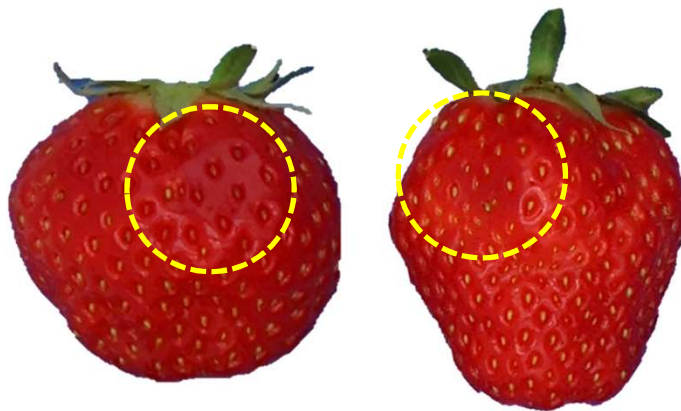


Bruise 2

Wet bruising



Malling Centenary



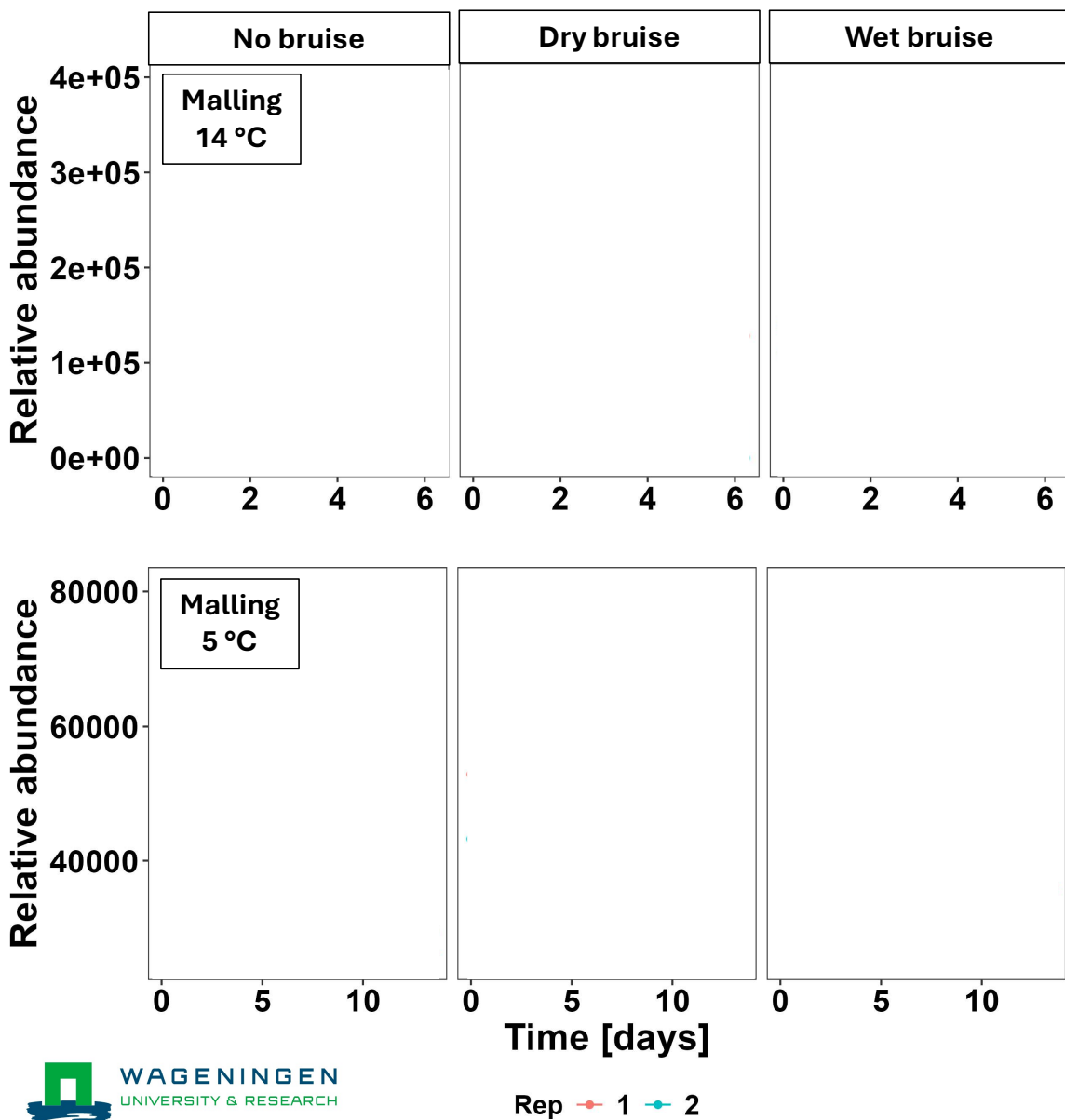
Elsanta

A background image showing several ripe, red strawberries with green leafy tops scattered across a solid blue surface. The strawberries are in various orientations, some facing the viewer and others slightly angled. A semi-transparent white horizontal band is centered across the image, containing the text 'VOC Results'.

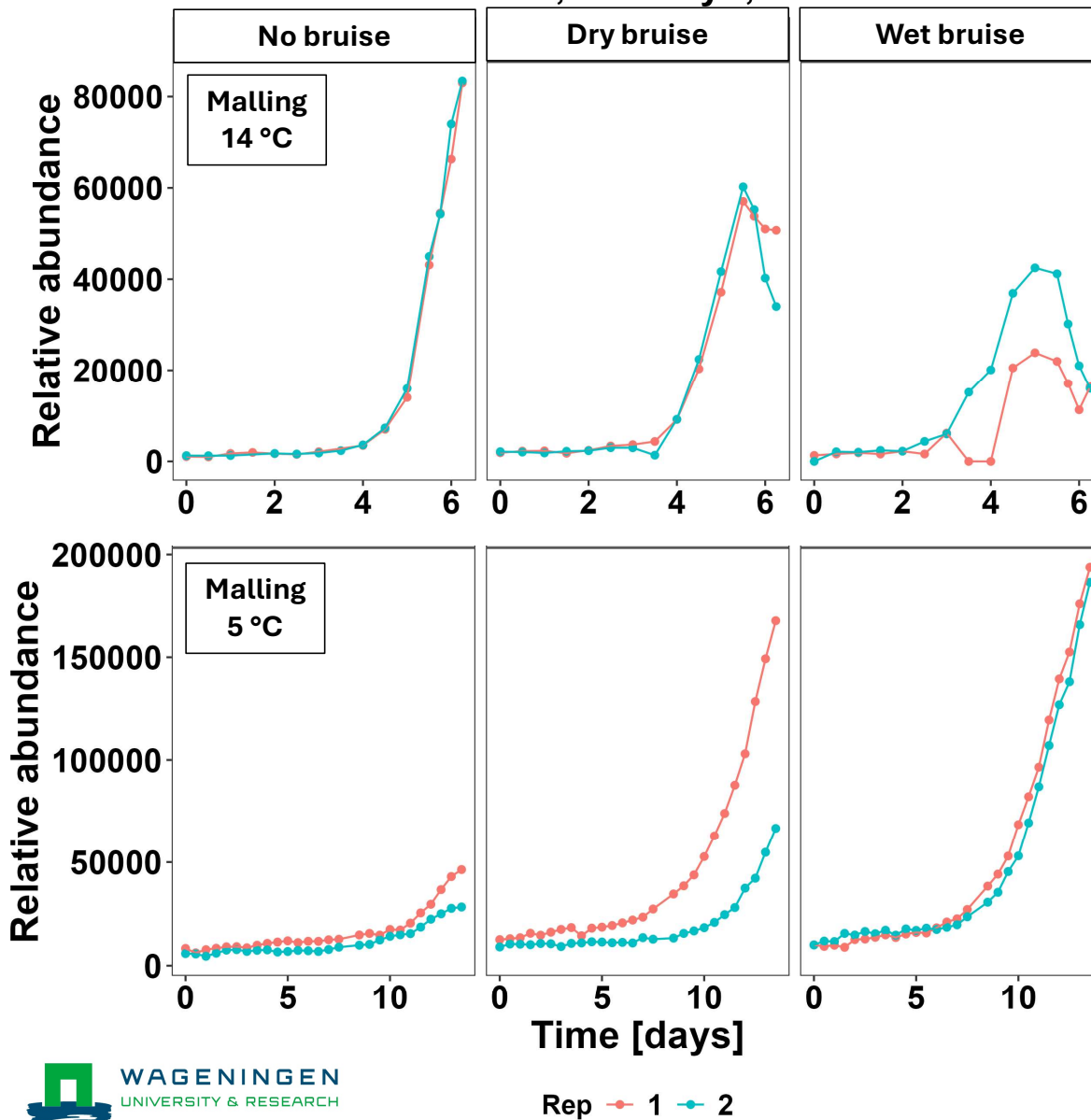
VOC Results

VOCs

- 67 unique compounds were detected
- Which individual VOCs and VOC ratios show **different initial values or trends** based on bruise score?



