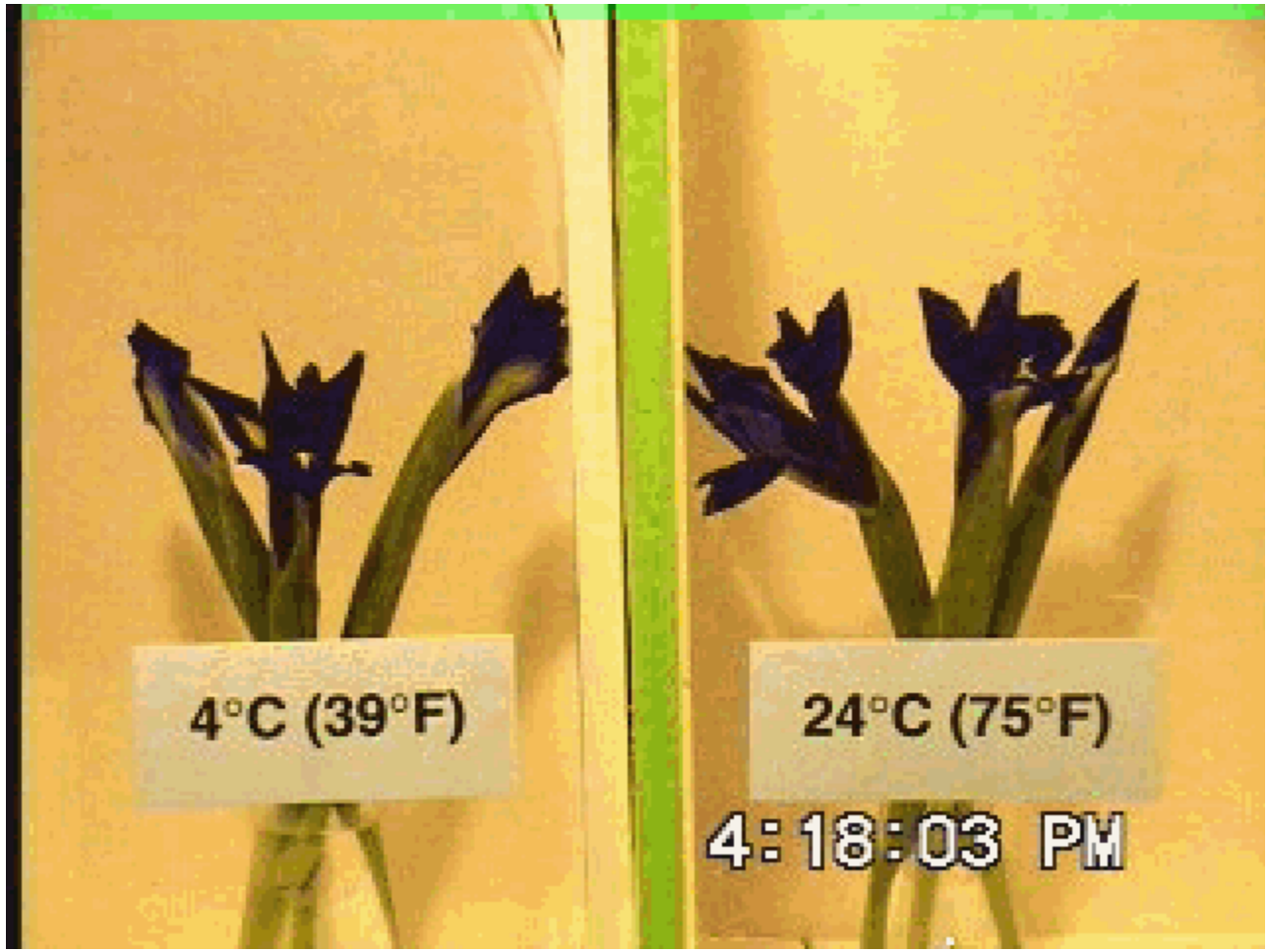
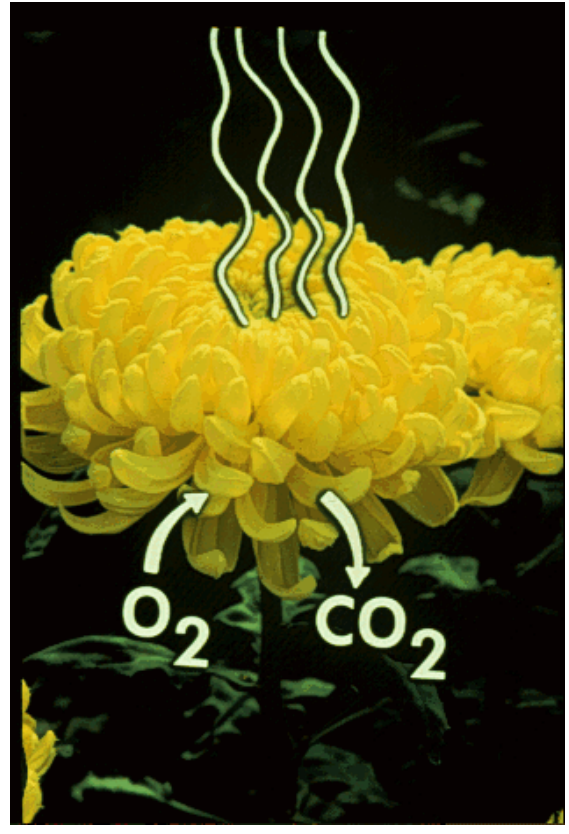
TEMPERATURE

