The Importance of Temperature

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Postharvest Short Course
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We’re handling living products!

- Perishable products are alive
- Plant tissues are composed of cells
- Each cell is a minute factory carrying out thousands of tasks simultaneously

RESPIRATION

- The combustion of sugars is called respiration
- The process uses oxygen and produces CO₂ and energy
  \[ C_6H_{12}O_6 + 6O_2 = 6 CO_2 + 6 H_2O \]
- We can determine the rate of development and aging by measuring the rate of CO₂ production
- Like determining activity in a factory by watching the smoke-stacks
Relative Perishability

Temperature - why is it important?
• Rate of deterioration \( \alpha \) rate of respiration
• Faster respiration, shorter life
• Respiration increases exponentially with \( T \)

Temperature effects on product life
• As temperature increases, the rate of deterioration increases exponentially
• For every 10 \( C \) increase in temperature, the rate of deterioration increases 2-3 fold
• This increase is described by the \( Q_{10} \) - the ratio of respiration at temperature \( T + 10 \) to that at temperature \( T \)
• High temperatures also accelerate water loss, disease growth, appearance of disorders, and unwanted growth of plant parts

Example Strawberries
• How long do they last at room temperature?
• \( Q_{10} \) (20 – 10) = 2
• Life at 10° C?
• \( Q_{10} \) (10 – 0) = 3
• Life at 0° C?
• We can store strawberries for two weeks at 0° C (if we control Botrytis)
Temperature also affects other factors that are important to product life

- Ethylene
  - Production
  - Response
- Water loss
- Wound response
- Disease
- Unintended growth

What is the correct temperature?

- Species from cool climates
  - 0 – 3° C
- Species from tropical climates
  - 10 – 15° C
- Species from sub-tropical climates
  - Varies
    - Avocados – 10° C
    - Kiwi - 0° C

Storage experiments

The ‘real’ world

First Red Roses
Narcissus
Temperature & respiration

\[ y = 14.262e^{0.1378x} \]

\[ R^2 = 0.9966 \]

Flowers lose vase life even under good temperature management

\[ y = -0.0314x + 4.493 \]

\[ R^2 = 0.9884 \]

Not just flowers

Monitoring tools

- Dataloggers
- Time/temperature labels
- Active RFID

Shelf-life model
- Based on respiration regressions
  - By species or cultivar
- Predicts remaining ‘vase life’

Monitoring tools
A new tool - active RFID tags

- Radio Frequency Identification Chip
- Antenna receives and transmits information in RF signals
- Passive chips already in widespread use (Walmart)
- Active tags include battery
  - Environmental sensors

Pilot Study

- 11 wholesalers sent tags to 48 domestic and offshore growers
- At the time of packing, the tags were placed into the flower boxes, which were shipped to the wholesalers
- The tags provided transit time and temperature data
- Our respiration/temperature model was used to calculate remaining vase life

Results

- Average transit time – 5 days
  - Minimum 1 day (air from CA)
  - Maximum 12 days (sea from Colombia)
- Average temperature – 10°C
  - Lowest – -2°C
  - Highest – 35°C
- Average vase life loss – 14%
  - Maximum 41%
  - Minimum 3%

Battery Assisted RFID Tag

- Long range identification
- Data tracking
- Time/temperature monitoring
- Sensor monitoring

Questions?