1-Butanol, 2-methyl-, acetate



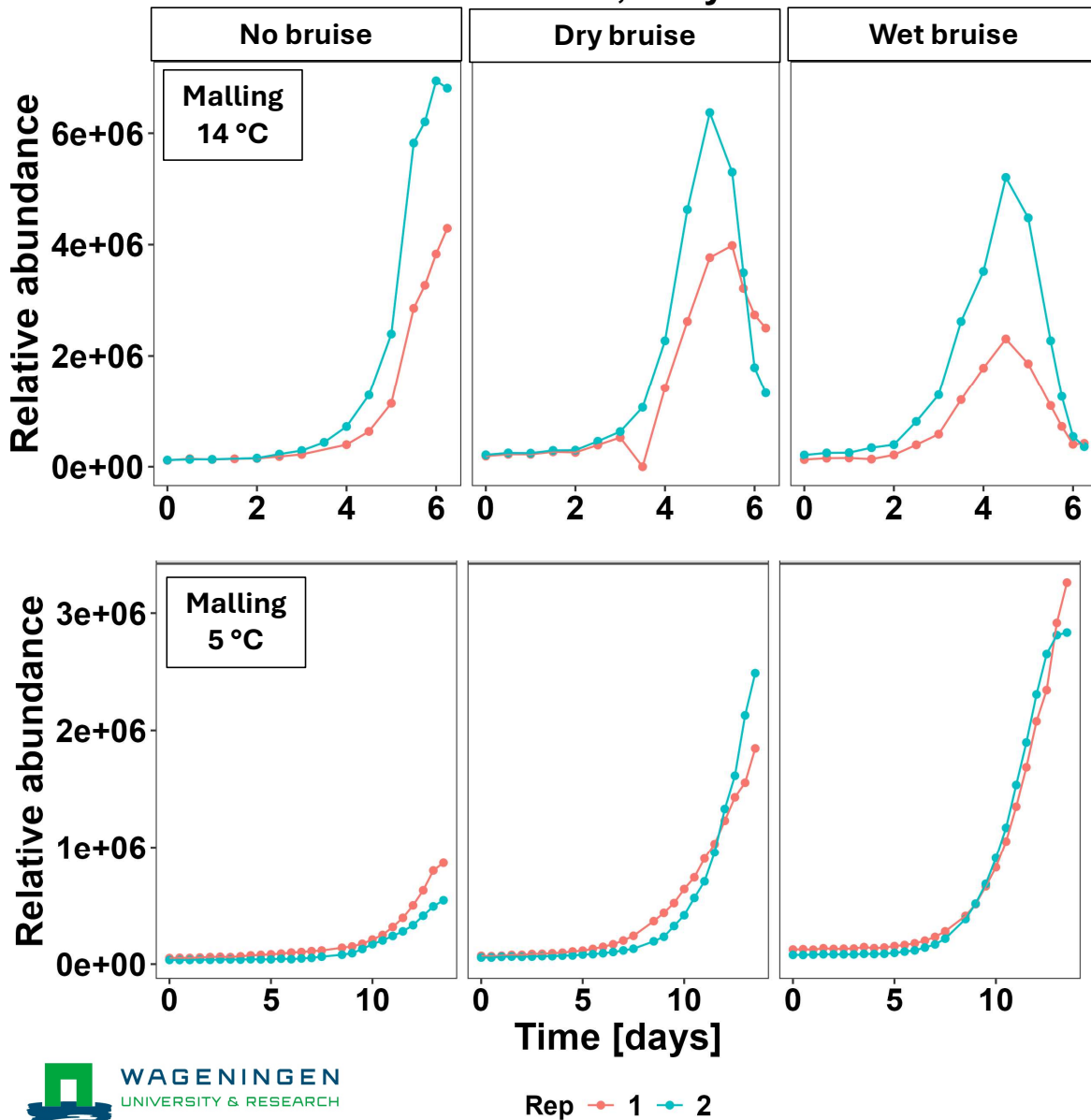
1-Butanol, 2-methyl-, acetate

Ester

Fruity aroma and flavor

- At 5 and 14 °C, peaks advance faster at **greater bruise severity**

Acetic acid, hexyl ester

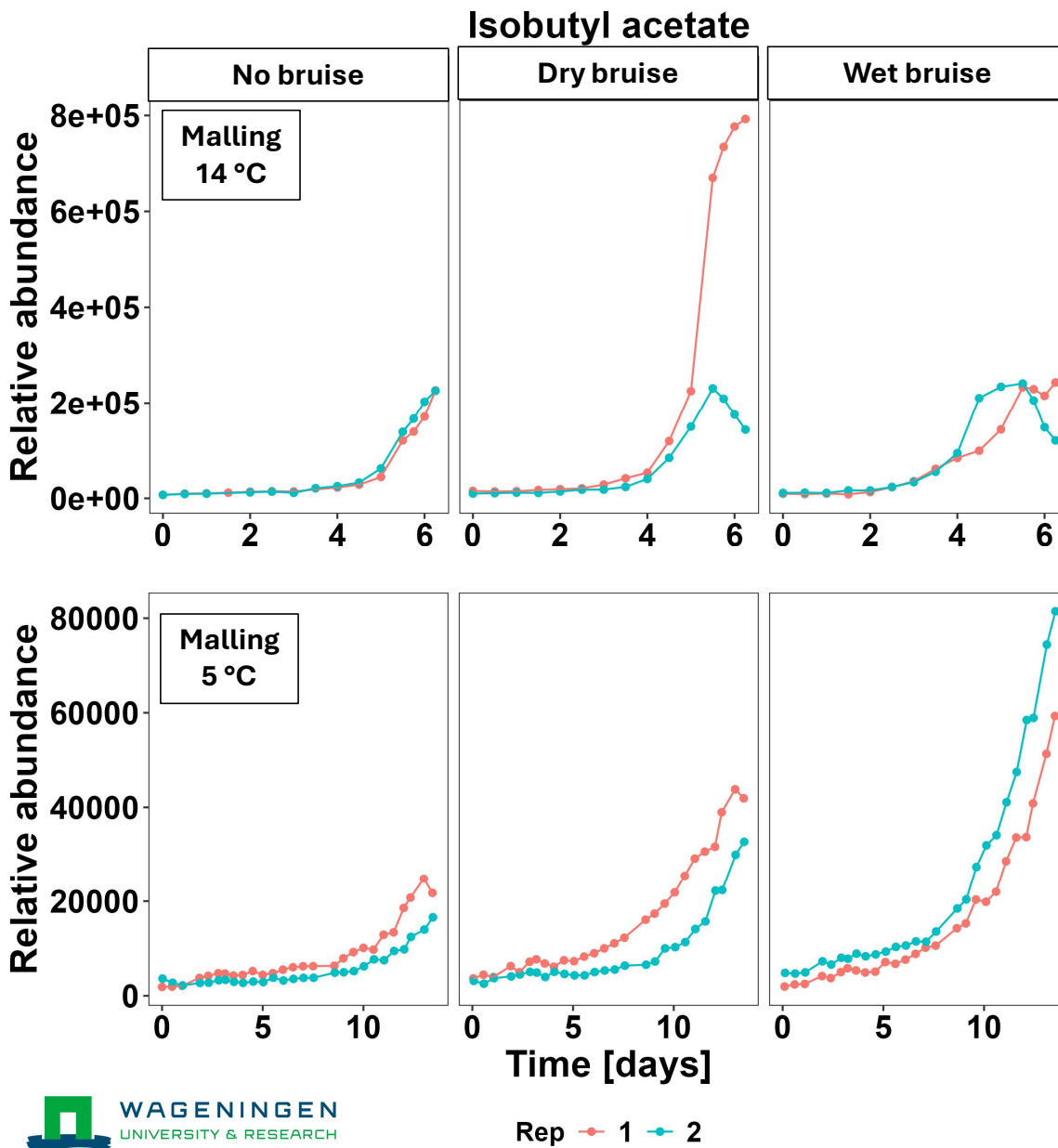


Acetic acid, hexyl ester

Ester

Highly abundant fruity aroma and flavor compound

- At 5 and 14 °C, initial values are comparable, peaks advance faster at **higher bruise scores**