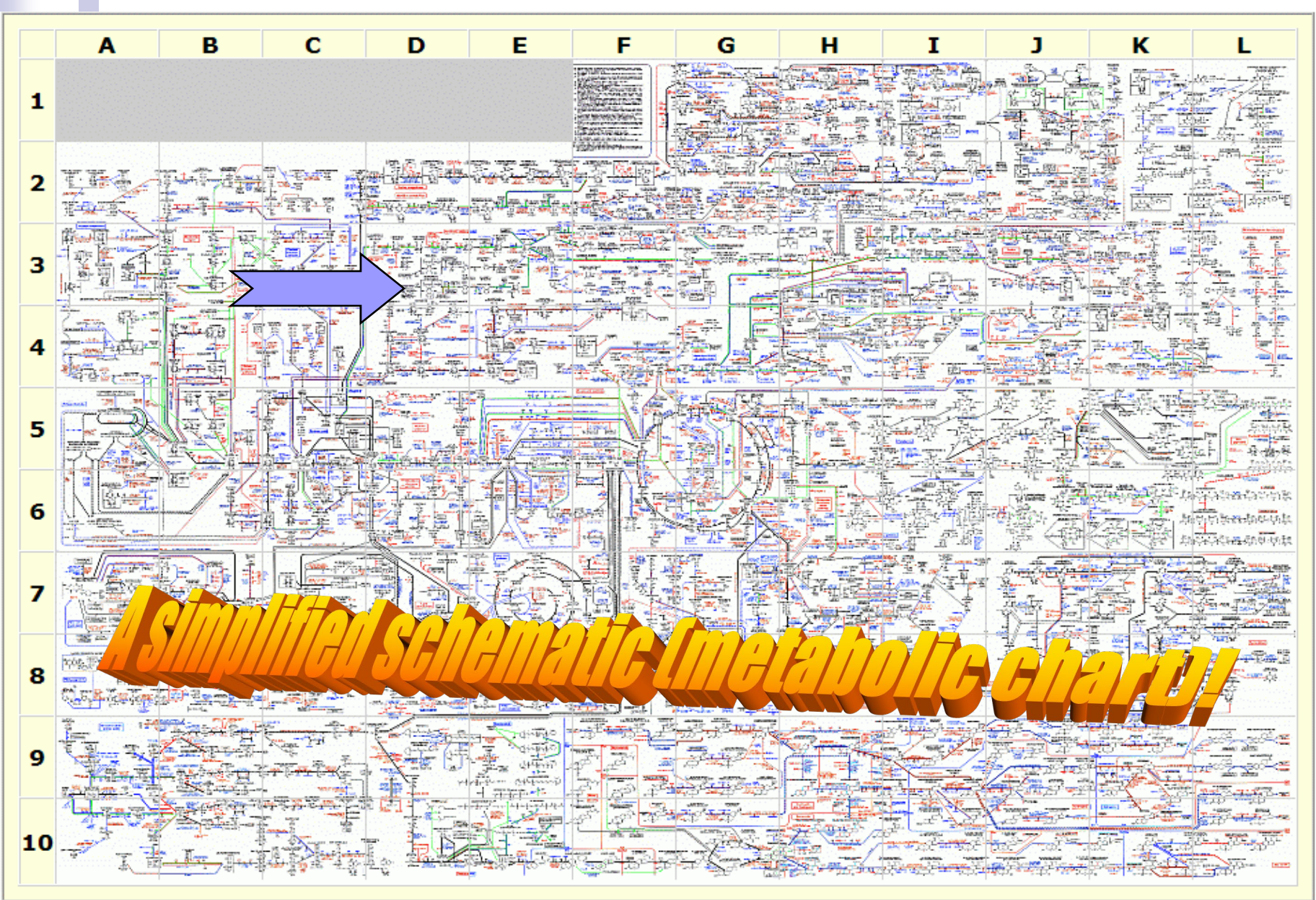
Importance and management

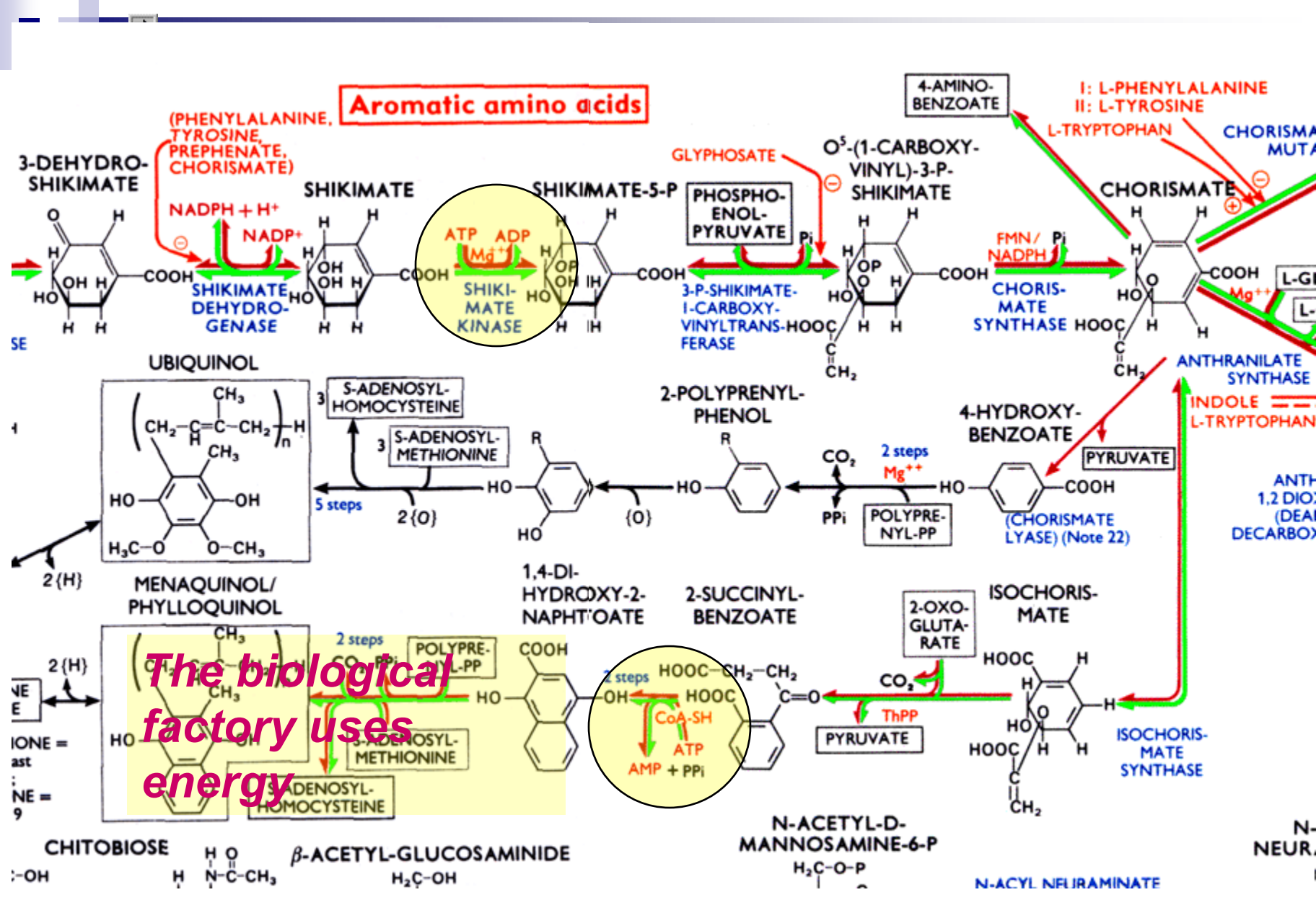

4°C (39°F)
24°C (75°F)
4:18:03 PM

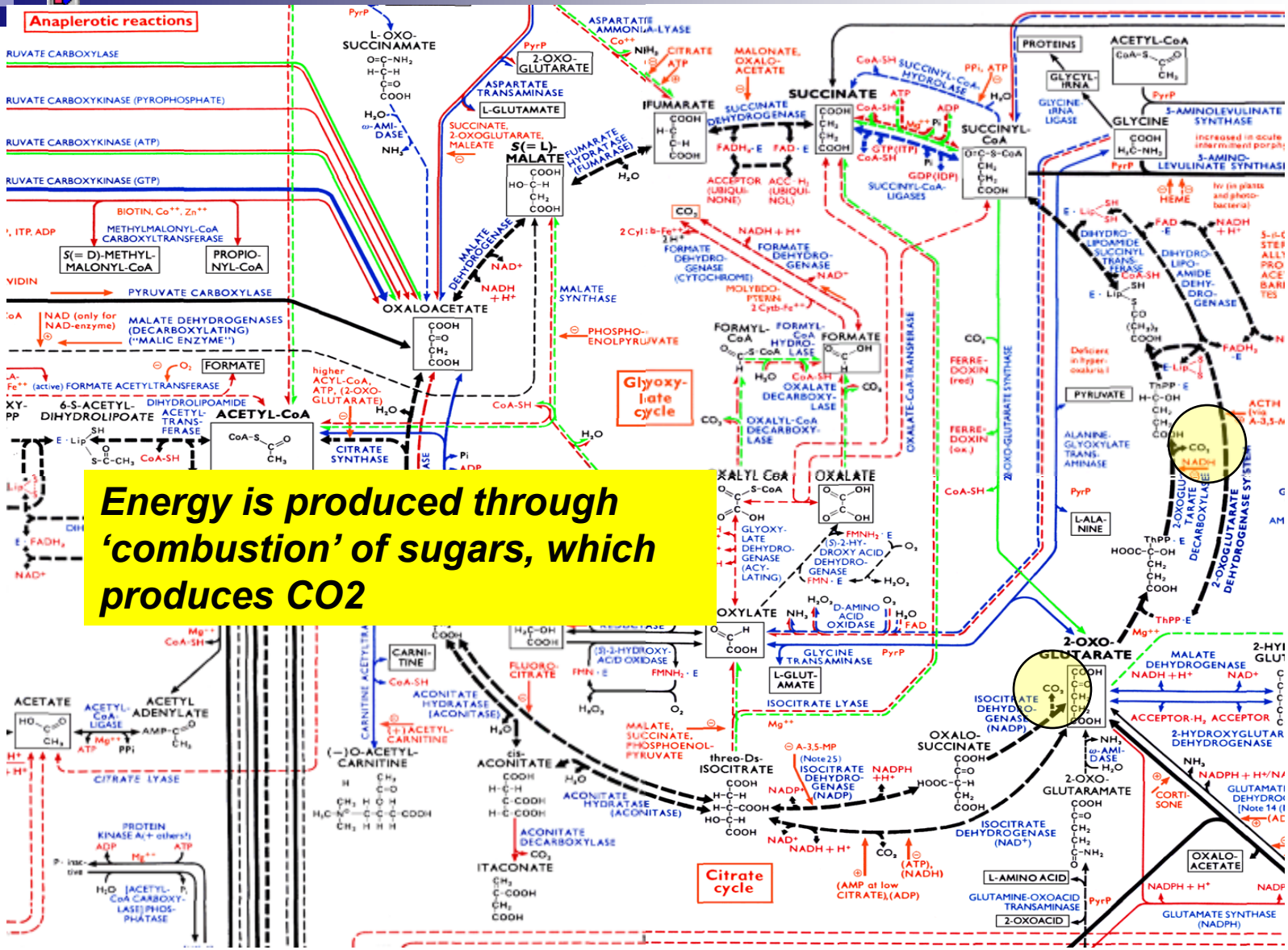
Temperature

- Perishable products are alive
- Life is a complex biochemical process
- Each cell is a minute factory carrying thousands of tasks simultaneously




A simplified schematic (metabolic chart)!


Aromatic amino acids
(PHENYLALANINE, TYROSINE, PREPHENATE, CHORISMATE)
3-DEHYDRO-SHIKIMATE
NADPH + H+
NADP+
SHIKIMATE
SHIKIMATE DEHYDRO-GENASE
ATP
ADP
Mg++
SHIKI-MATE KINASE
SHIKIMATE-5-P
PHOSPHO-ENOL-PYRUVATE
Pi
GLYPHOSATE
O5-(1-CARBOXY-VINYL)-3-P-SHIKIMATE
3-P-SHIKIMATE-1-CARBOXY-VINYLTRANS-FERASE
FMN / NADPH
Pi
CHORIS-MATE SYNTHASE
CHORISMATE
4-AMINO-BENZOATE
I: L-PHENYLALANINE
II: L-TYROSINE
L-TRYPTOPHAN
ANTHRANILATE SYNTHASE
INDOLE
L-TRYPTOPHAN
UBIQUINOL
S-ADENOSYL-HOMOCYSTEINE
S-ADENOSYL-METHIONINE
5 steps
2 {O}
{O}
2-POLYPRENYL-PHENOL
4-HYDROXY-BENZOATE
CO2
2 steps
Mg++
PPi
POLYPRE-NYL-PP
PYRUVATE
(CHORISMATE LYASE) (Note 22)
2 {H}
MENAQUINOL/ PHYLLOQUINOL
1,4-DI-HYDROXY-2-NAPHTHOATE
2-SUCCINYL-BENZOATE
2-OXO-GLUTA-RATE
ISOCHORIS-MATE
CoA-SH
ATP
AMP + PPi
ThPP
ISOCHORIS-MATE SYNTHASE
The biological factory uses energy
CHITOBISE
β-ACETYL-GLUCOSAMINIDE
N-ACETYL-D-MANNOSAMINE-6-P
N-ACYL NEURAMINATE

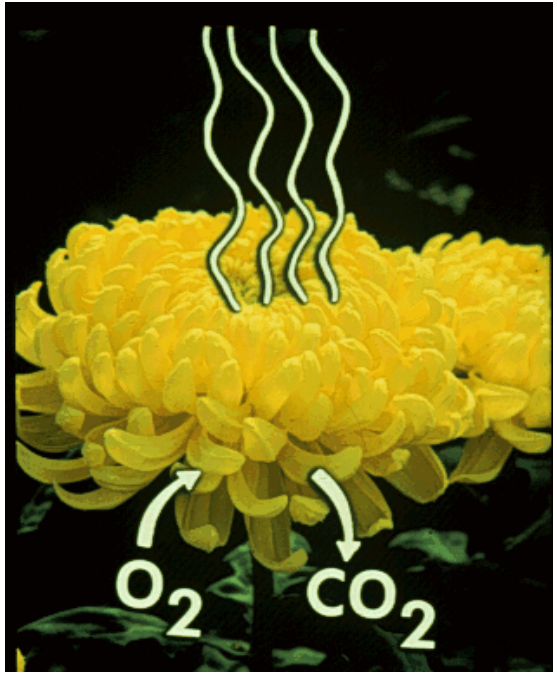

Anaplerotic reactions
Energy is produced through 'combustion' of sugars, which produces CO2
Glyoxylate cycle
Citrate cycle
OXALOACETATE
CITRATE SYNTHASE
ACETYL-CoA
SUCCINATE
FUMARATE
S(=L)-MALATE
ISOCITRATE
2-OXOGLUTARATE
SUCCINYL-CoA
GLYCINE
PYRUVATE
OXALATE
GLYOXYLATE
ACONITATE
ITACONATE
CARNITINE
ACETATE
ACETYL ADENYLATE
L-GLUTAMATE
L-ALANINE
L-GLUTAMATE
2-OXOGLUTARAMATE
OXALOSUCCINATE
PROTEINS
FORMATE
PROPIONYL-CoA
S(=D)-METHYLMALONYL-CoA

