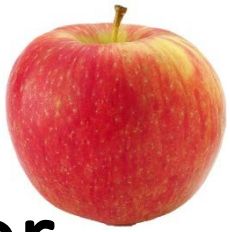

The DA meter – a magic bullet for harvest decisions, or just hype?

Chris Watkins

Cornell University, Ithaca, NY

DA Meter Assessment of Apple Maturity: Myths, Realities and Challenges

- “There has been much hype about maturity assessment of tree fruit using the DA meter developed at the University of Bolgna, Italay and distributed by T.R. Turoni S.L.R.”

Peter Toivonen, 2014.
Orchard network, Ontario,
Canada, 18 (4): 10-11.

The collective research of

Franny Doerflinger

Yosef Al-Shoffe

Jackie Nock

Shao Xingfeng

Kazem Arzani

Colleagues

- Peter Toivonen
- Jennifer DeEll
- Ines Hanrahan
- 'Mimmo' Costa

With funding from

- **NY Apple Research and Development Program**
- **USDA-NIFA**
- **AgroFresh**

And assistance from AgroFresh team responsible for Harvista trials
Nate Reed
Fernando Edagi
Ken Silsby
Keith Culver

Outline

- What is the DA meter?
- Why are we interested, and what are the criteria for evaluation?
- Results
- Conclusions

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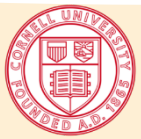


I_{AD} measurements with the DA meter

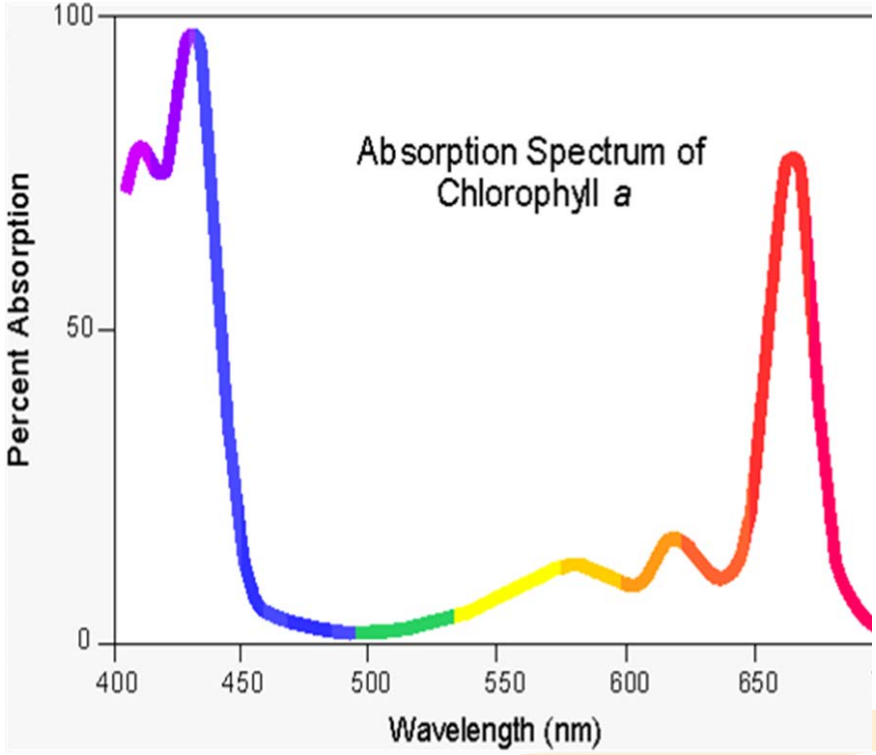
- Delta Absorbance (DA) meter
  - Hand held non-destructive measurement
  - Developed from vis/NIR spectroscopy
  - Difference of Absorbance (DA or I_{AD}) between 670 and 720nm

Absorbance measurement principles

I_{AD} measurement:

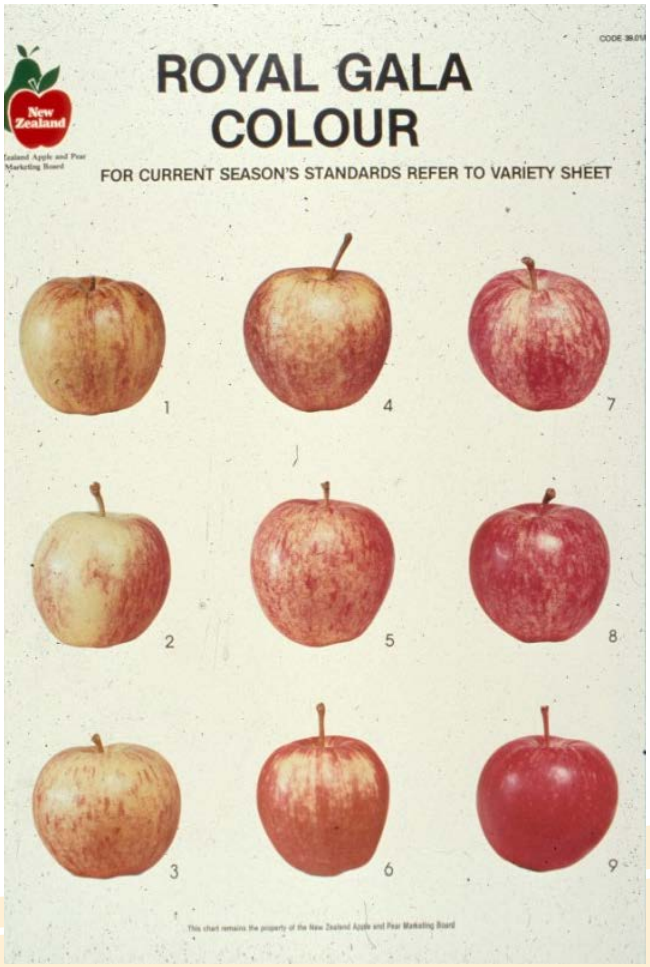
- Chlorophyll *a* peaks at ~ 660 nm
- I_{AD} measures Chlorophyll *a* in the peel

  I_{AD} = Abs (670 nm) – Abs (720 nm)



http://www.umich.edu/~chem125/softchalk/Exp2_Final_2/Exp2_Final_2_print.html

Essentially an electronic color chart that provides an index representing Chlorophyll a concentrations



But DA meter is not limited by red coloration of fruit

DA meter provides readings in the range of 0 to 3.0 for apple fruit

Field use?