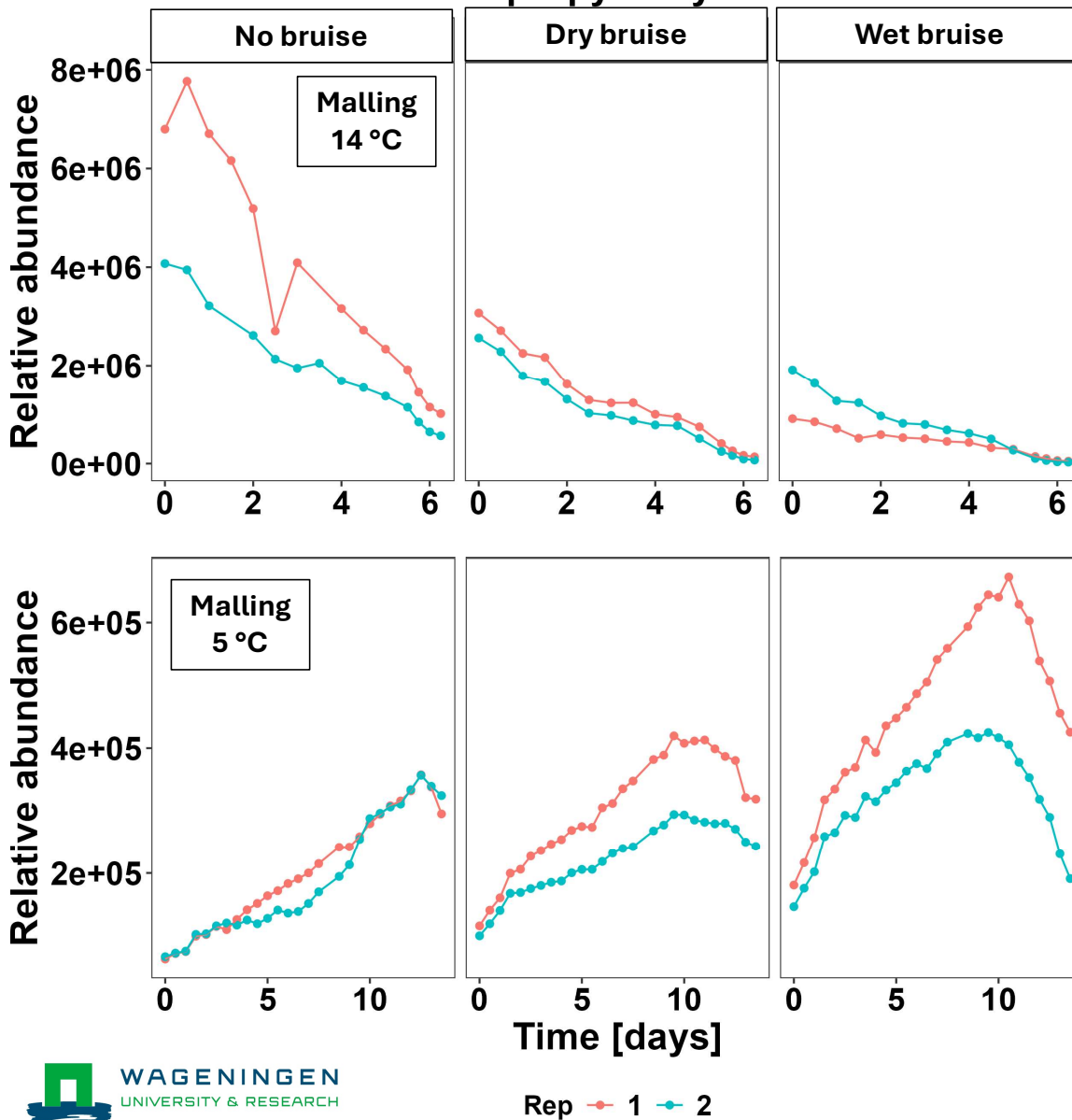
Isobutyl acetate

Ester

Fruity, banana-like aroma

- At 5 and 14 °C, increased values over time with **greater bruise severity**

Isopropyl butyrate



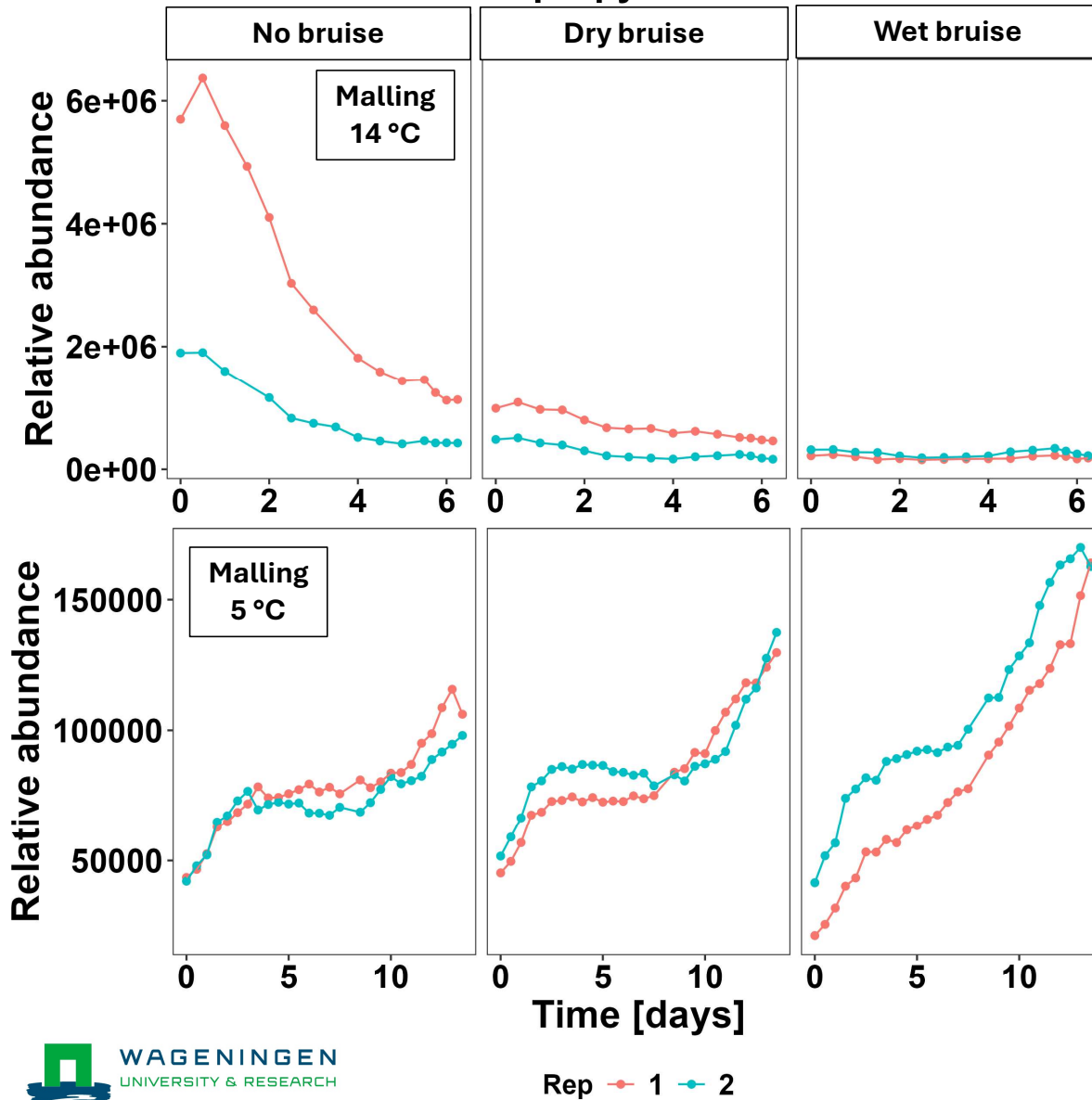
Isopropyl butyrate

Ester

Fruity aroma and flavor

- At 14 °C, higher initial values with **lower bruise severity**
- At 5 °C, higher initial values with **greater bruise severity**

Isopropyl acetate



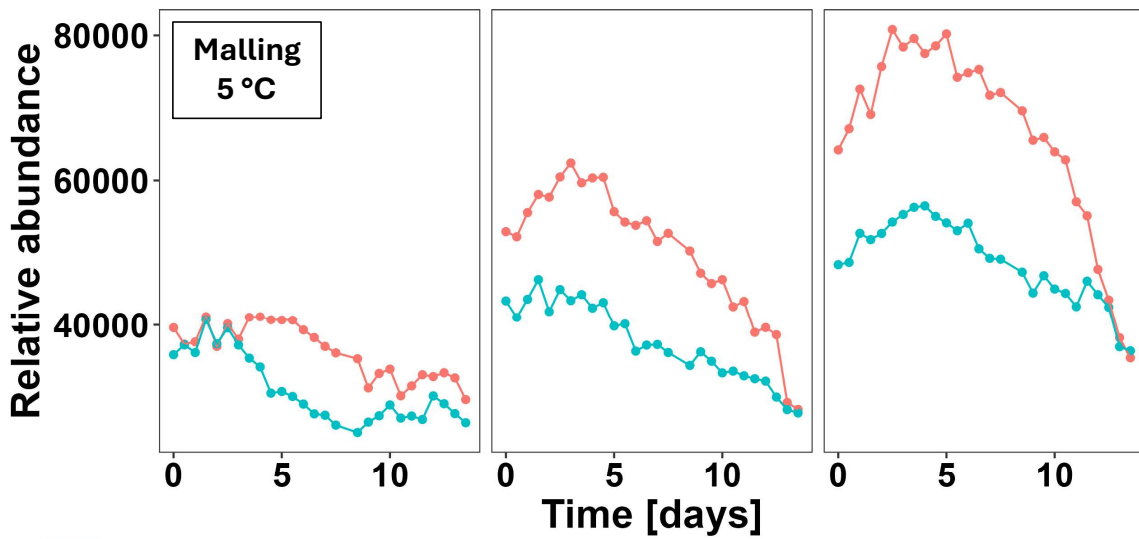
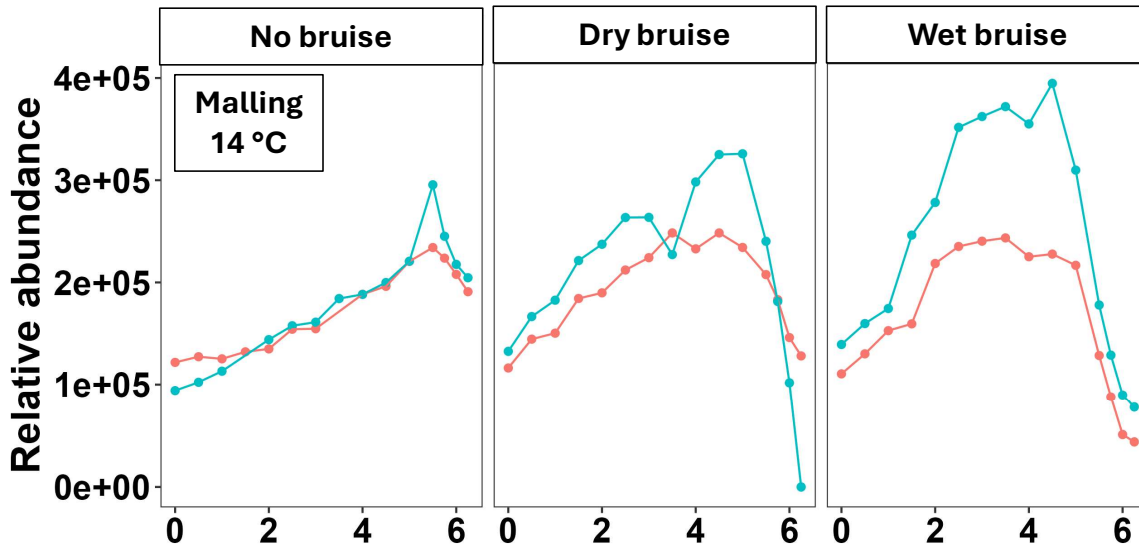
Isopropyl acetate

Ester

Fruity aroma

- At 5 and 14 °C, higher initial values with **lower bruise severity**
- At 5 °C, values increase faster over time with **greater bruise severity**

2-Pentanone



Time [days]

Rep — 1 — 2

2-Pentanone

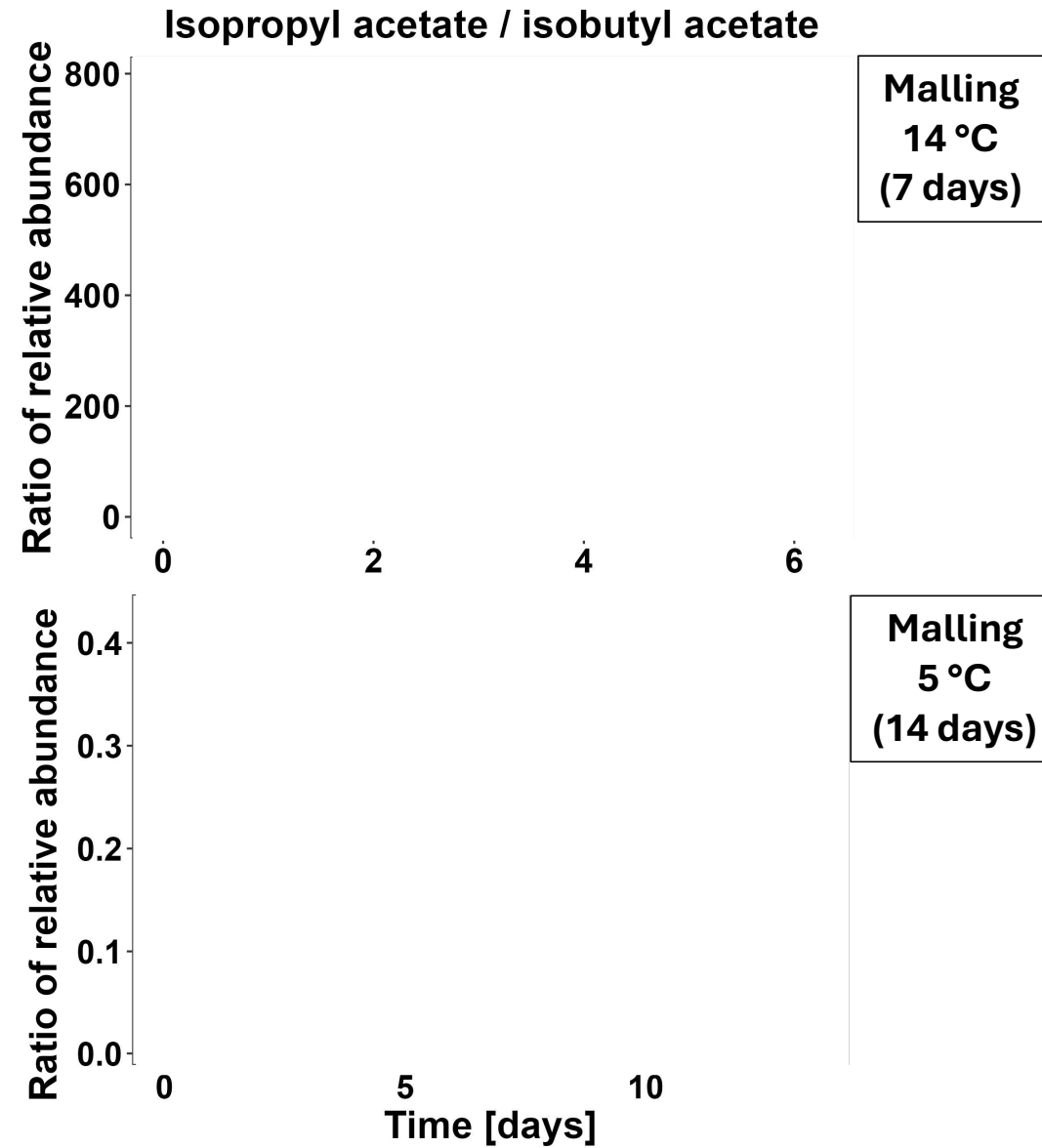
Ketone

Fruity aroma and flavor

- At 14 °C, peaks advance faster at **greater bruise severity**
- At 5 °C, higher initial values with **greater bruise severity**