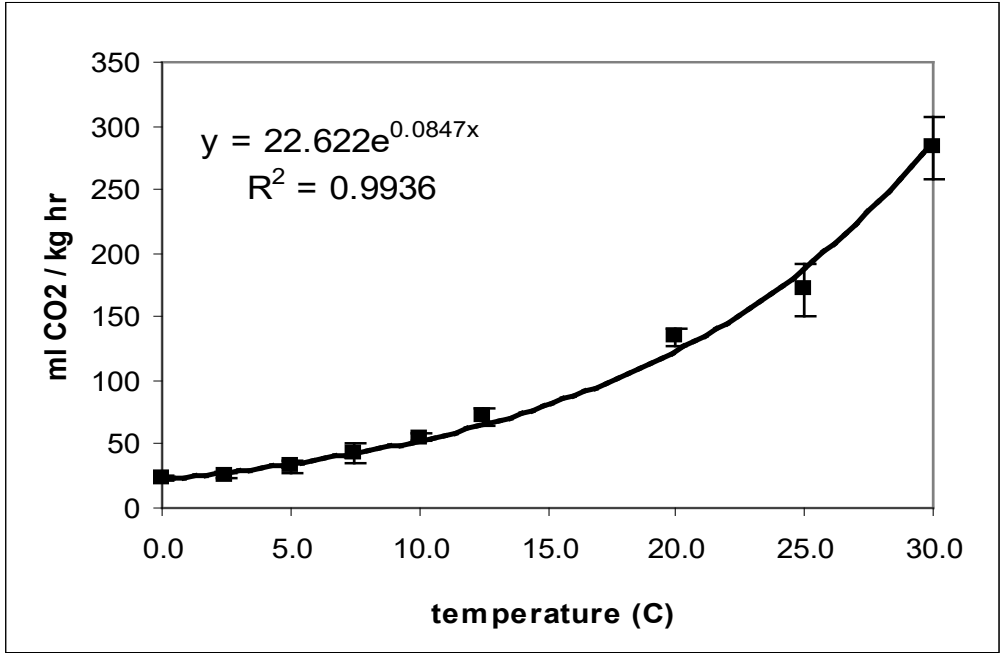
RESPIRATION

- 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 CO_2 production
- Like determining activity in a factory by watching the smoke-stacks

Temperature - why is it important?

- Rate of deterioration α rate of respiration
- Faster respiration, shorter life
- Respiration increases exponentially with T