Courtesy of Ines Hanrahan,

Washington Tree Fruit Research Commission

Courtesy of Peter Toivonen,

Agriculture and Food Canada, BC

Outline

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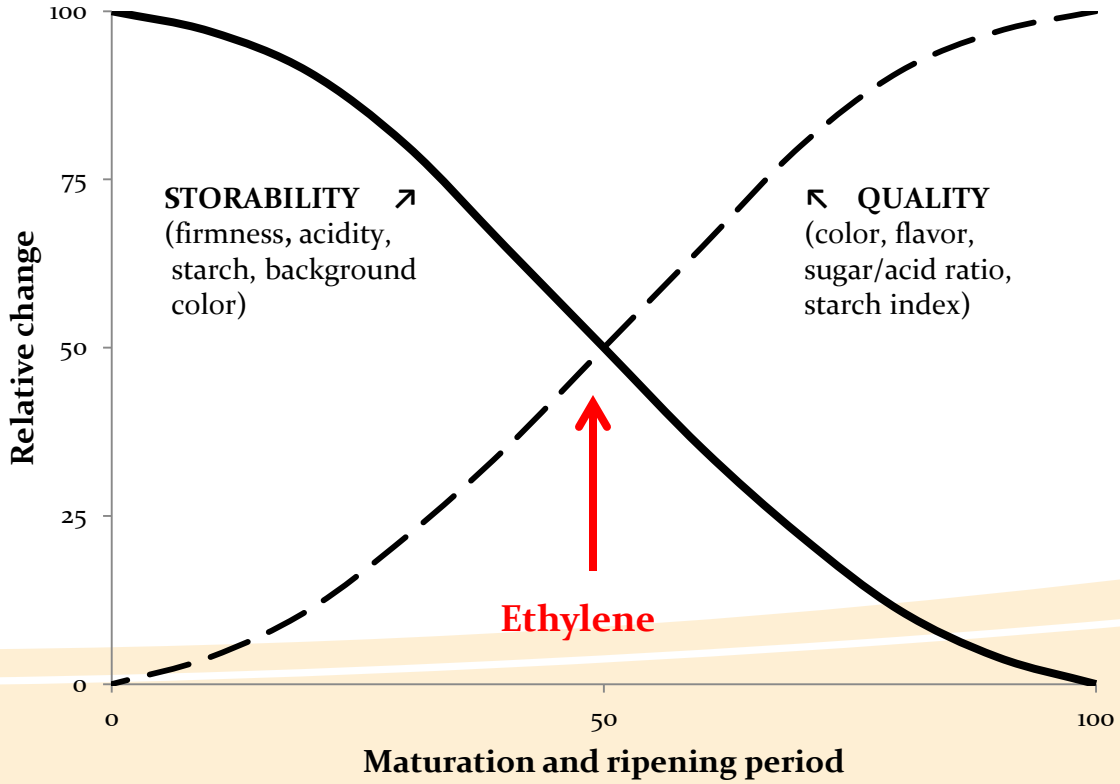
Why are we interested?

Harvest date is critical to quality of fruit in the market place, and often associated with storage disorder issues



Current tools to assess “Maturity” (Harvest indices)

Maturity indices

- **Internal ethylene concentration (IEC)**
- Starch pattern index (SPI)

Where does the DA meter fit in?

Quality indices

- Firmness
- Soluble solids concentration
- Acidity
- Red coloration
- (background color/ground color)

Recent published research on the DA meter for apple fruit - examples

- I_{AD} values at harvest and after storage correlated with firmness, SSC and TA of 'Red Delicious', 'Granny Smith' and 'Pink Lady' – potential to sort fruit at harvest and after storage for different marketing classes (Nyasordzi et al., 2013).
- I_{AD} values do not relate to storage quality (other than chlorophyll) in fruit stored in CA or treated with 1-MCP (Toivonen and Hampson, 2014)
- I_{AD} values of 0.59 to 0.36 proposed as 'start' and 'finish' dates for long term air stored 'Honeycrisp' apples (DeLong et al., 2014).

With courtesy of John Delong

Honeycrisp DA meter model steps:

i) Measure fruit quality attributes ‘at harvest’ [including DA meter readings(I_{AD})];

ii) Store 38^{o}F for 3-4 months;

iii) Assess disorder incidence after removal;