VOC ratio

isopropyl acetate / isobutyl acetate



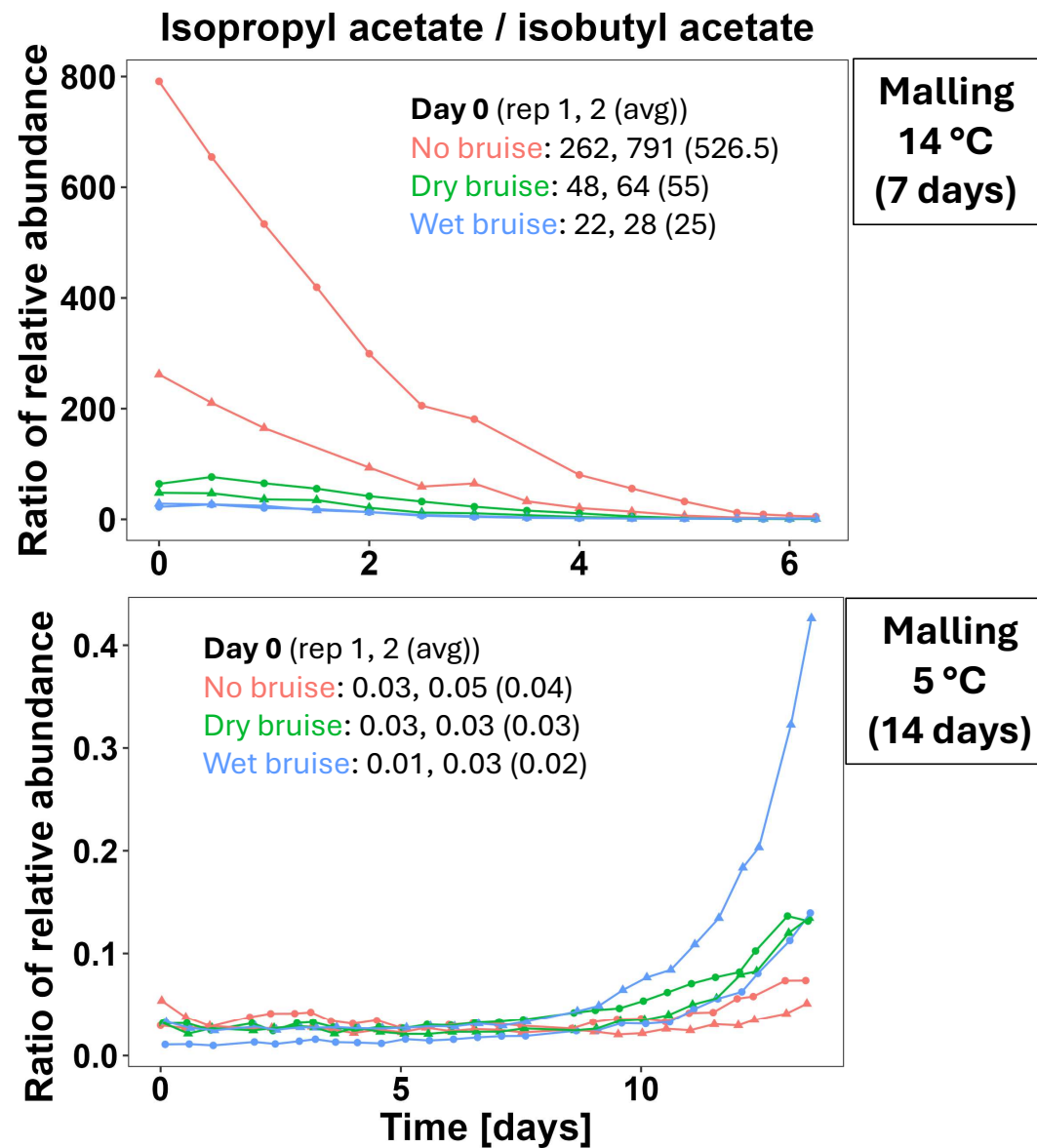
Bruise level • None • Dry • Wet Replication • 1¹⁸ • 2

VOC ratio

isopropyl acetate / isobutyl acetate

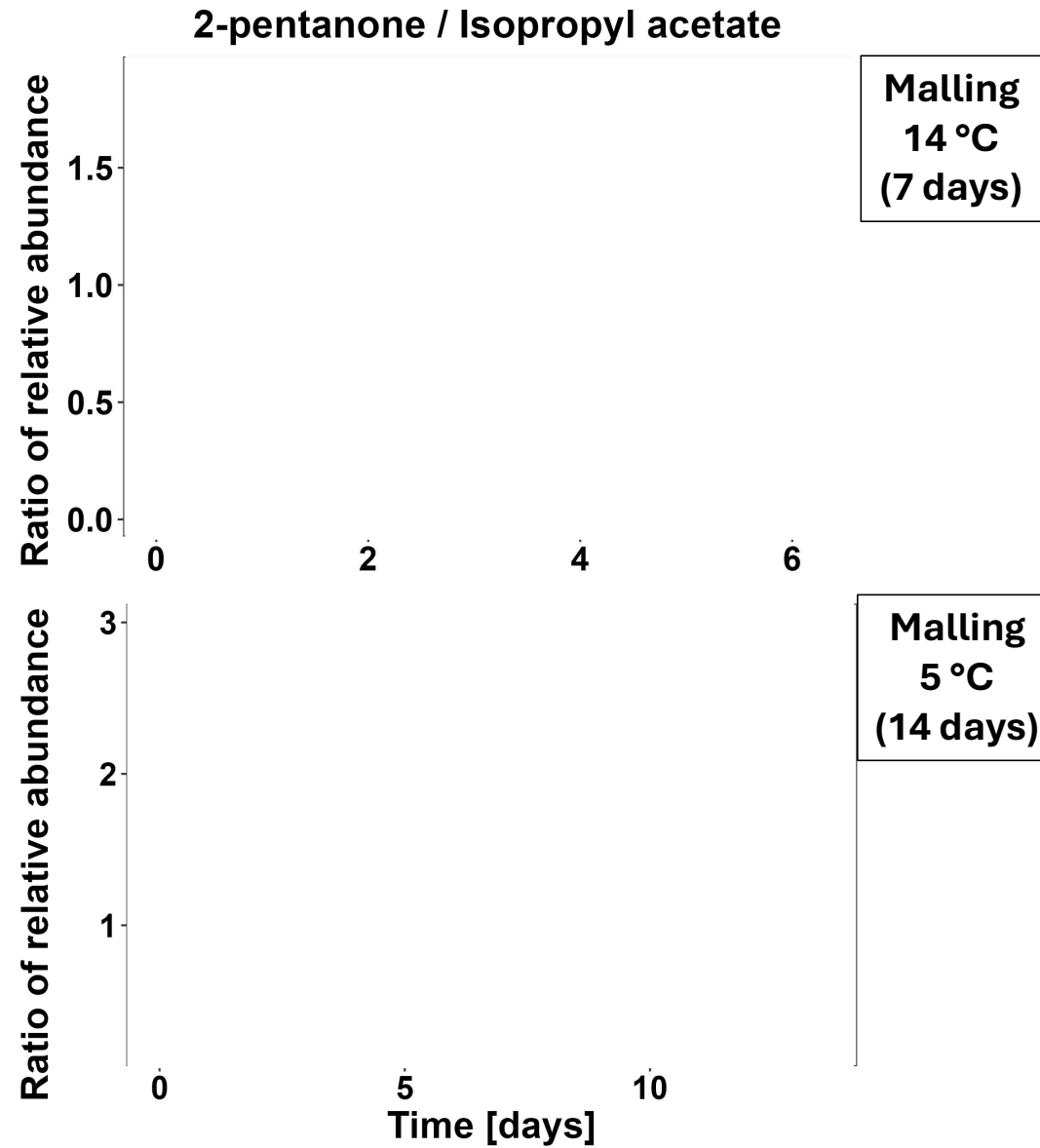
At 14 °C storage, the **no bruise** group was **9.5 and 21x higher** than **dry bruise** and **wet bruise** groups, respectively.

There was no clear signal at 5 °C storage.



VOC ratio

2-pentanone / isopropyl acetate

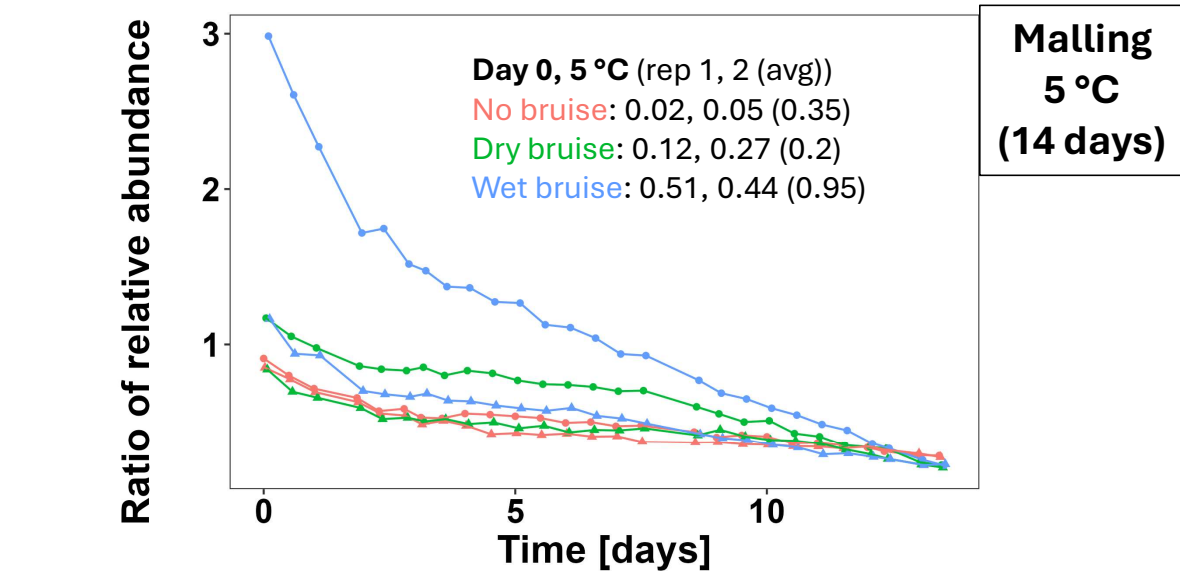
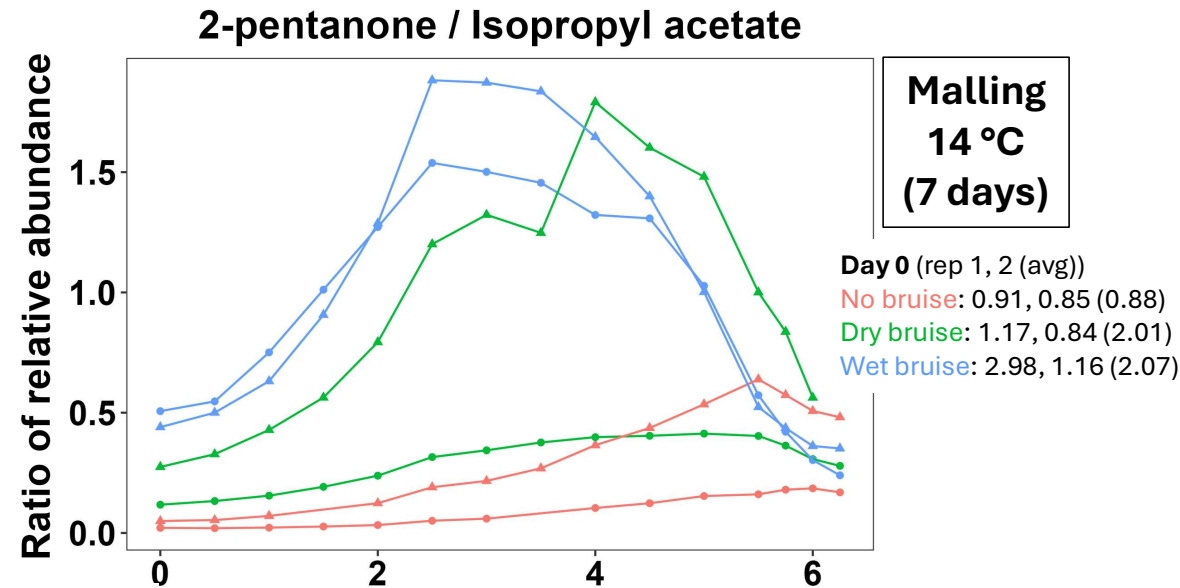