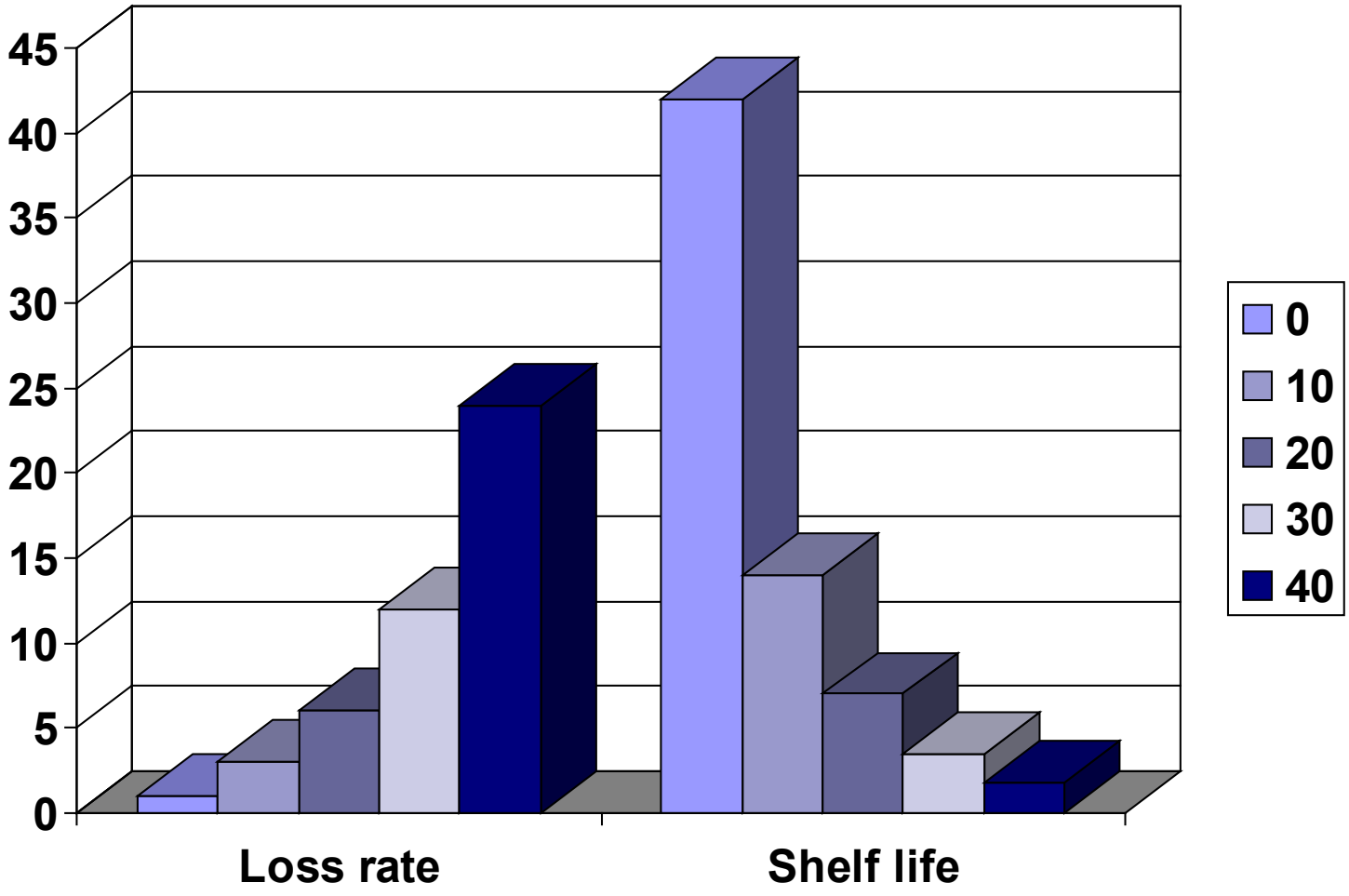




Temperature effects on flower life

- 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

The Effects of Q10

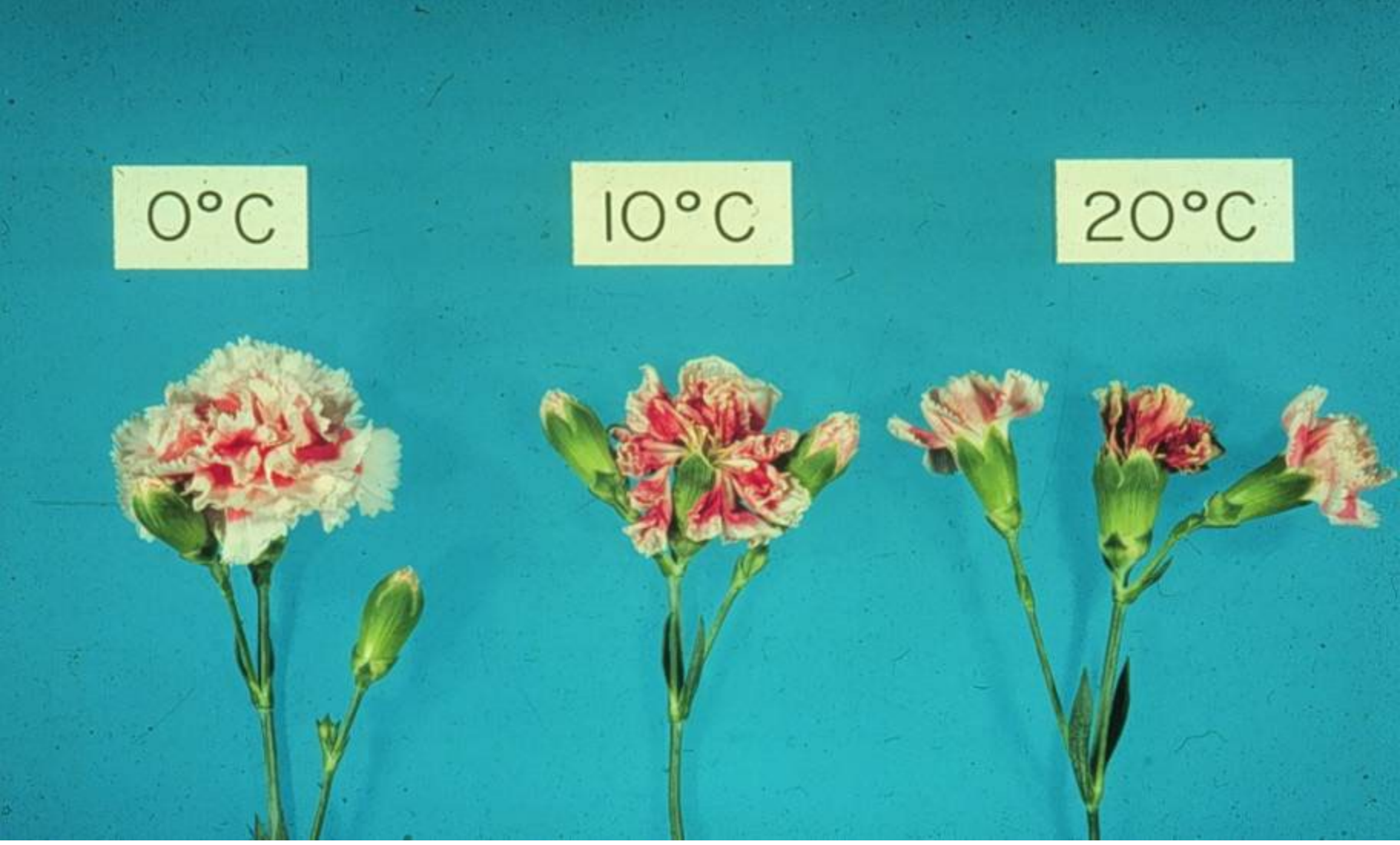


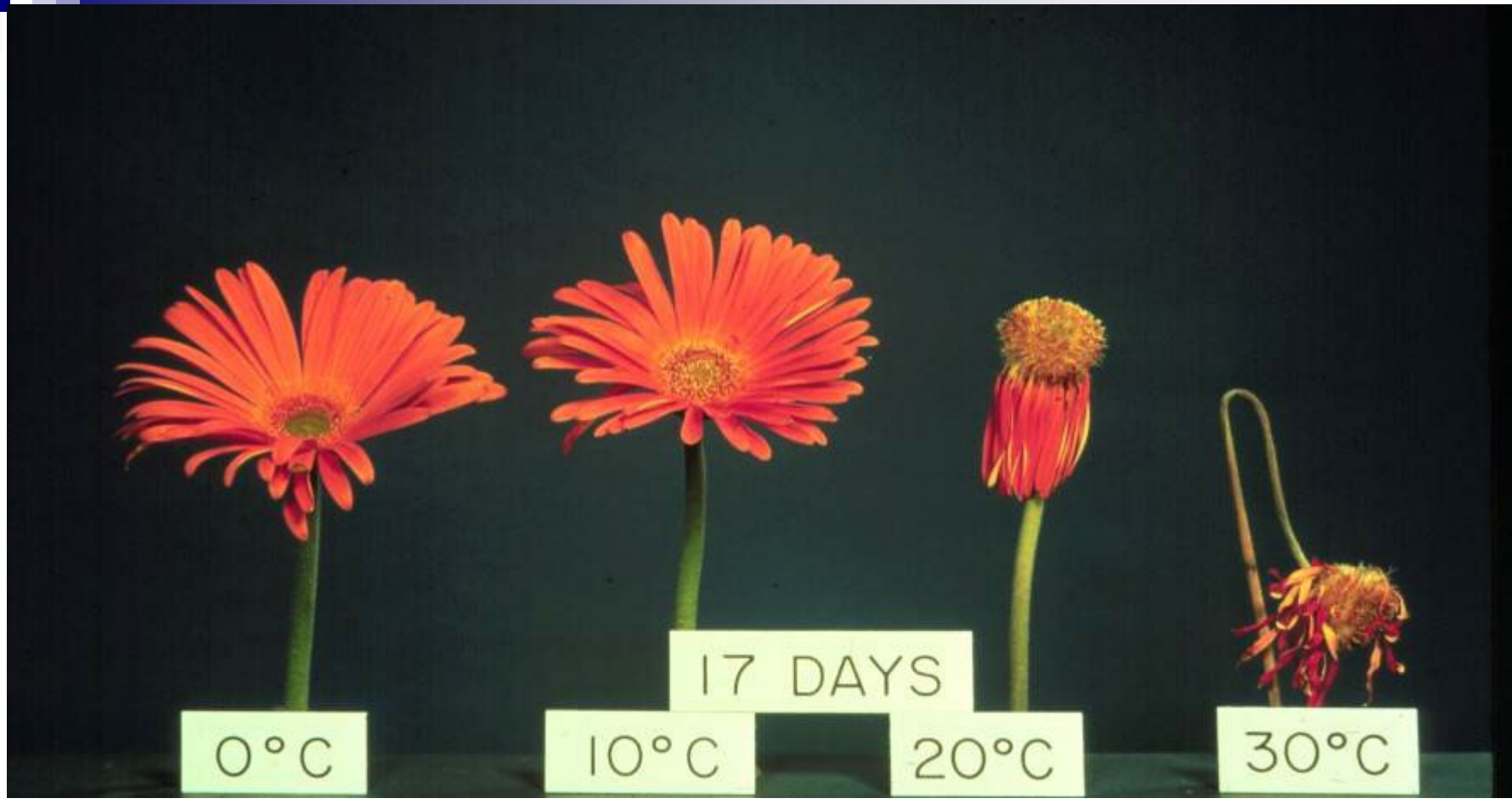
Example: *Carnations*

- Last for seven days at 20 C
- $Q_{10} = 2$
- Life = 14 days at 10 C
- Life = 28 days at 0 C
- We can *easily* store carnations for four weeks at 0 C (if we control *Botrytis)*

Temperature also affects other factors that affect product life

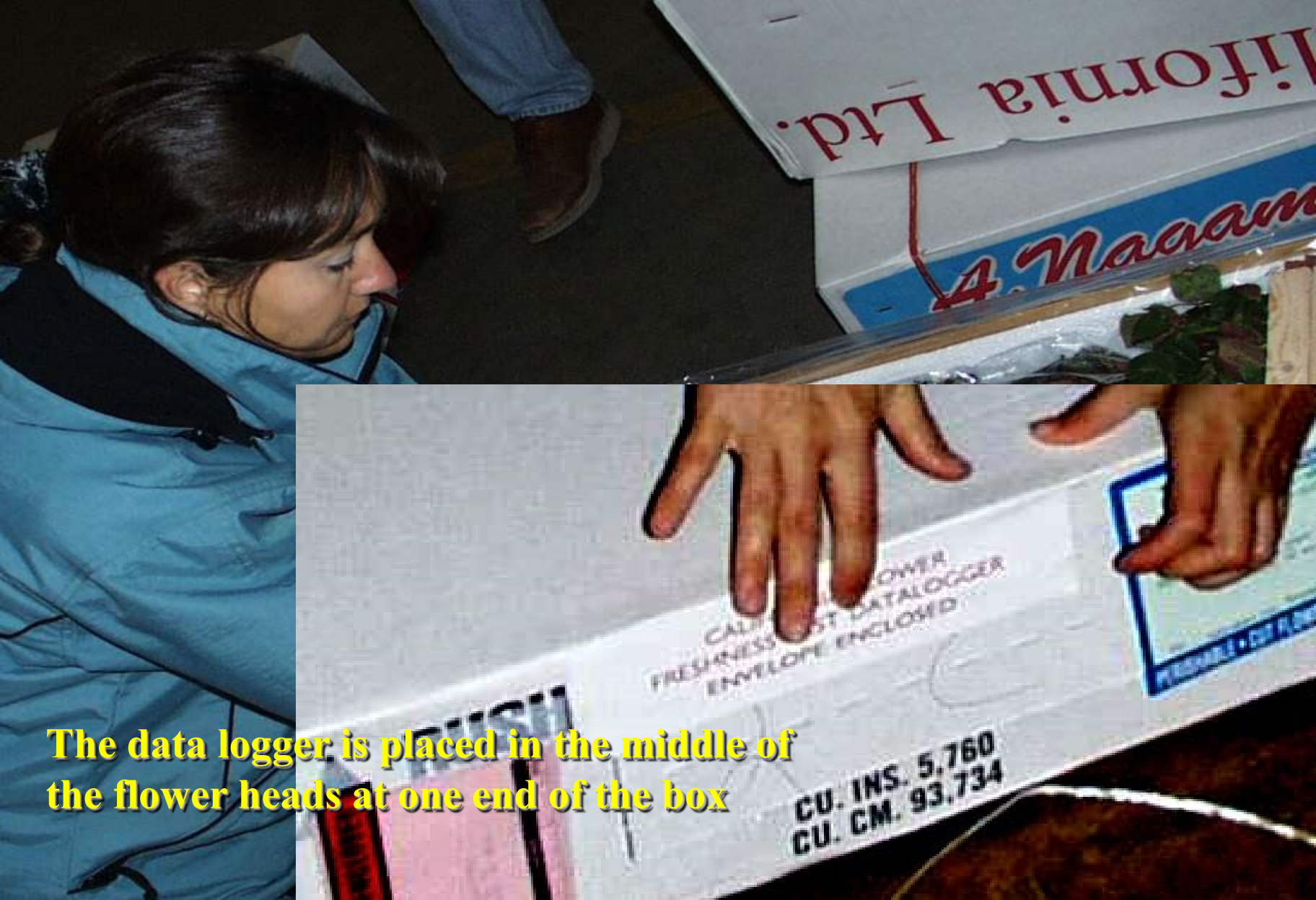
- Ethylene
- Water supply
- Damage
- Disease
- Food supply
- Growth


0°C
10°C
20°C


17 DAYS
0°C
10°C
20°C
30°C

What about the real world? Transportation monitoring


The data logger is placed in the middle of
the flower heads at one end of the box

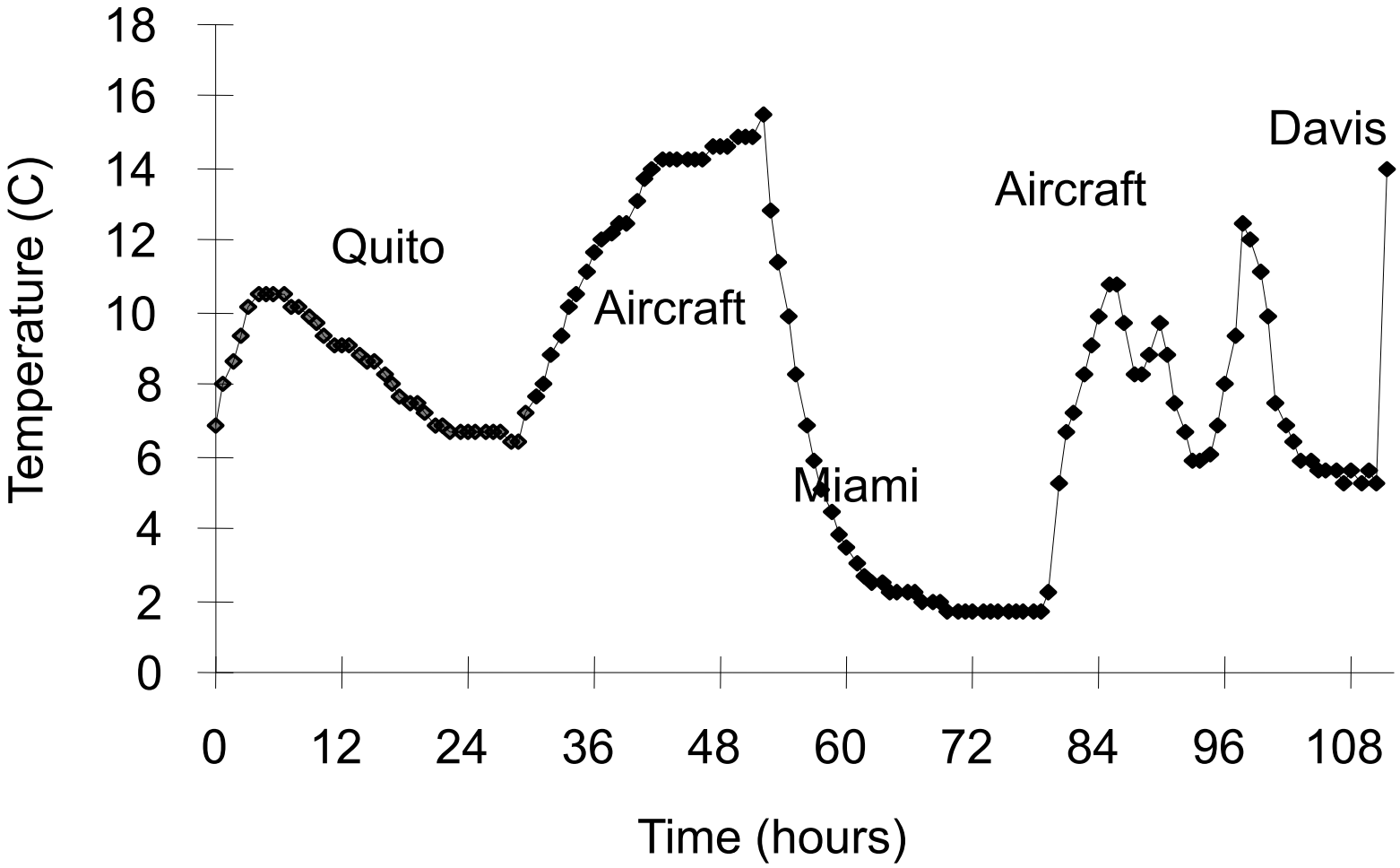


The data logger is placed in the middle of the flower heads at one end of the box