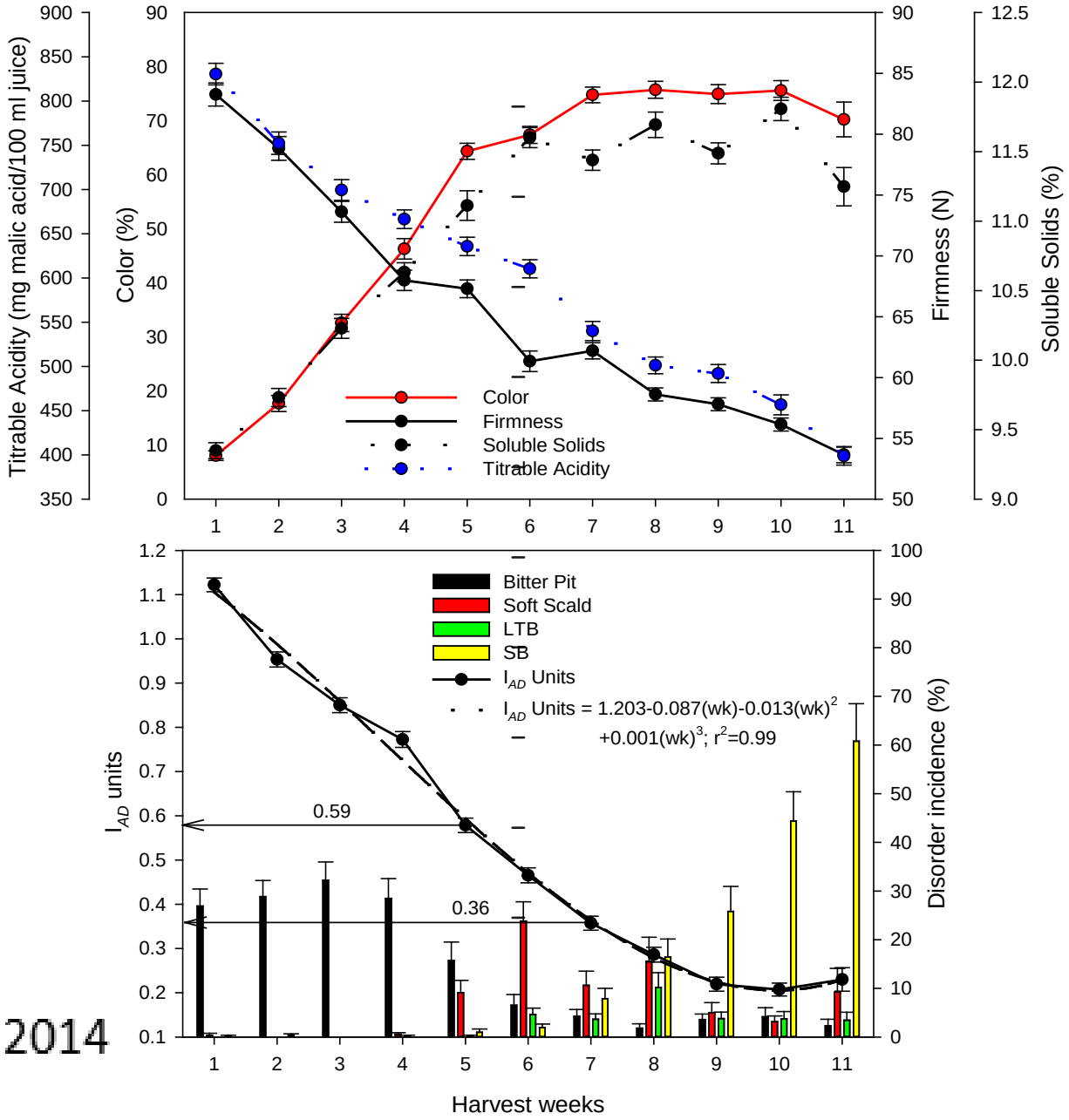
iv) Optimal harvest window = period having high quality attributes (at harvest),

and fewest disorders (post-harvest);

v) Optimal harvest window delineated in DA meter units.

(Note: usually a 2-week period)

2010-2012 Honeycrisp Quality, I_{AD} & Disorder Data



DeLong et al., 2014

Honeycrisp Harvest Maturity conclusions for Nova Scotia (John DeLong et al.)

DA meter model message:

As the Honeycrisp reading:

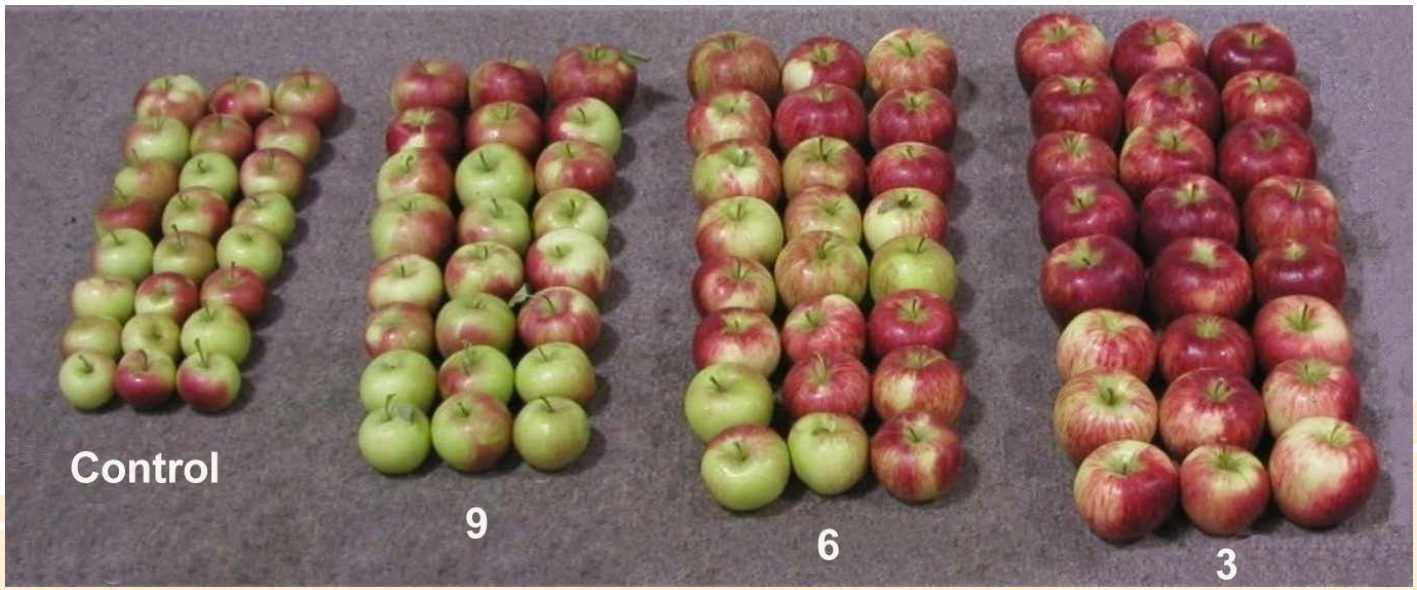
i) ≤ 0.60 ➡ begin harvest

i) Between 0.60 and 0.35 ➡ good for long-term storage

ii) <0.35 ➡ sell first. No long-term storage

Ignored admonitions from DeLong et al. (2014)

- **Develop for each cultivar**
- **Several years research required**
- **Regionally based**



Fruit per cm^{-2} TCSA

Why region is important

- Excellent color development in Nova Scotia
- Different maturity profiles allowing more concentrated harvest dates
  - 3-4 harvests not uncommon in NY
- Different disorder development profiles
  - Stippen (on tree pit appears more problematic in NY)
  - Depending on region and growing season we have much greater concern about soft scald and soggy breakdown