VOC ratio

2-pentanone / isopropyl acetate

At 14 °C storage, the **no bruise** group was **~2.3x lower** than the **dry bruise** and **wet bruise** groups.

At 5 °C storage, the **no bruise** and **dry bruise** groups were **2.7-4.8x lower ratio** than the **wet bruise** group, respectively.



Bruise level — None — Dry — Wet Replication • 1 ▲ 2 121

Summary & next steps

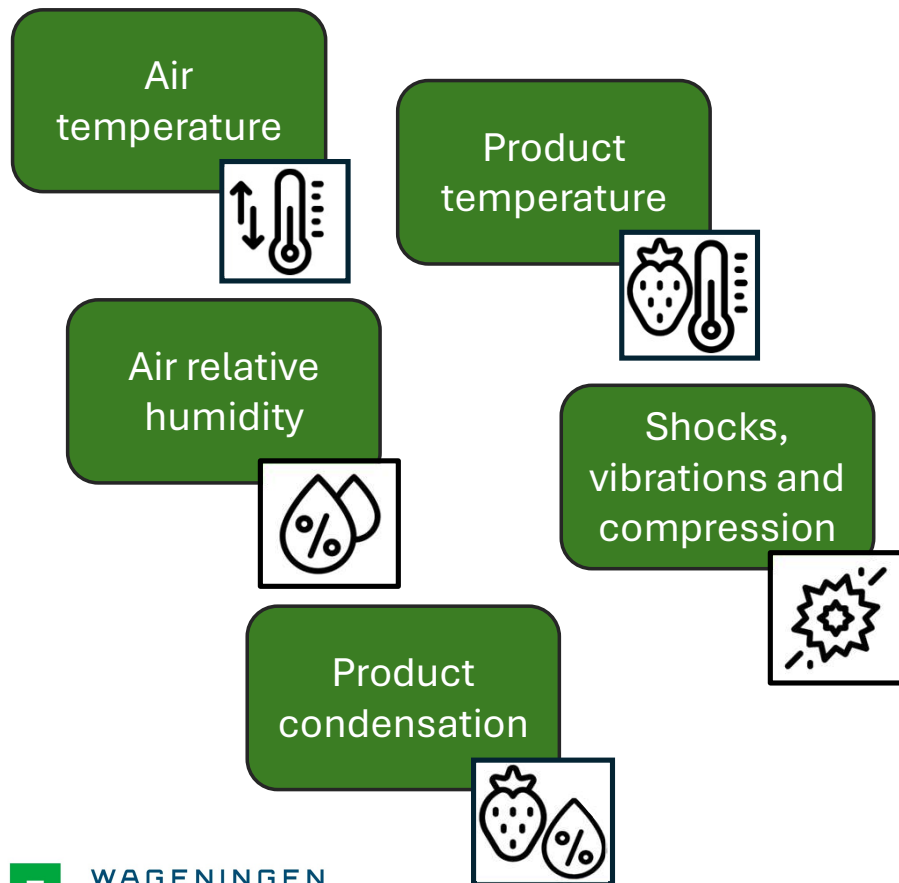
- **VOCs show promise as early indicators of bruise severity**
 - **Candidate early VOC and VOC ratios:**
 - Isopropyl butyrate
 - Isopropyl acetate/ isobutyl acetate
 - 2-pentanone / isopropyl acetate
- Investigate other individual VOCs indicative of initial quality
- Investigate ratios consistent among both varieties and storage conditions (5 and 14 °C)

Multiparameter sensing in the postharvest strawberry supply chain

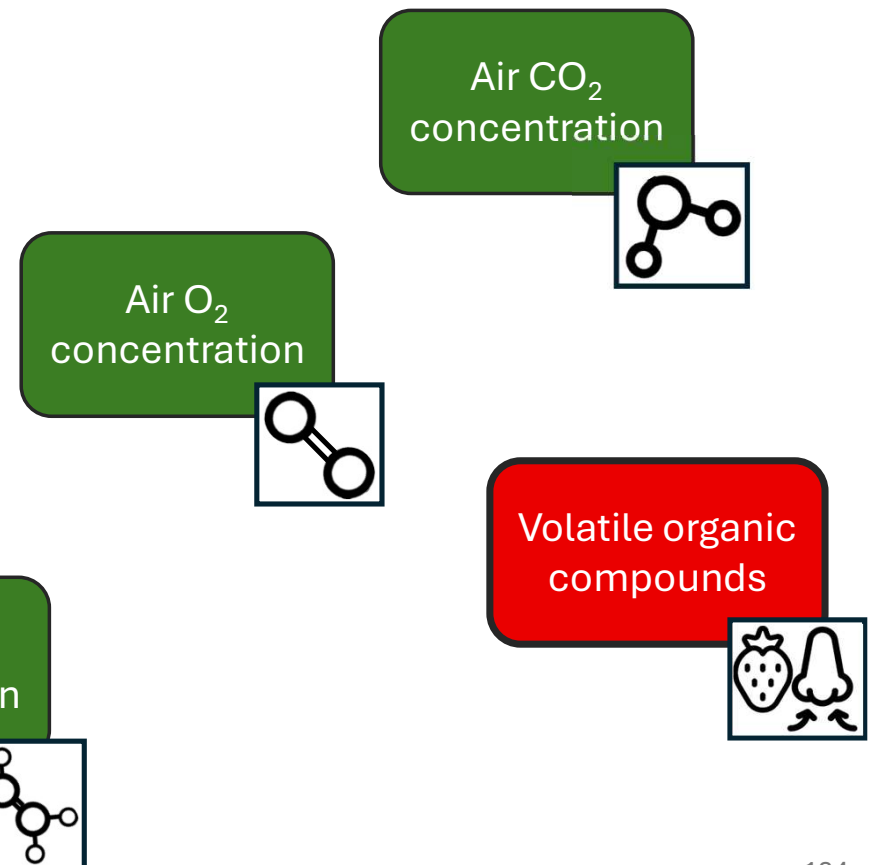
Multiparameter sensing in the postharvest strawberry supply chain