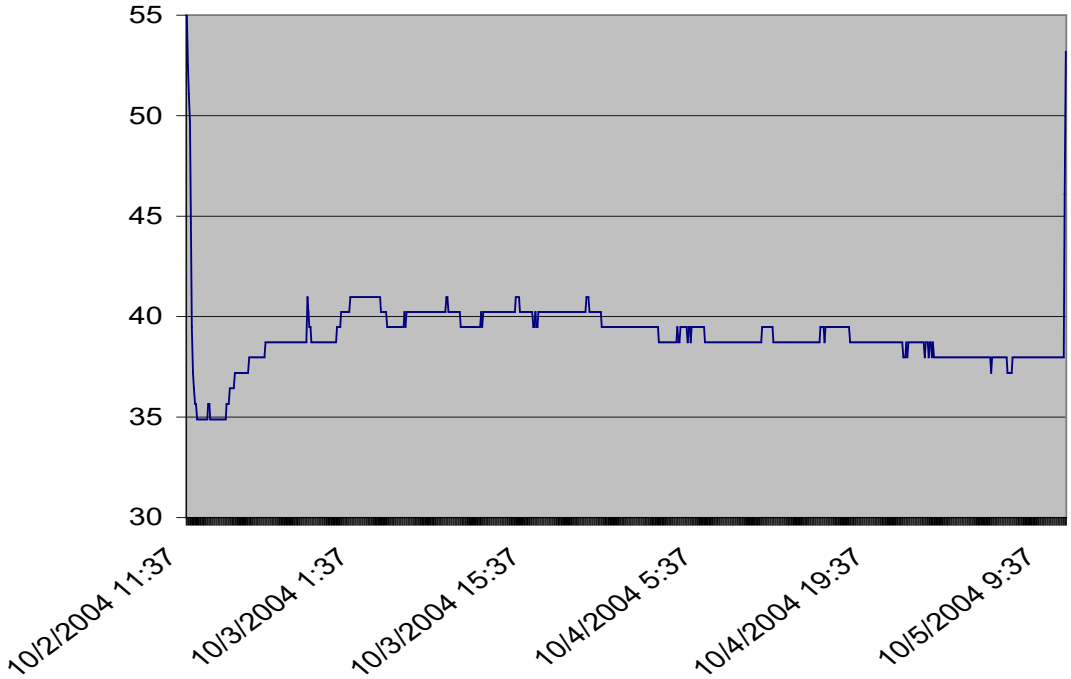
History of an average rose

- Day 1 Harvested and cooled overnight
- Day 2 Graded, packed, cooled
- Day 3 To airport, flown to Miami
  - Clear customs/agriculture
  - Re-cooled
- Day 4 On truck for transport
- Day 8 Arrives at wholesaler
  - Unboxed, rehydrated, cooled
- Day 9 Sold to retail florist
- Day 10 Placed in arrangement for customer
- Peak harvest for Valentine's Day (February 14) roses in Mexico is January 28!