Honeycrisp separation by DA reading

Honeycrisp separation by DA reading

Our objectives

To evaluate the DA meter by determining the relationships between I_{AD} values and:

- Other harvest indices such as ethylene and starch indices
- Storability of fruit of different cultivars, especially incidence of physiological disorders
- Effects of preharvest factors such as Harvista and other plant growth regulators (PGRs)
  - Especially important in NYS

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Some of our studies

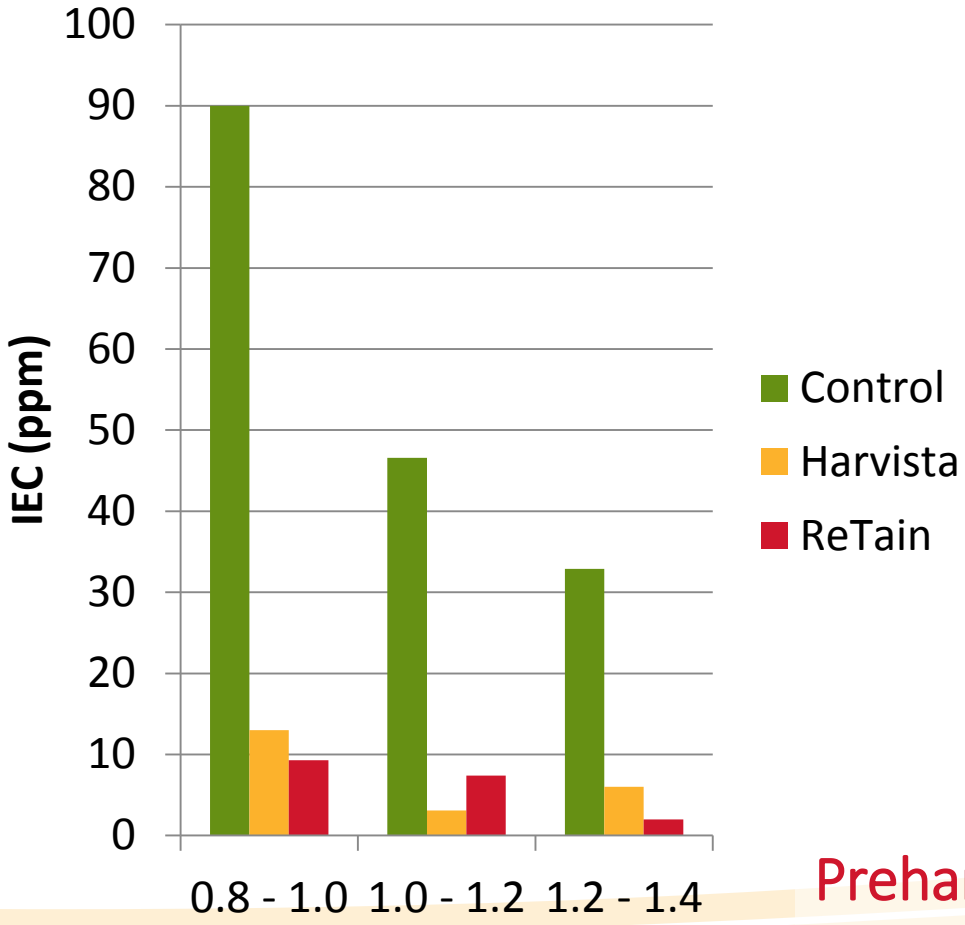
1. ‘Delicious’ apples untreated or treated with Harvista (preharvest 1-MCP) or ReTain (AVG) to investigate relationships between I_{AD} values, harvest indices and superficial scald (Arzani et al.)
2. ‘Honeycrisp’ apples untreated or treated with Harvista to investigate relationships between I_{AD} values and soft scald (Al-Shoffe et al.)
3. Relationships between I_{AD} values and harvest indices in Empire apple fruit (Doerflinger et al.)
4. Relationships between I_{AD} values and harvest indices in fruit of 9 apple cultivars (Shao et al.)

1. Delicious and superficial scald

- Replicate ‘Delicious’ trees untreated or sprayed with Harvista or ReTain (gift from Valent Biosciences)
- Fruit harvested and divided into categories based on DA meter readings
- Internal ethylene concentrations (IECs) measured and fruit stored for scald development

Only at harvest results today

I_{AD} values and internal ethylene concentrations (ppm) - Delicious



- Relationships between and I_{AD} values good for untreated fruit

  – lower I_{AD} values = riper fruit and higher IEC.