From farm to retail, quantitative parameters can

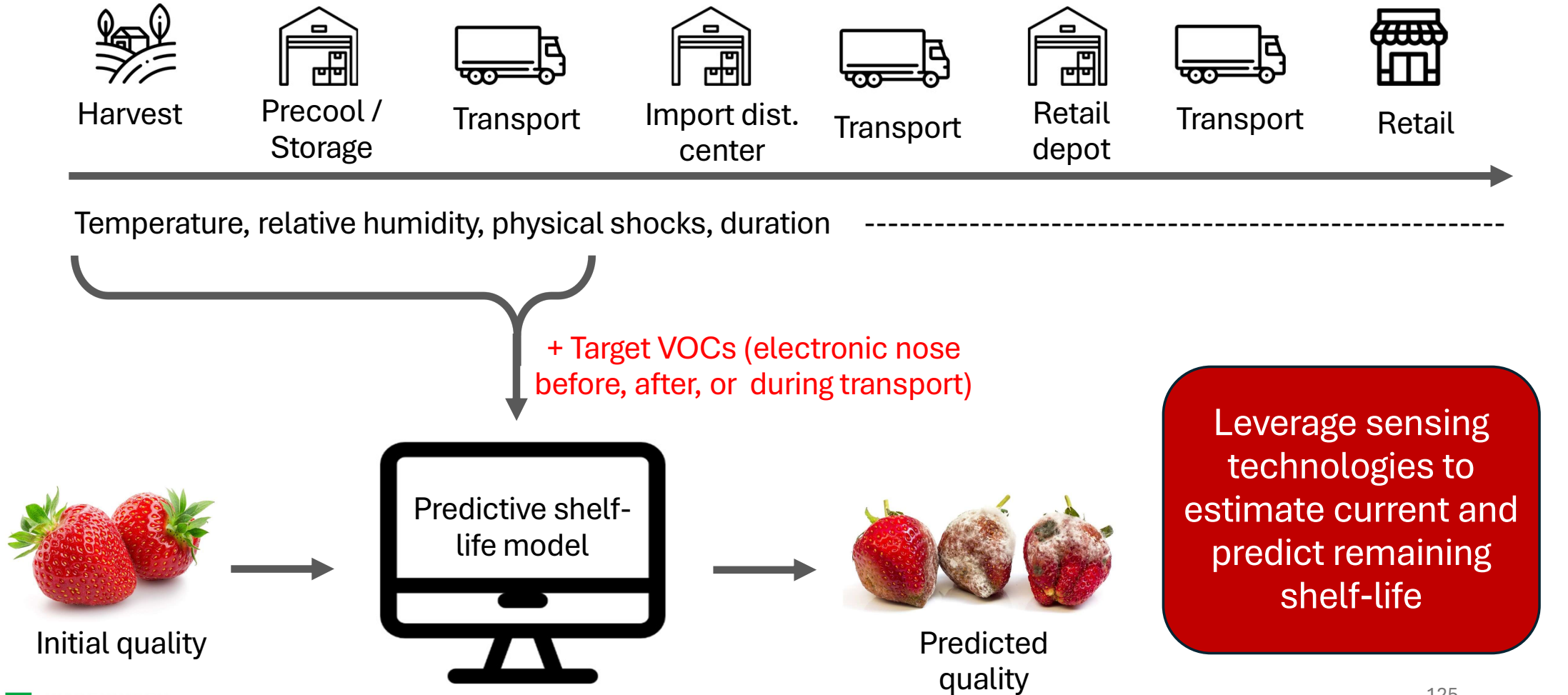
influence quality

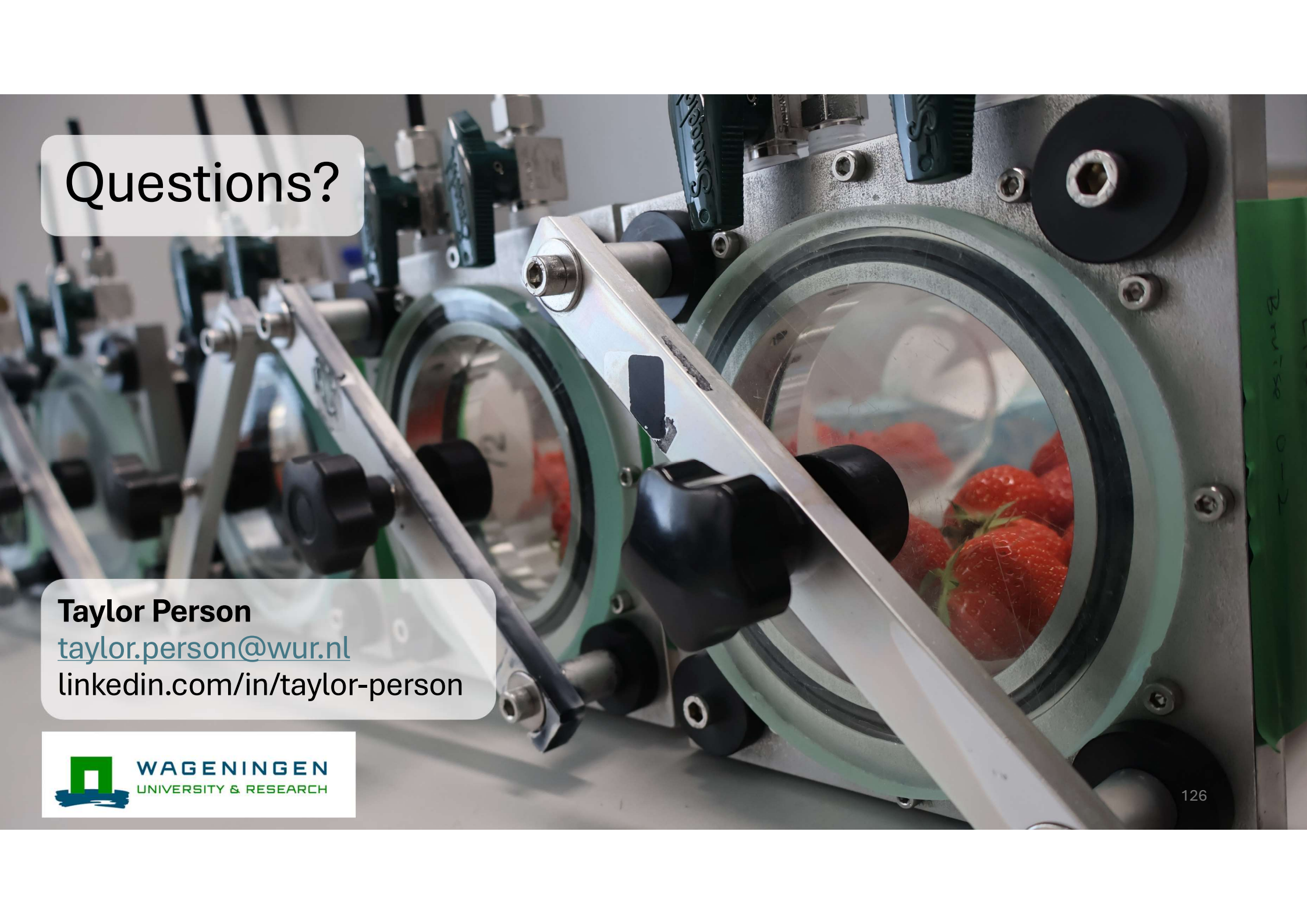


indicate quality



Application in the postharvest supply chain





Questions?

Taylor Person

taylor.person@wur.nl

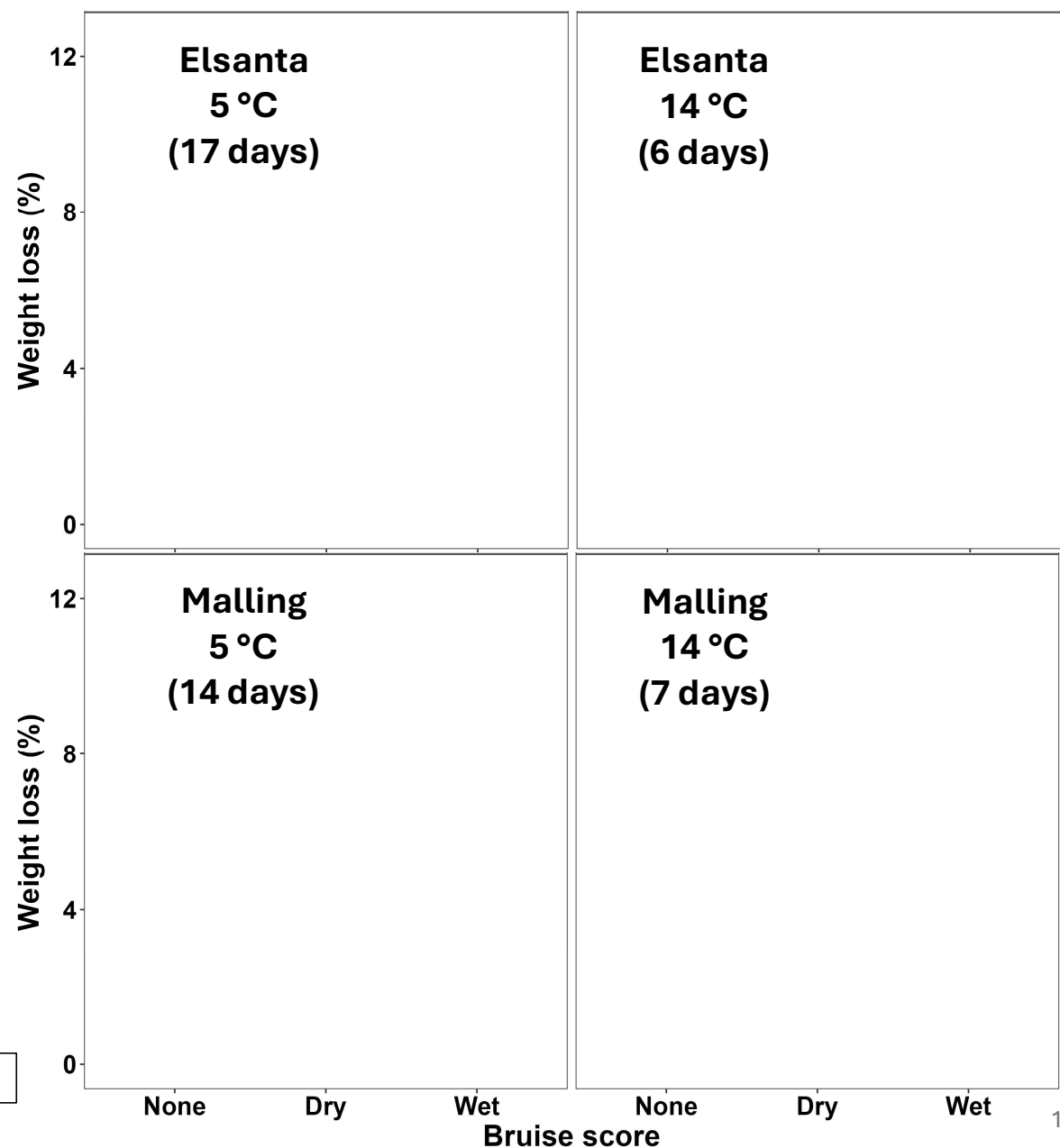
[linkedin.com/in/taylor-person](https://www.linkedin.com/in/taylor-person)



WAGENINGEN
UNIVERSITY & RESEARCH

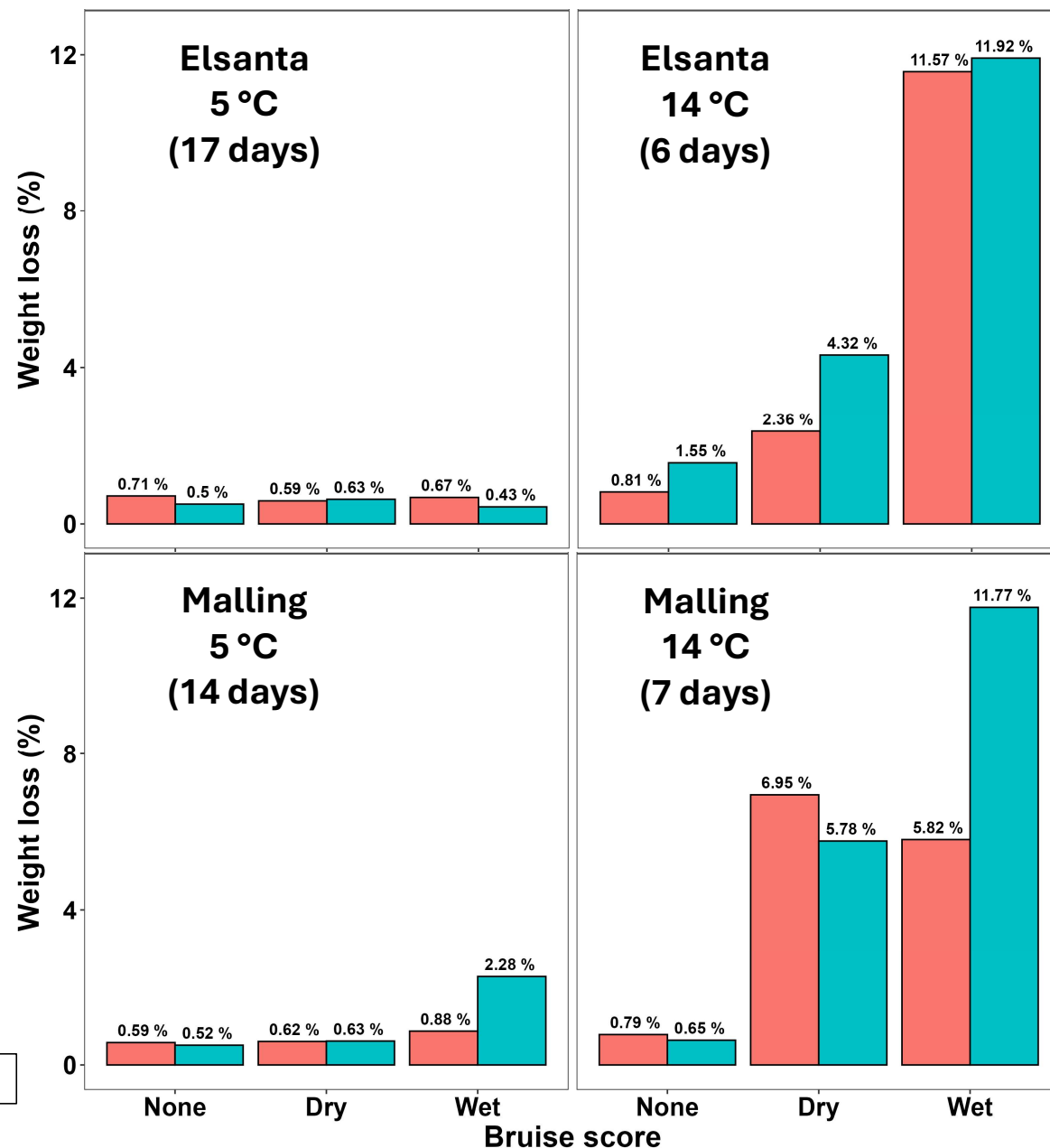
Weight loss

- Percent weight loss calculated from initial (day 0) and final timepoints.