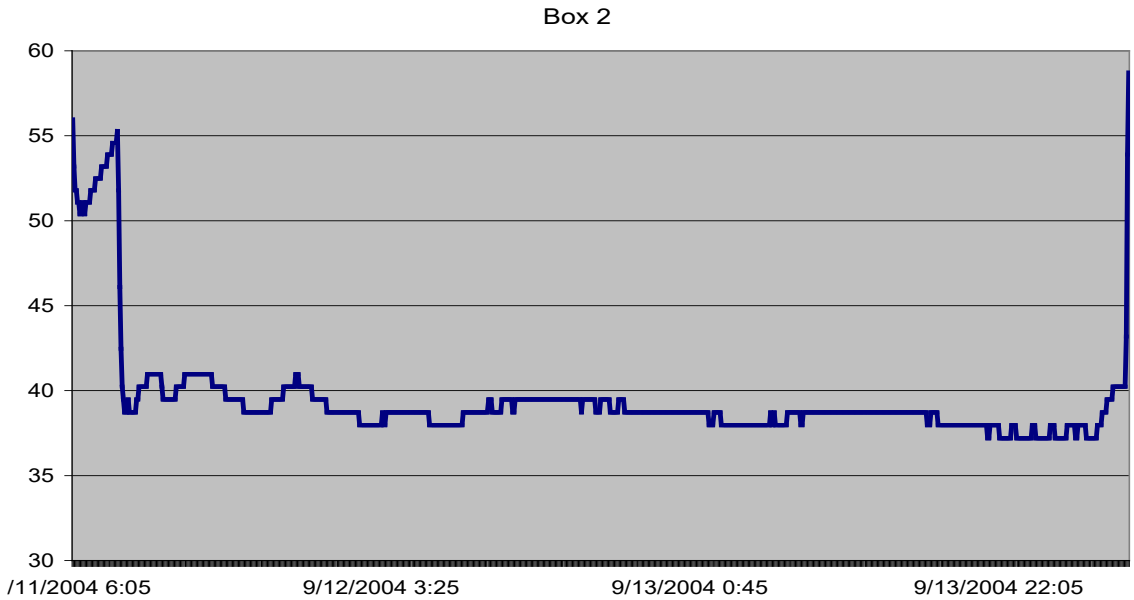
History of an average rose



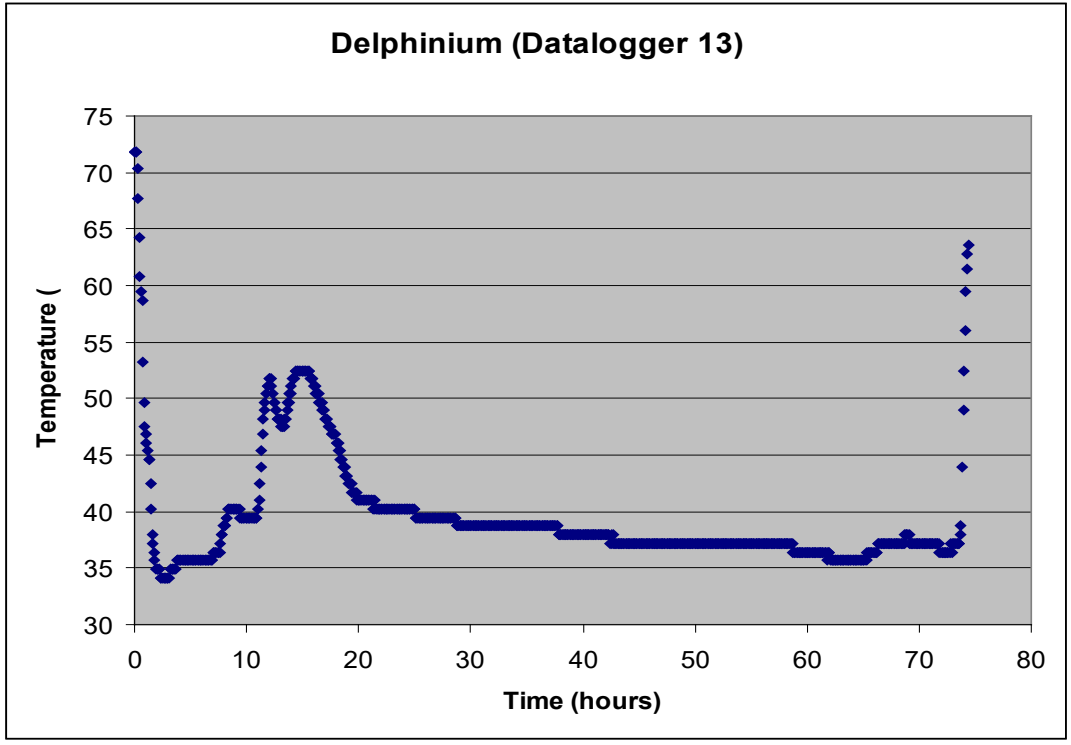
Our track record is poor



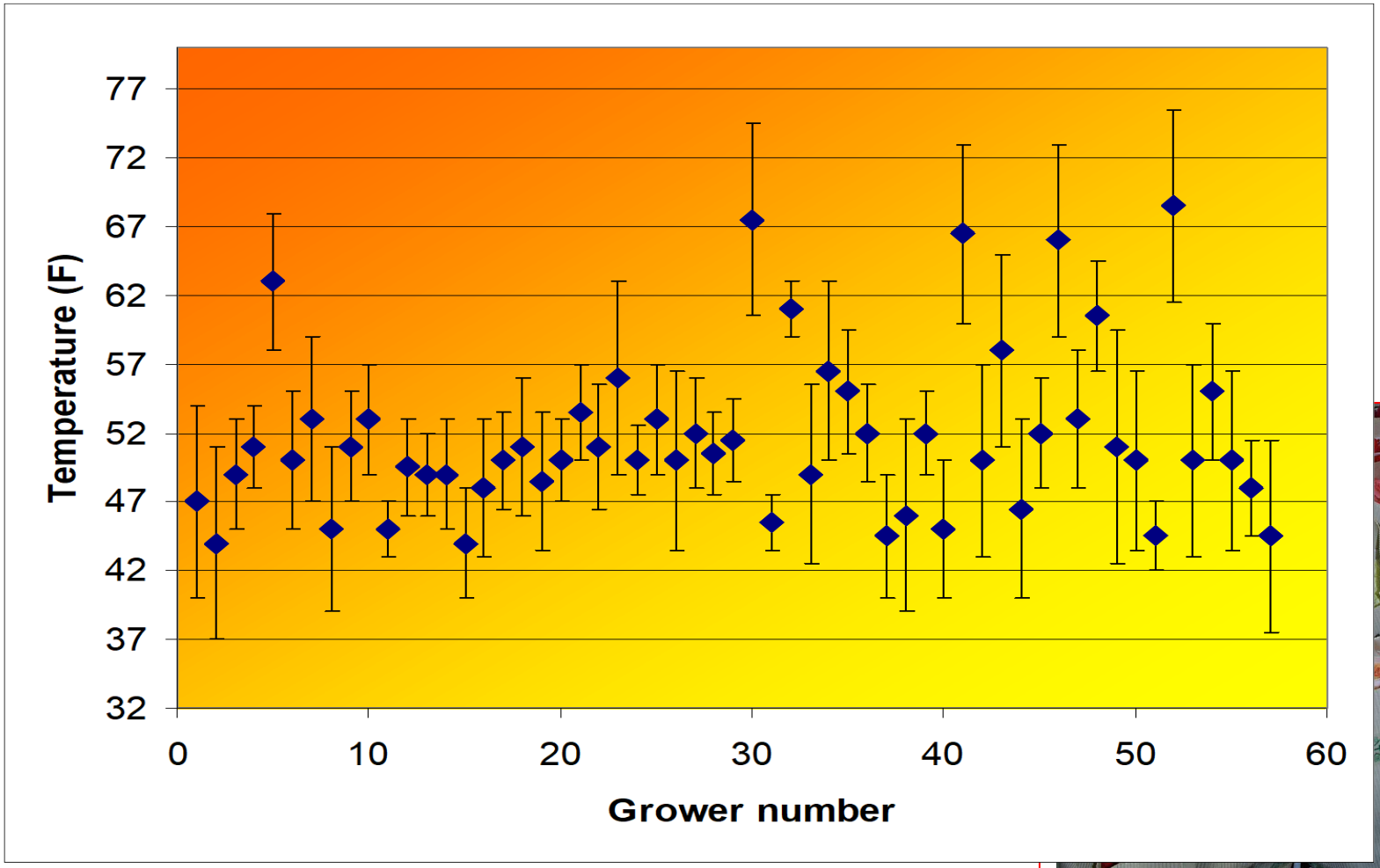
Our track record is poor



Our track record is poor



Our track record is poor



Storage experiments

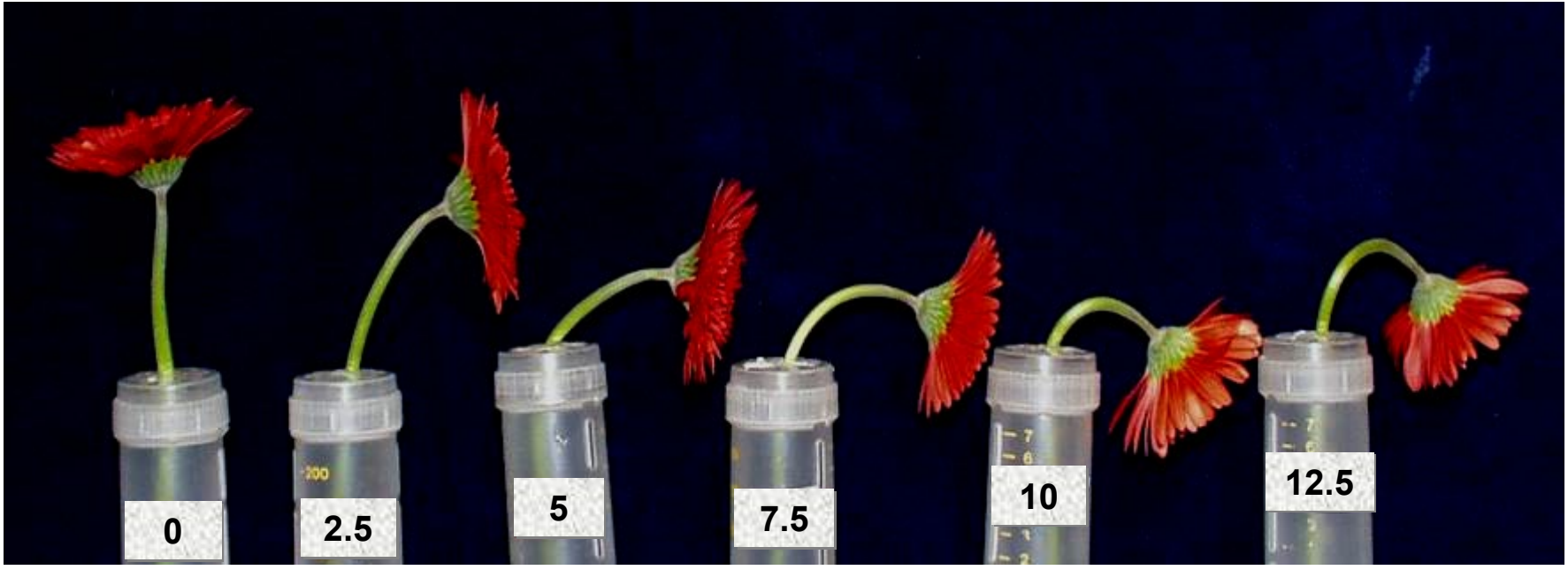