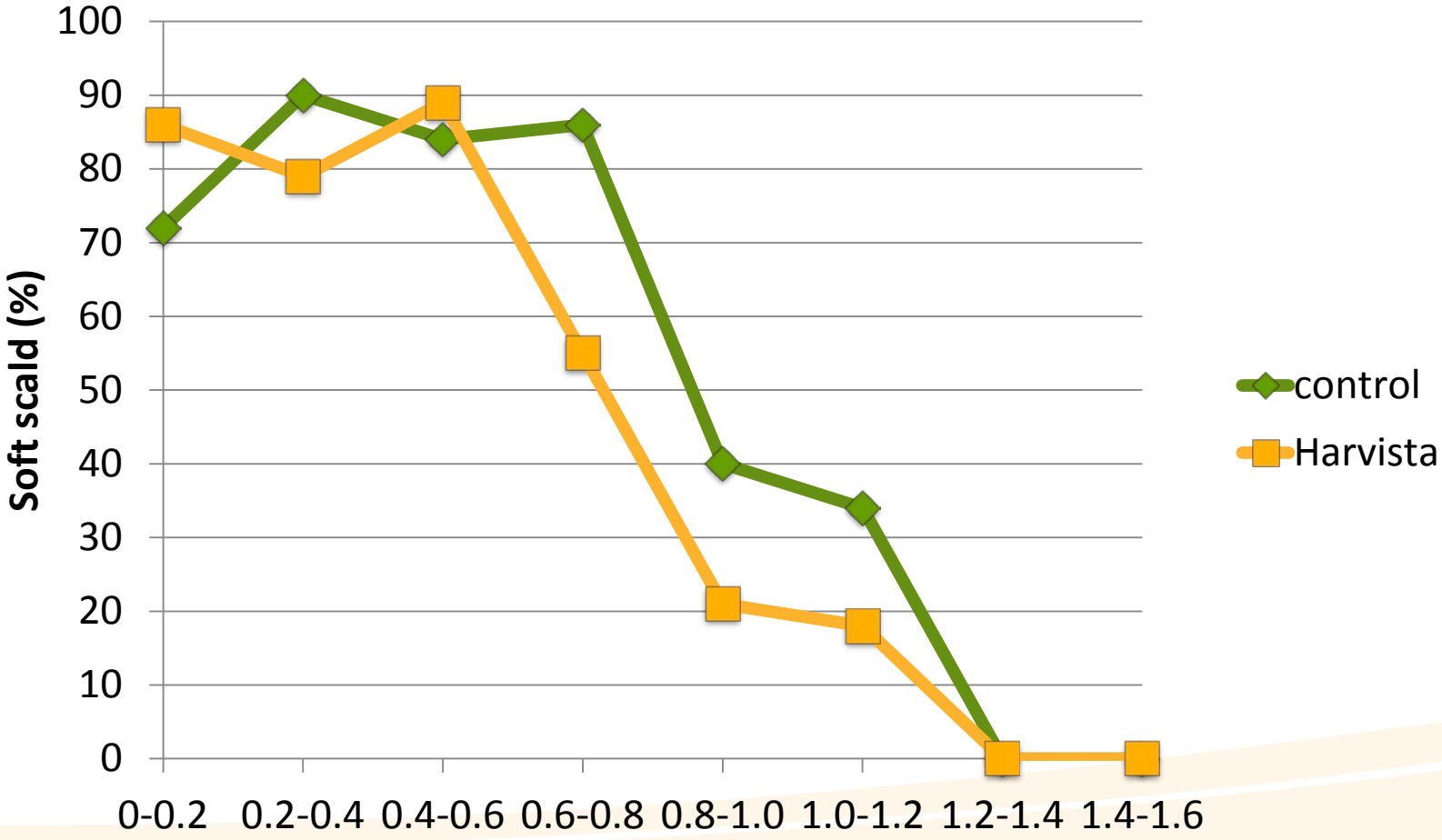
- Harvista and ReTain trts result in loss of relationship within an given I_{AD} value.

Preharvest factors such as PGR may interfere with interpretation of DA meter readings

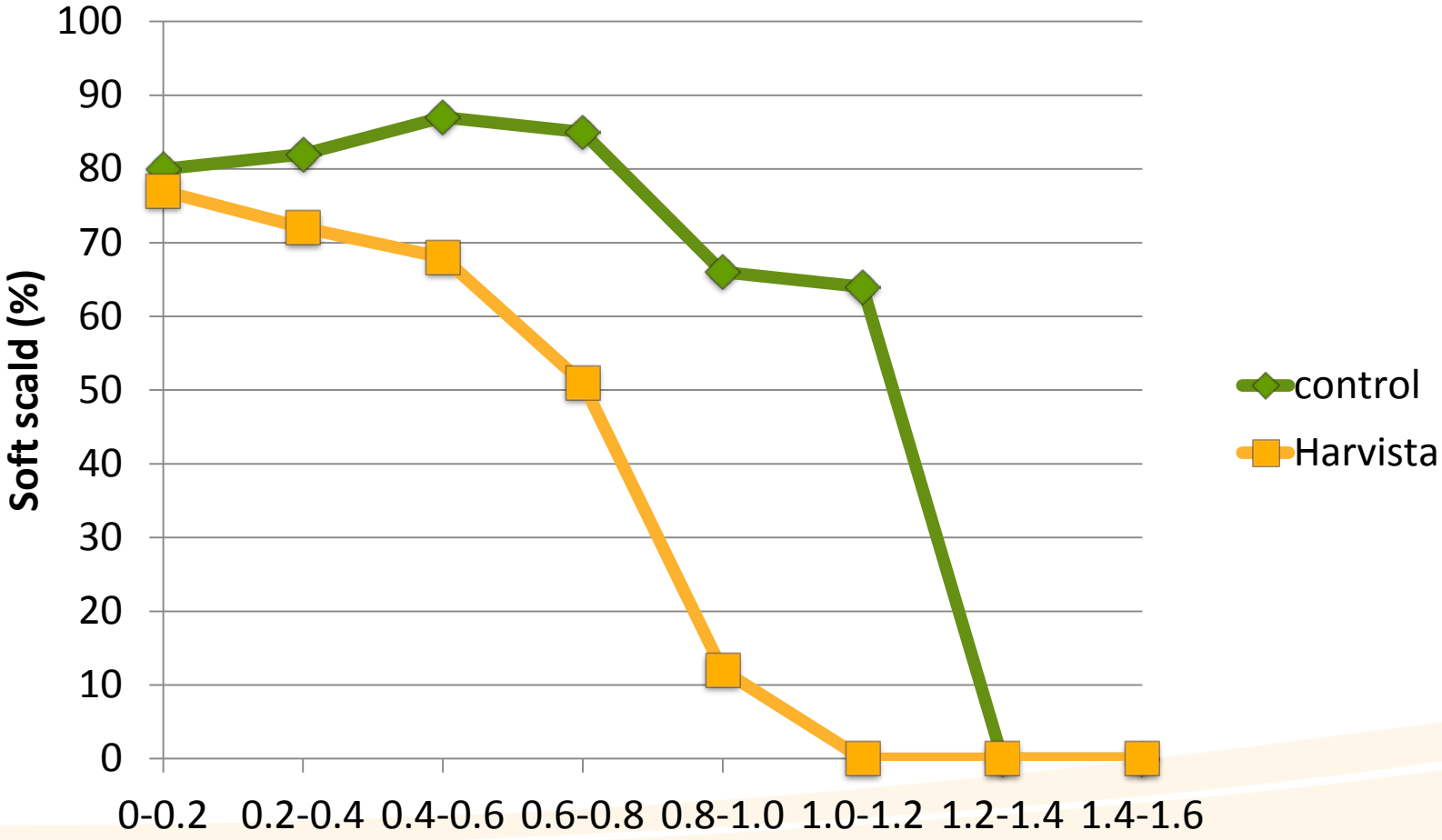
2. ‘Honeycrisp’ and soft scald incidence