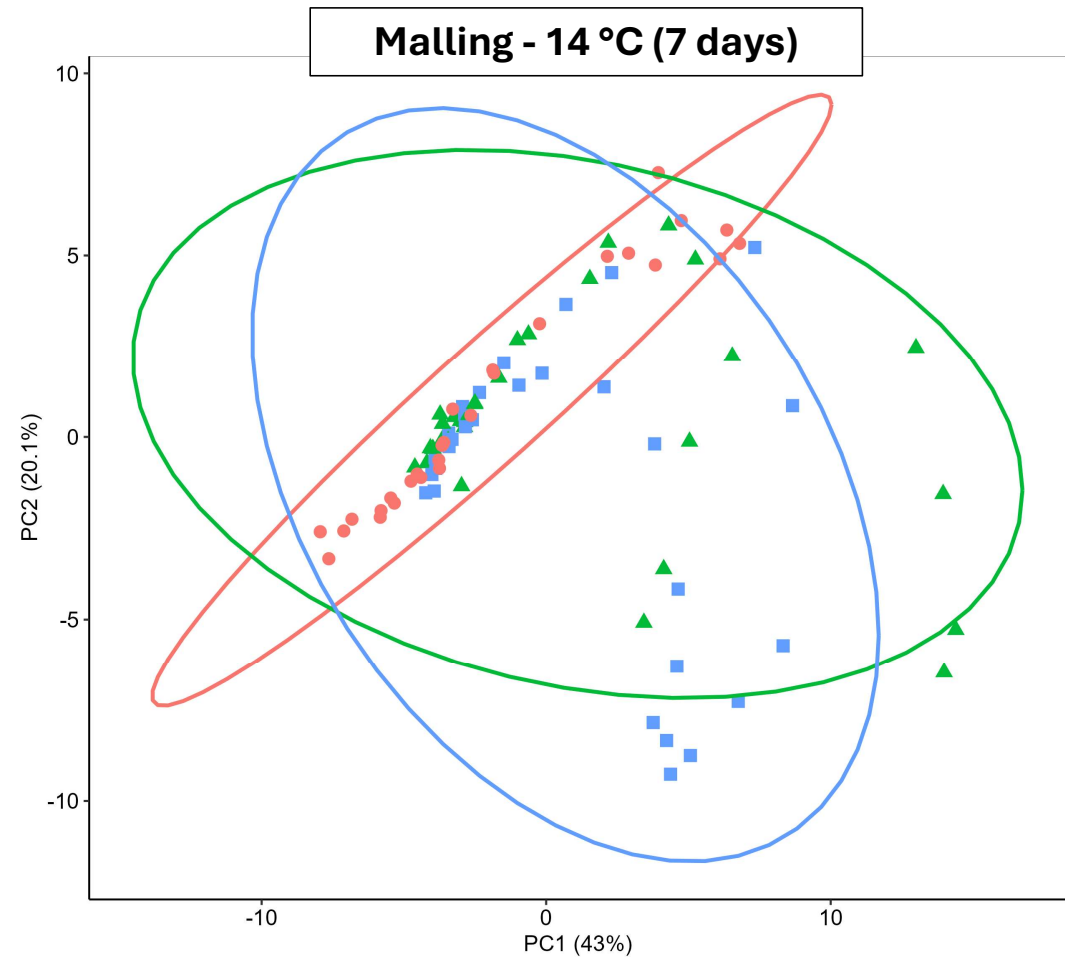
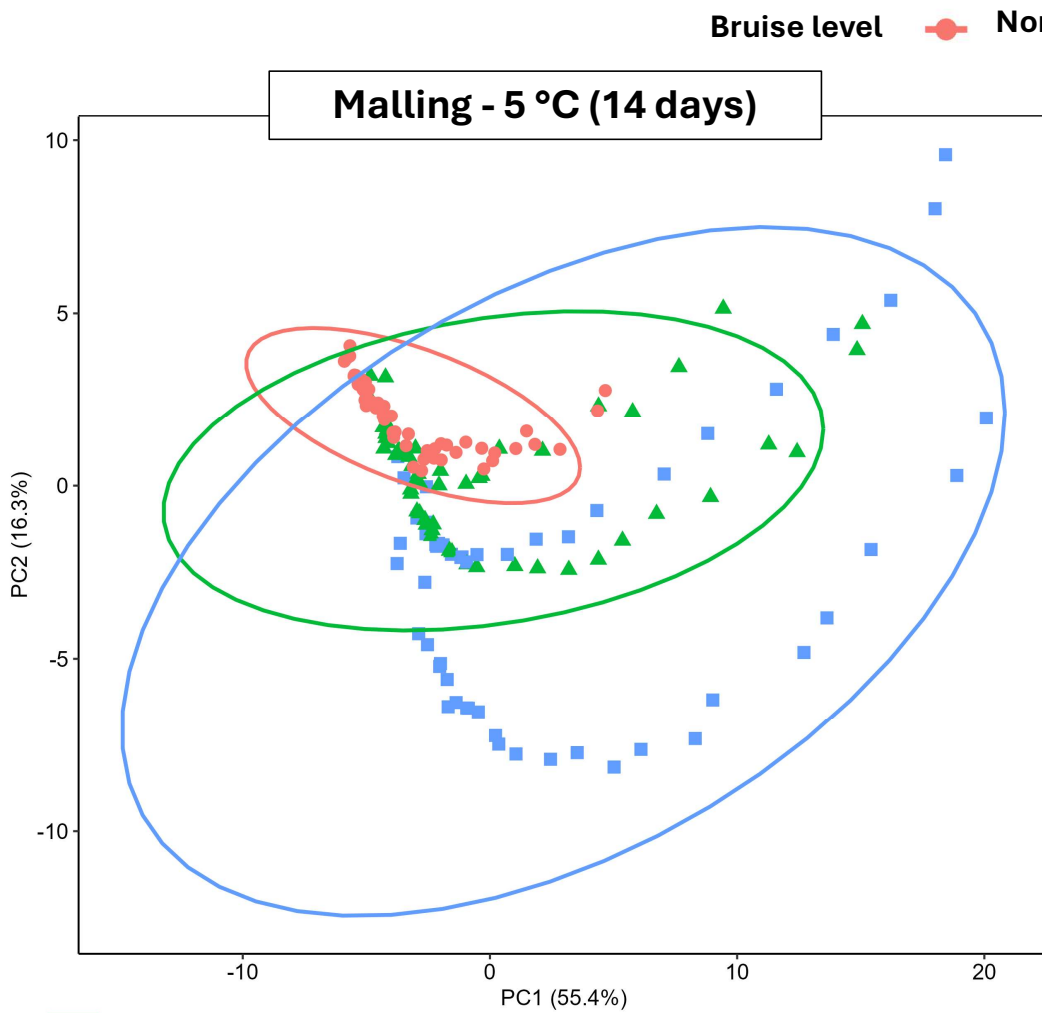


Weight loss

- Weight loss was comparable between cultivars
- Weight loss was greater with **higher with greater bruise scores at 14 °C**, but consistently low at 5 °C



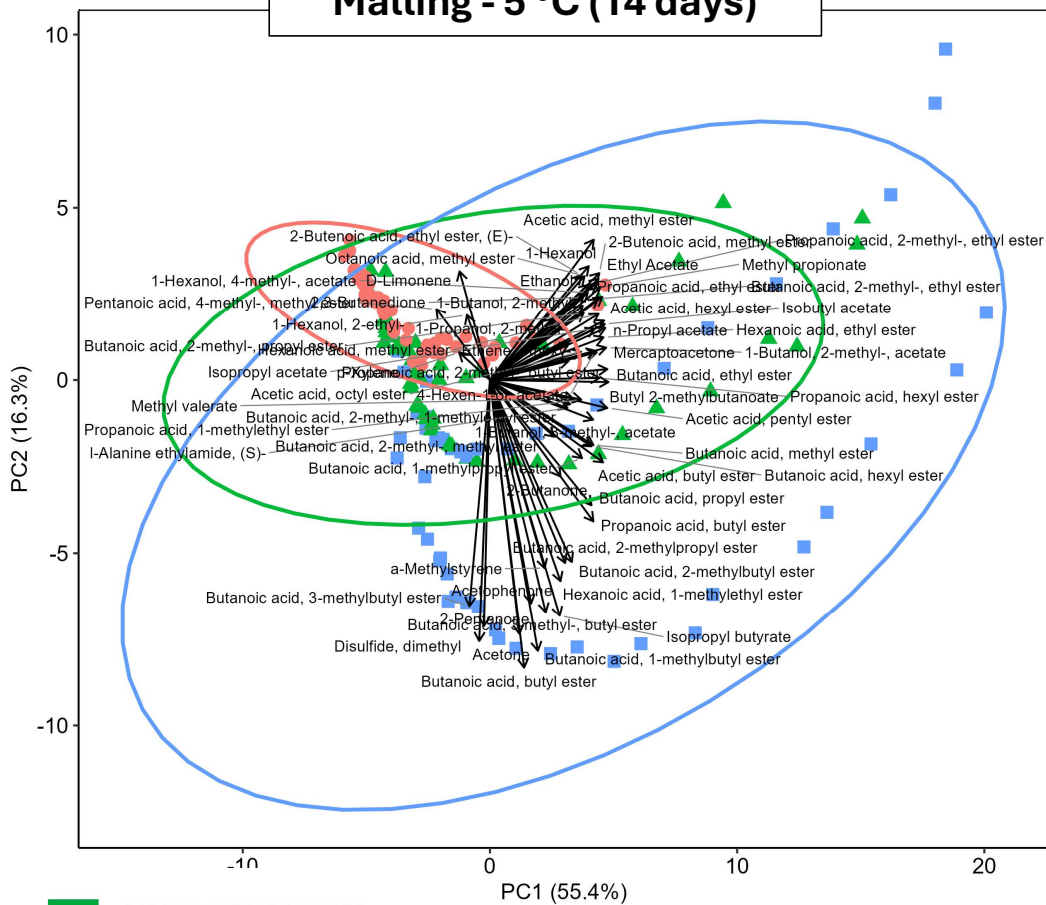
Principal Component Analysis (PCA)