Storage experiments

Storage experiments

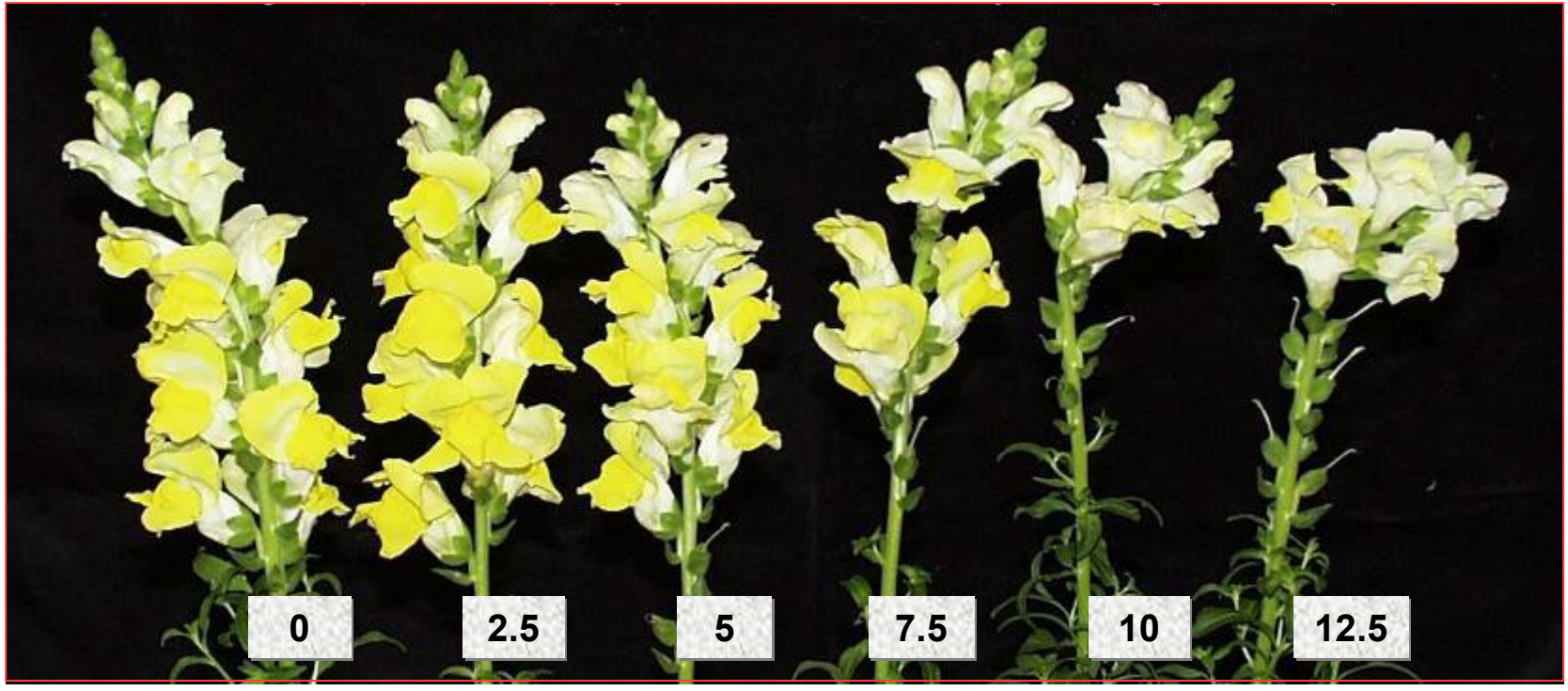
Storage experiments

First Red Roses
5 days storage, 8 days display

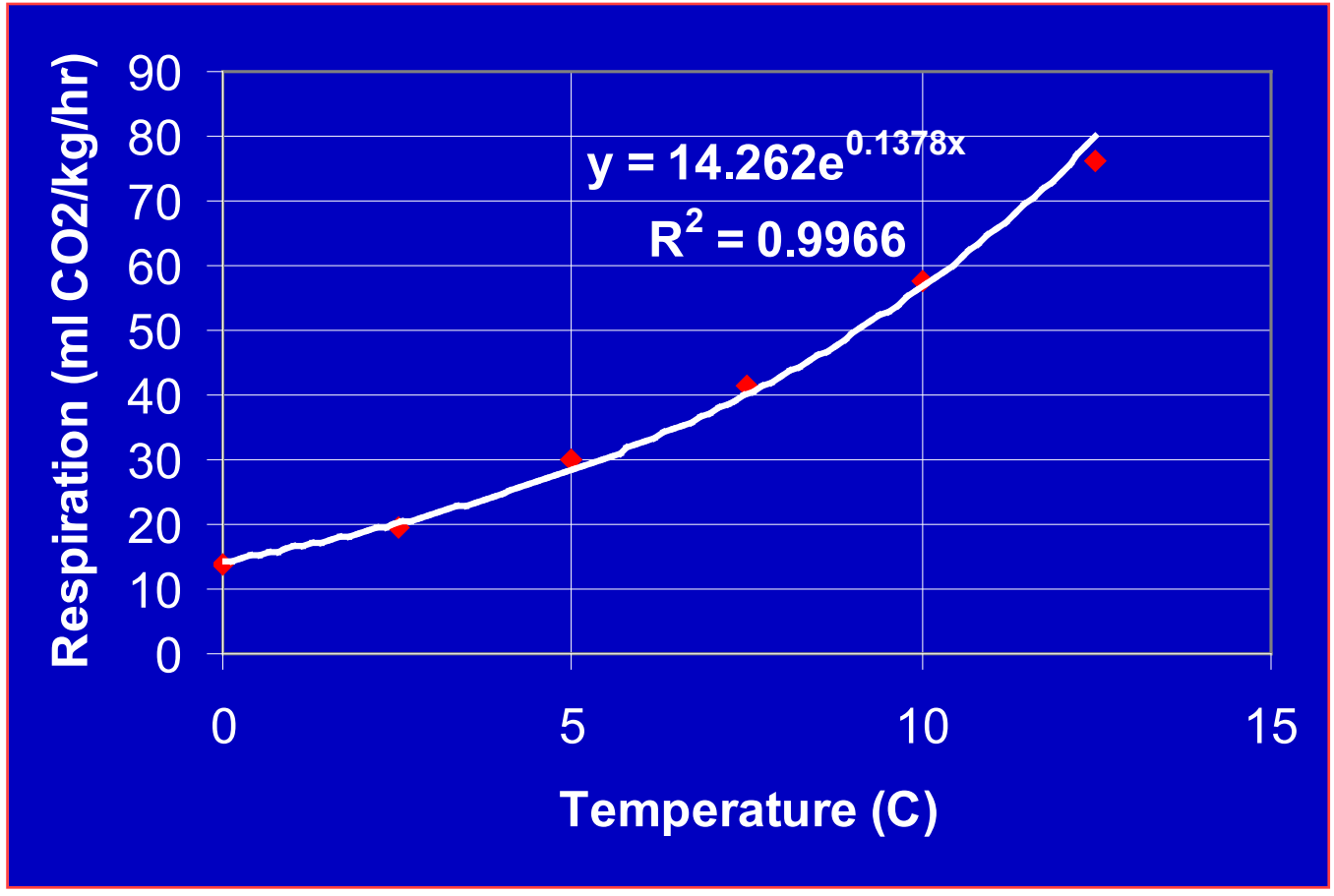
Gerbera
4 days storage, 1 day display



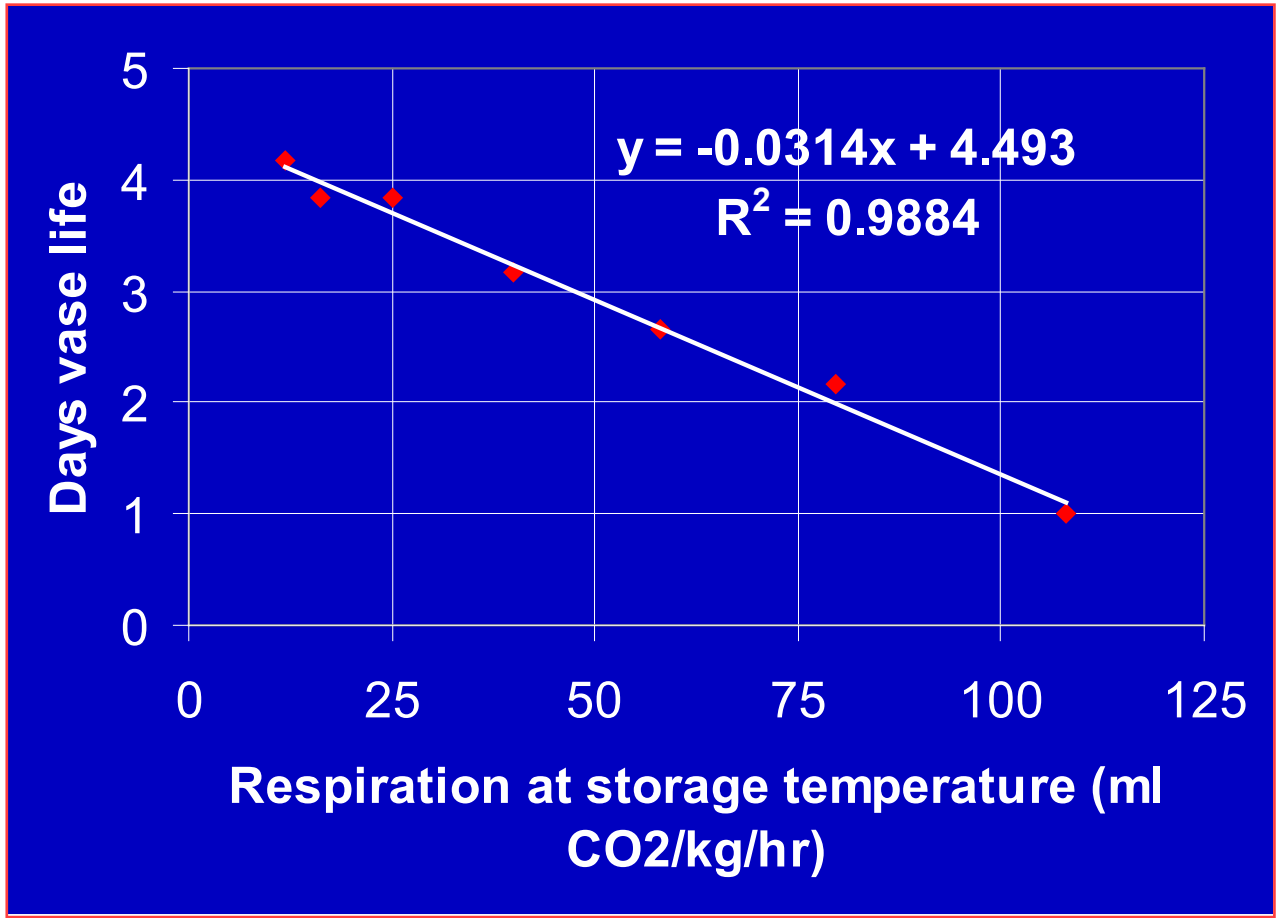
Snapdragons
4 days storage, 4 days display