- Replicate ‘Honeycrisp’ trees untreated or sprayed with Harvista
- Fruit harvested at three 1-week intervals and divided into categories based on DA meter readings
- Internal ethylene concentrations (IECs) measured and fruit stored at 33^{o}F for soft scald development

Soft scald (%) in Honeycrisp apples at different I_{AD} value categories: Harvest 1



Soft scald (%) in Honeycrisp apples at different I_{AD} value categories: Harvest 2



Summary

- Soft scald incidence is higher in less ripe fruit (lower I_{AD} values).
- Harvista can decrease soft scald development.
- However, relationship between disorder development and I_{AD} values can be dissociated by
  - Harvest date
  - a PGR such as Harvista.

Note - Commercial acceptability of fruit may over-ride decisions made on basis of I_{AD} values.

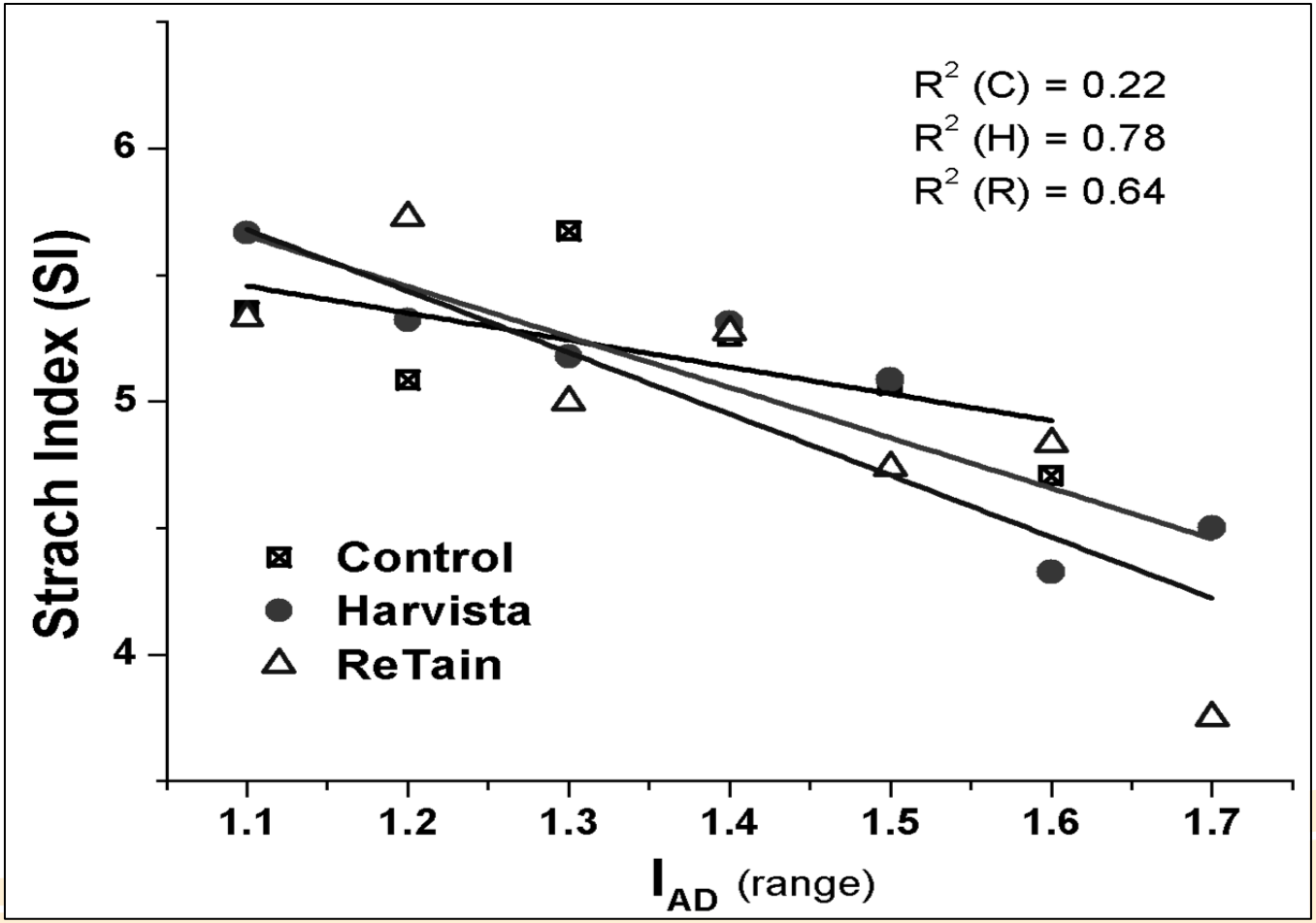
Honeycrisp separation by DA reading

Huge variation among standards now. How will these change for long term CA storage?