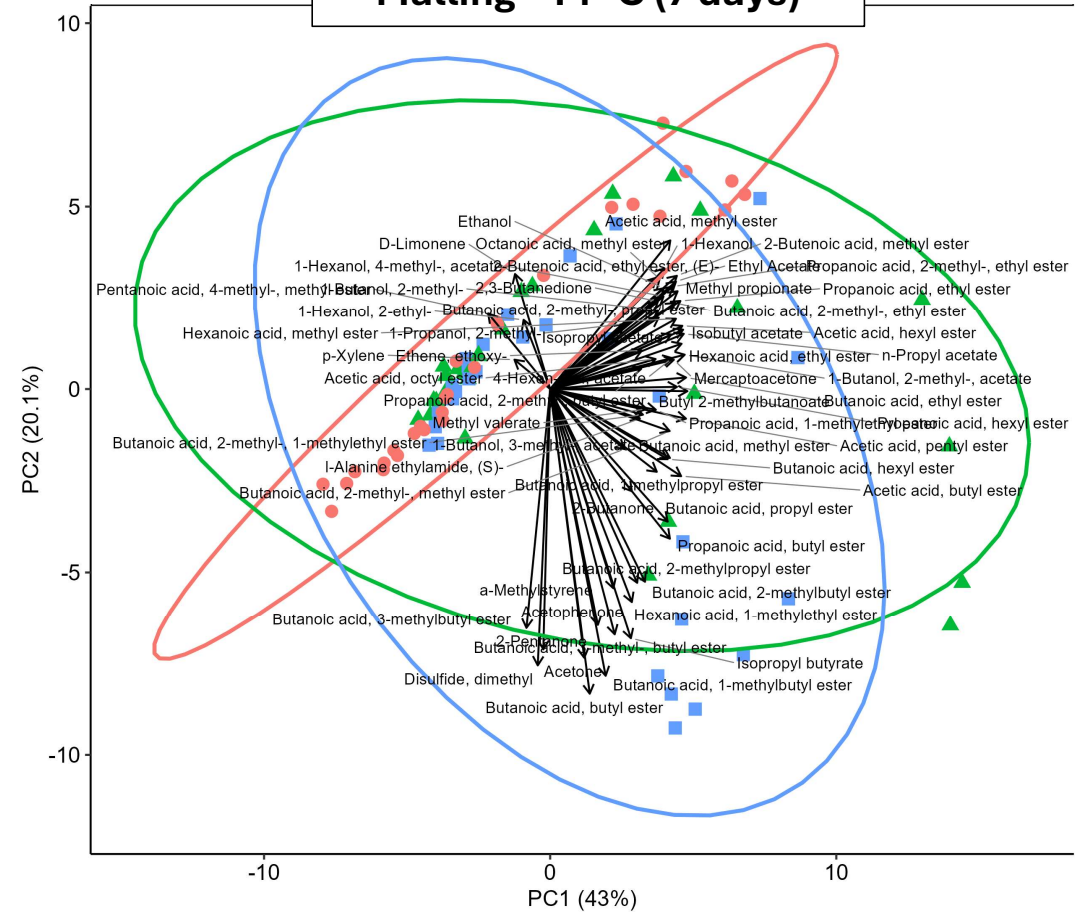
Principal Component Analysis (PCA)

Bruise level ● None ▲ Dry ■ Wet

Malling - 5 °C (14 days)

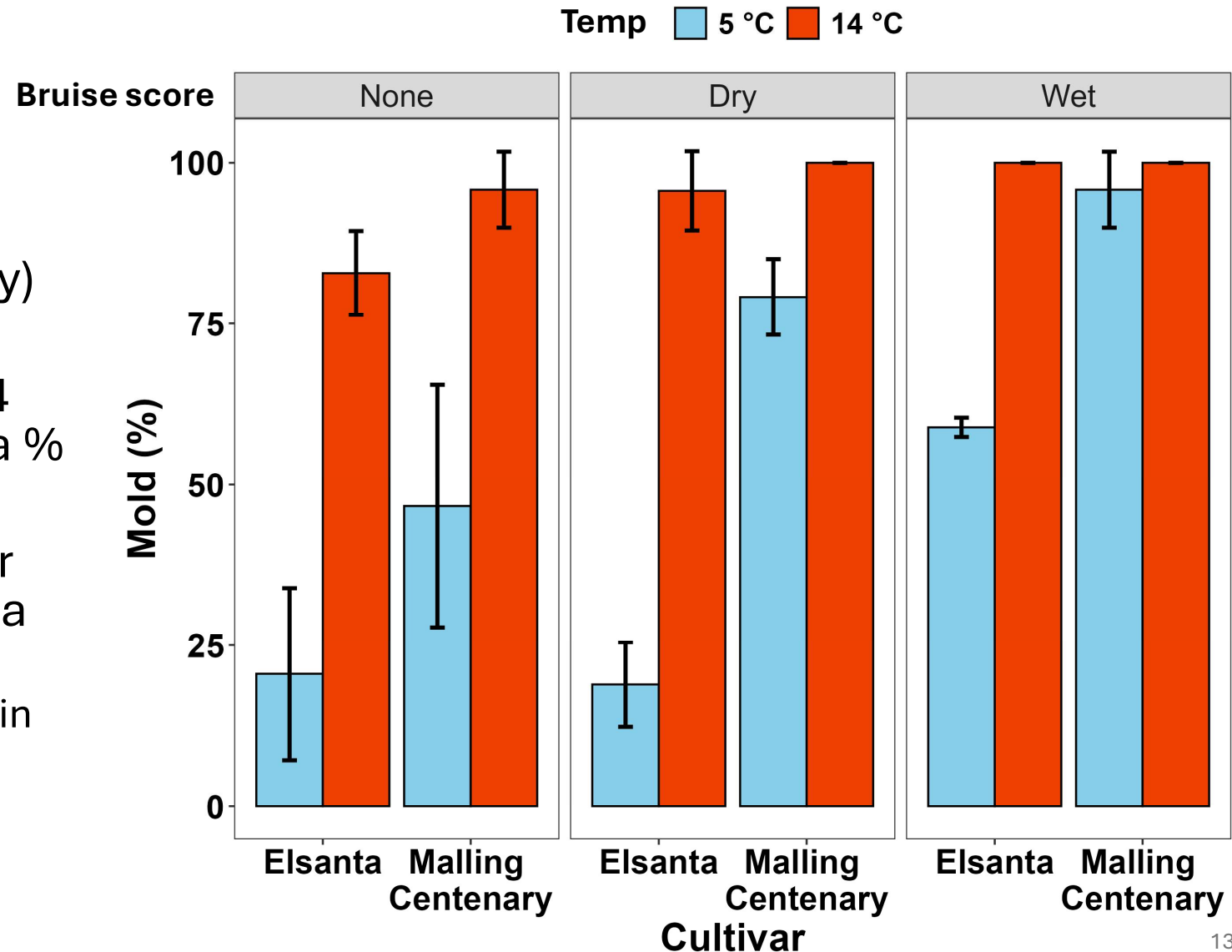


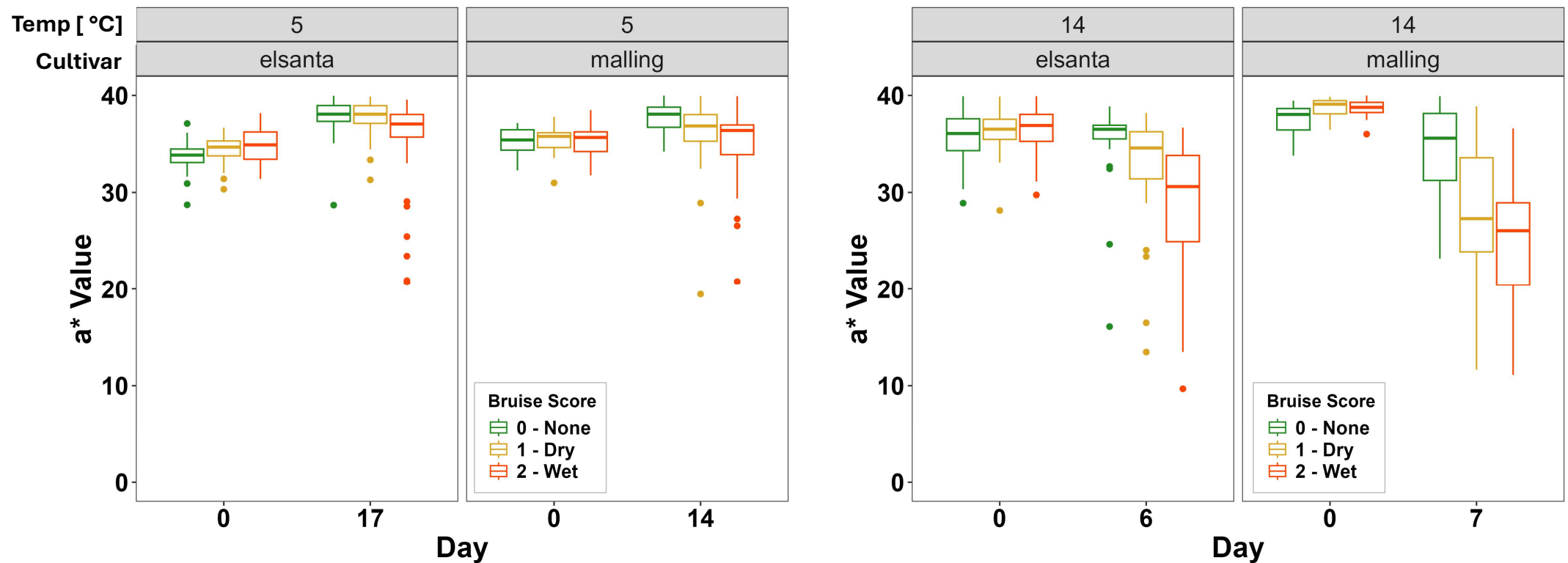
Malling - 14 °C (7 days)



Mold

- **Mold score was lowest** (<25%) for **Elsanta** with bruise 0 (none) and 1 (dry)
- >75% mold present in strawberries stored at 14 °C for 6 & 7 days (Elsanta % Malling C.)
- Malling C. showed higher bruise levels than Elsanta after storage in 5 °C.
 - Greater harvest maturity in Malling?





Color

- Reduction in a^* (darkening, loss of bright red)
- Reduction in a^* with increasing bruise score was observed in both varieties at warmer temperatures.
- **Higher temperature accelerates color change as a function of bruise severity, while colder temperature minimizes color loss**



**5TH INTERNATIONAL
STRAWBERRY CONGRESS**

Thursday

Networking Break

- Sponsors & Exhibitors Fair
- Poster Sessions

Sponsored by