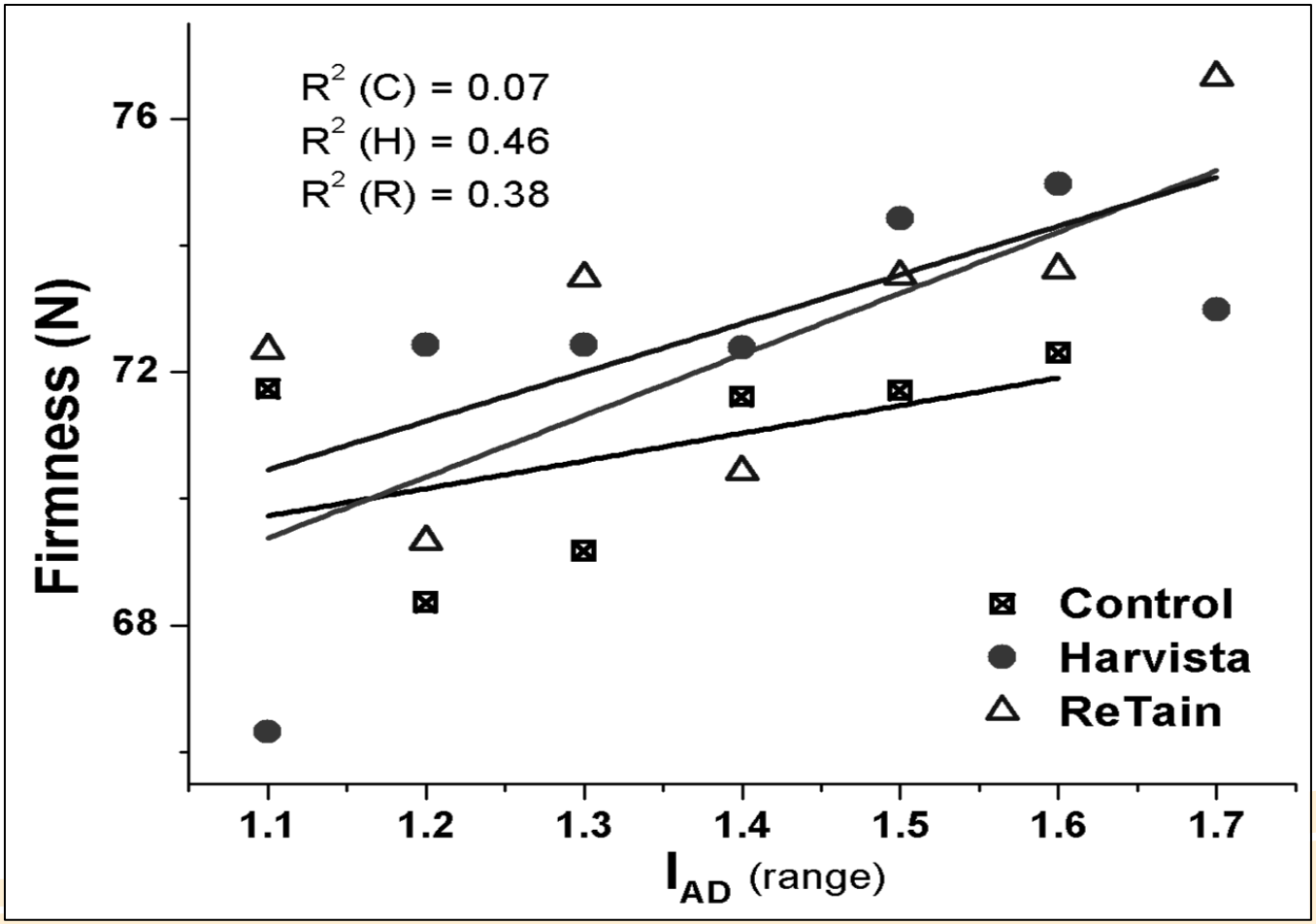
3. Empire

- ‘Empire’
  - fruit from orchard in Western NY
  - Untreated or treated with ReTain (AVG) 4 weeks or Harvista (1-MCP) 1 week before first harvest
  - 3 harvests: September 26, October 3 and 10 Measurements:
  - IEC
  - I_{AD}
  - Firmness
  - SPI

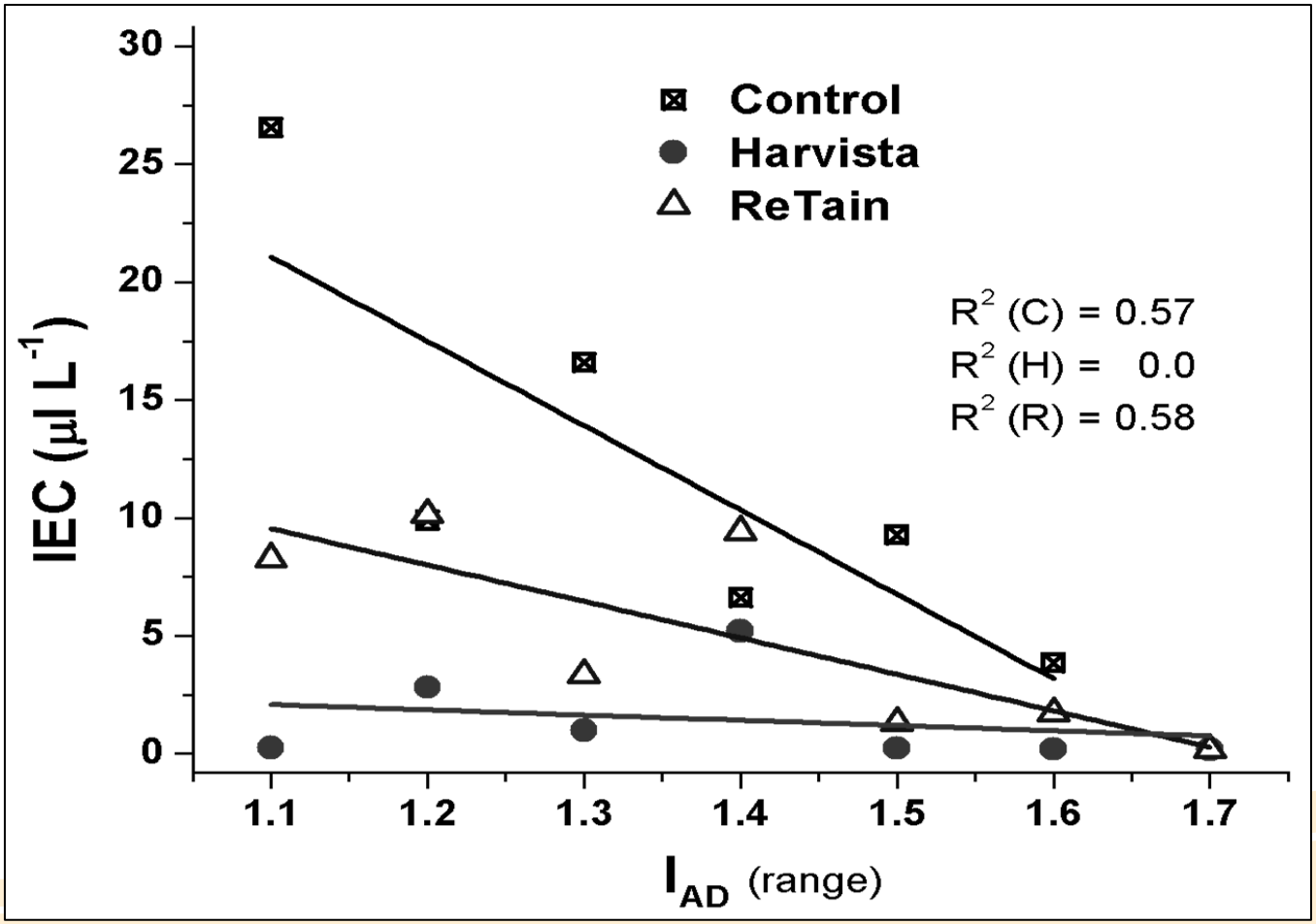
SPI vs. range of I_{AD}



Firmness vs. range of I_{AD}



IEC over range of I_{AD}



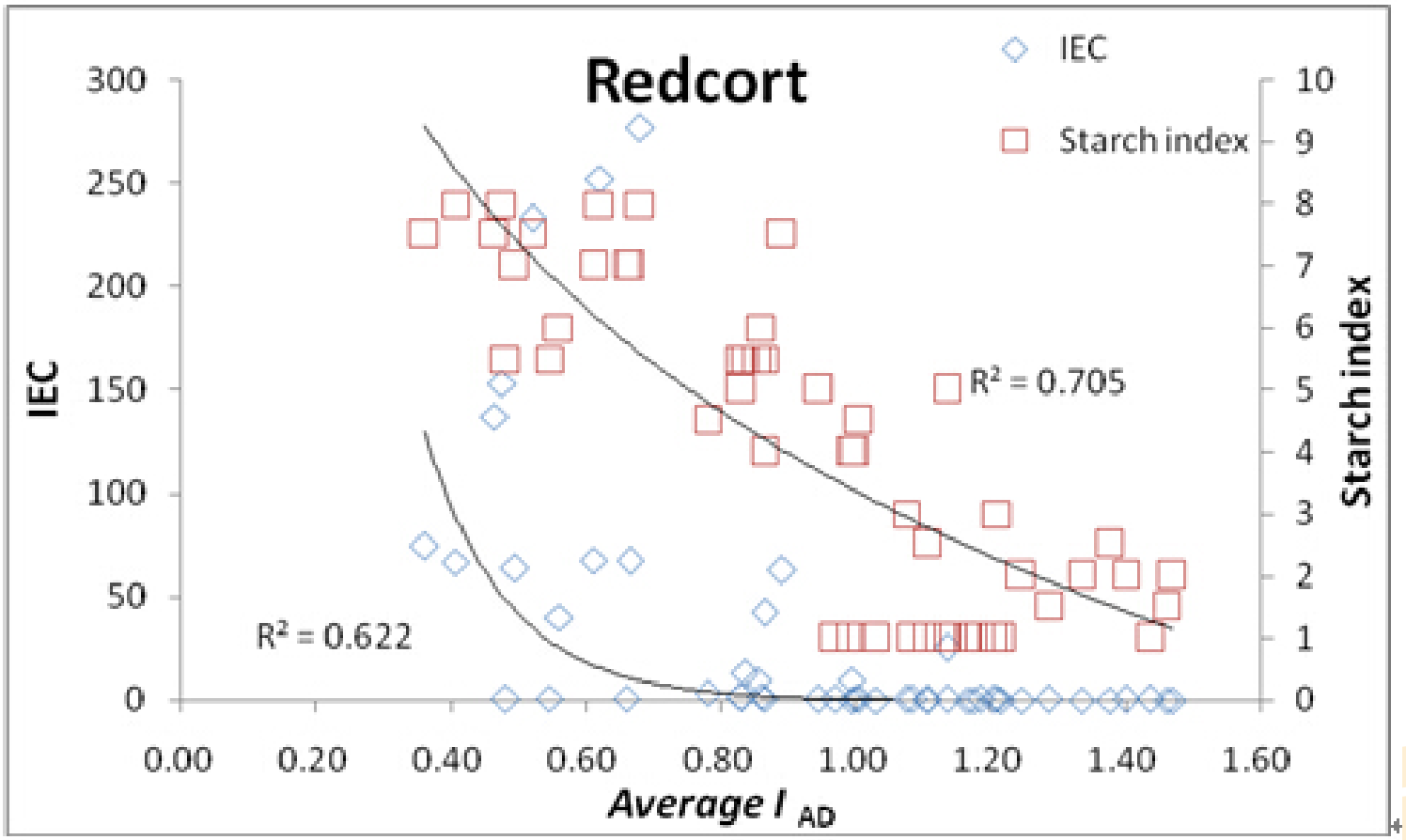
3. Relationships between IAD values and harvest indices for 9 cultivars

- Harvest indices plus I_{AD} values assessed at weekly intervals for several weeks

Relationships between I_{AD} values and chlorophyll a

Cultivar	R^2
NY-1	0.797
NY-2	0.756
Cortland	0.818
Fuji	0.732
Honeycrisp	0.817
Jonagold	0.481
Mutsu	0.678
McIntosh	0.671
RedCort	0.633

Example of relationship between IEC and SPI with I_{AD} values



Summary:

- Generally good correlations between I_{AD} values and chlorophyll concentrations, but exceptions exist.
- Depending on cultivar (e.g. 'RedCort'), relationships between I_{AD} values and IEC and starch indices are good. Suggests that in some cases might be useful non-destructive measure if relationships apply across orchards and growing regions.

Conclusions

- Correlations of I_{AD} values with other harvest indices are present, but variable, and depend on cultivar.
  - As stated by Peter Toivonen, 'I_{AD} tells you about how much chlorophyll is in the peel of the apple – nothing more'
- Relationship between I_{AD} values at harvest and disorders may be affected by preharvest factors such as PGRs.
- Research is ongoing to investigate its usefulness for cultivars within and across different growing regions.
- Overall unlikely to replace standard harvest indices, but rather supplement, although future potential for precision harvest if reliable in the field.
- Incorporation in to presort lines may have greater potential


Thank you
Questions?