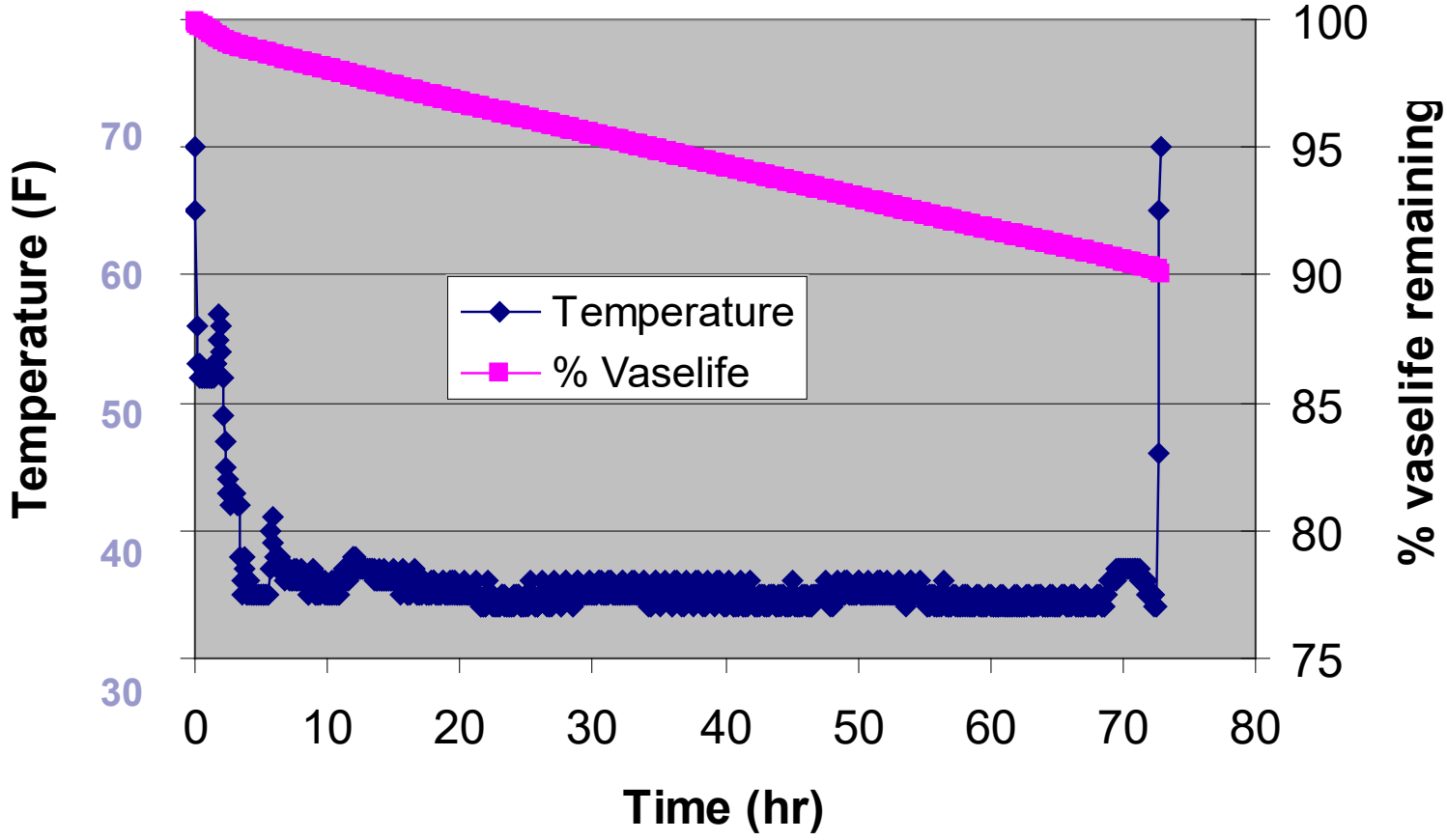
Narcissus
Temperature & respiration



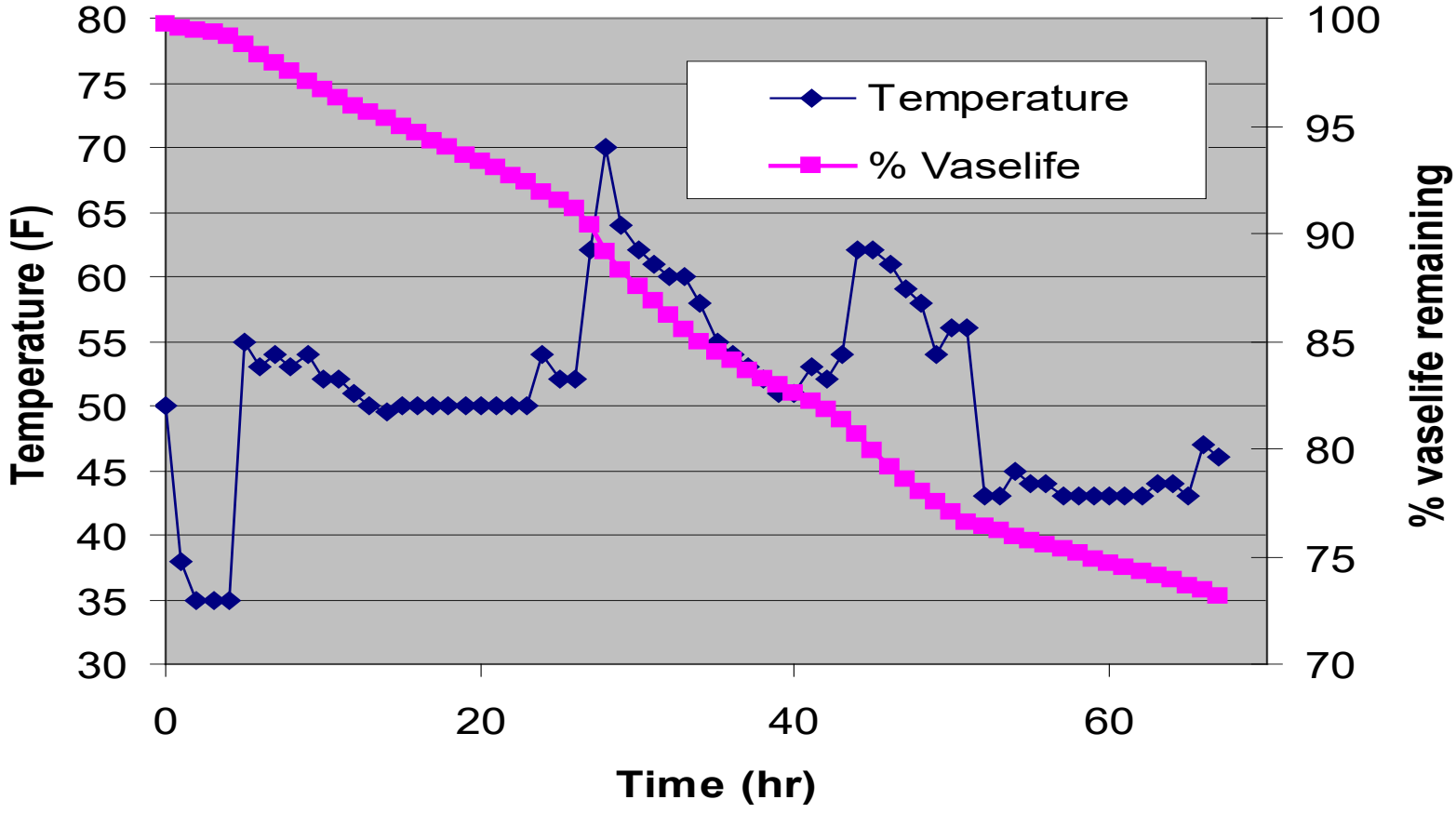
Narcissus
Respiration & Vase life



Flowers lose vaselife even under good temperature management



More vaselife is lost when temperatures are bad

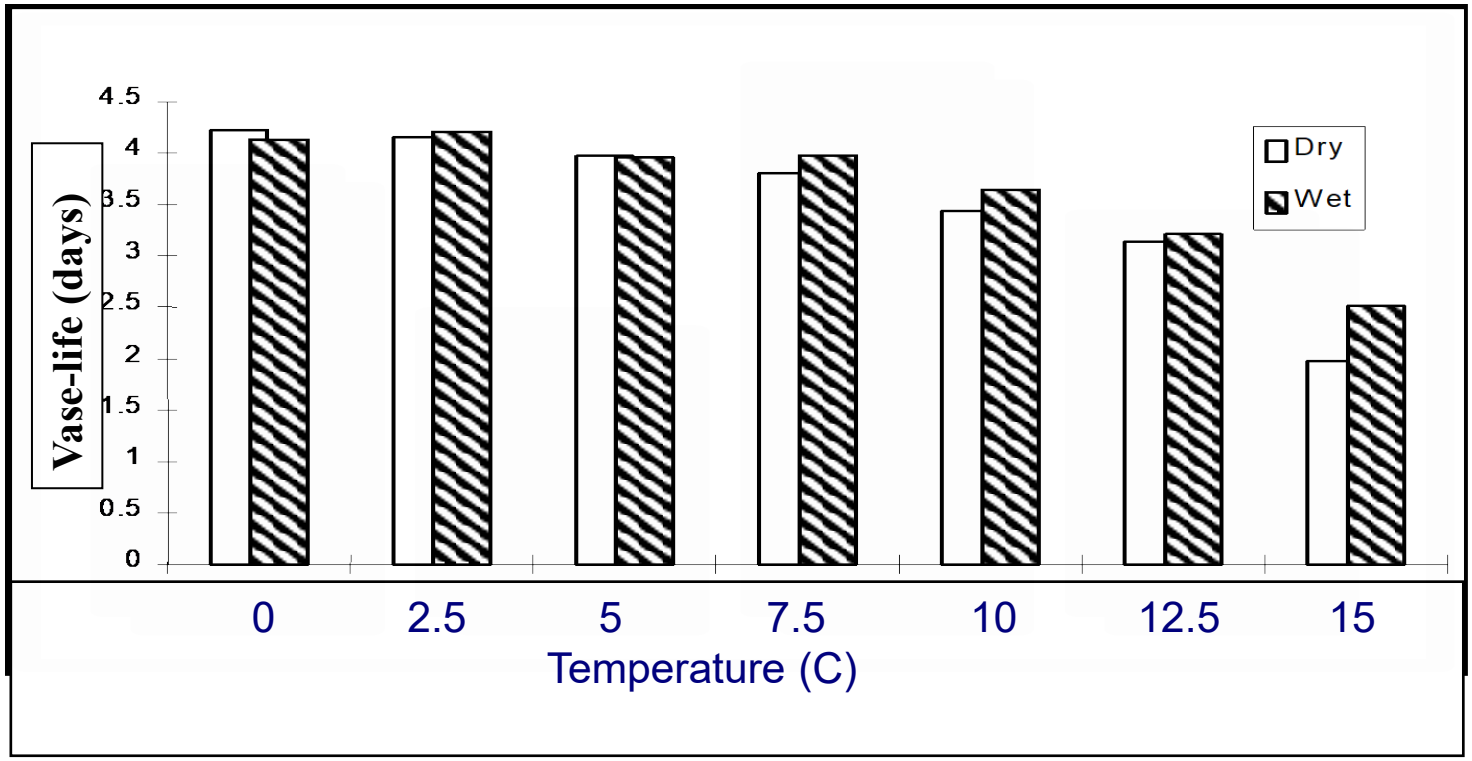


Do Proconas help?

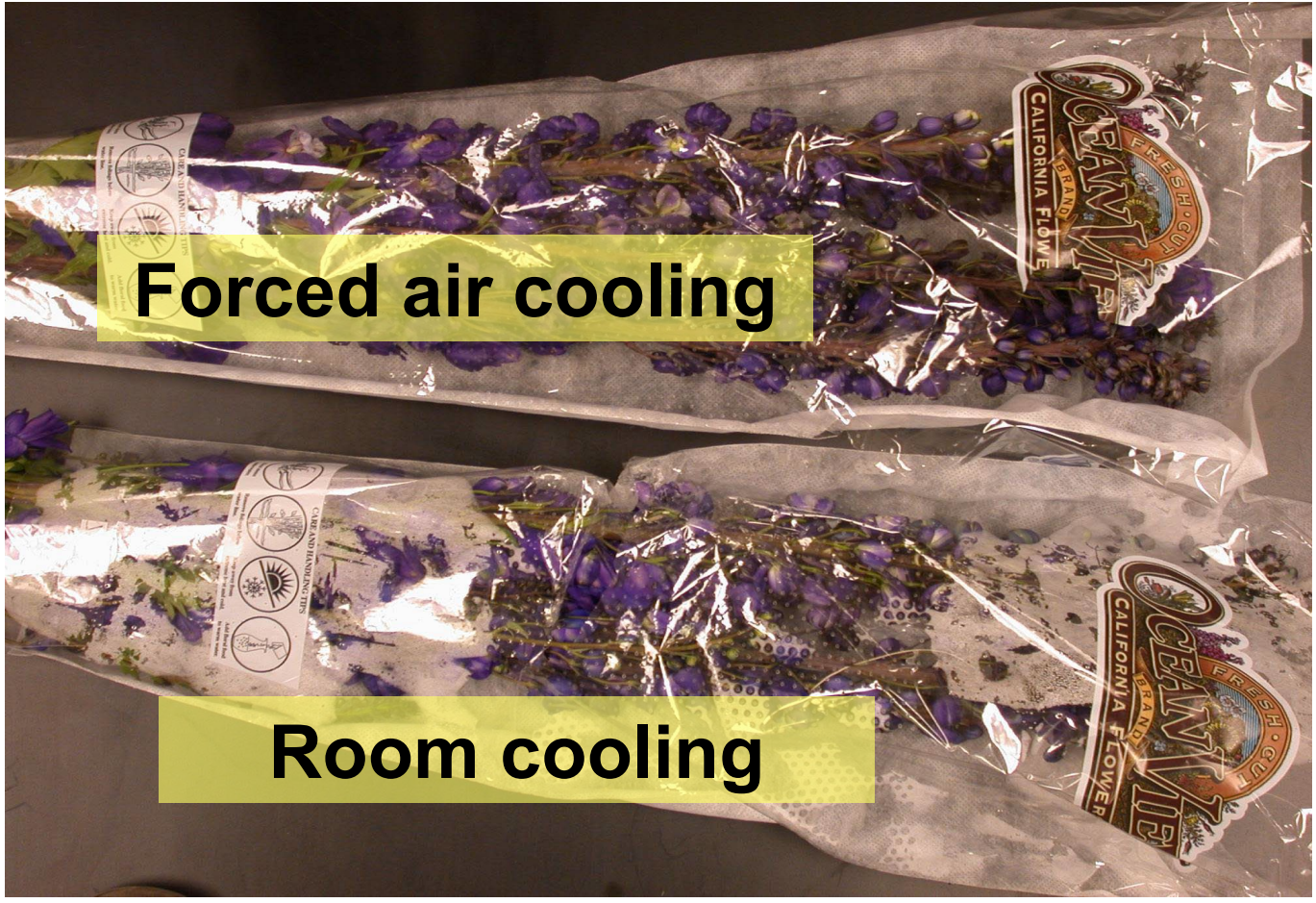
Do Proconas help?

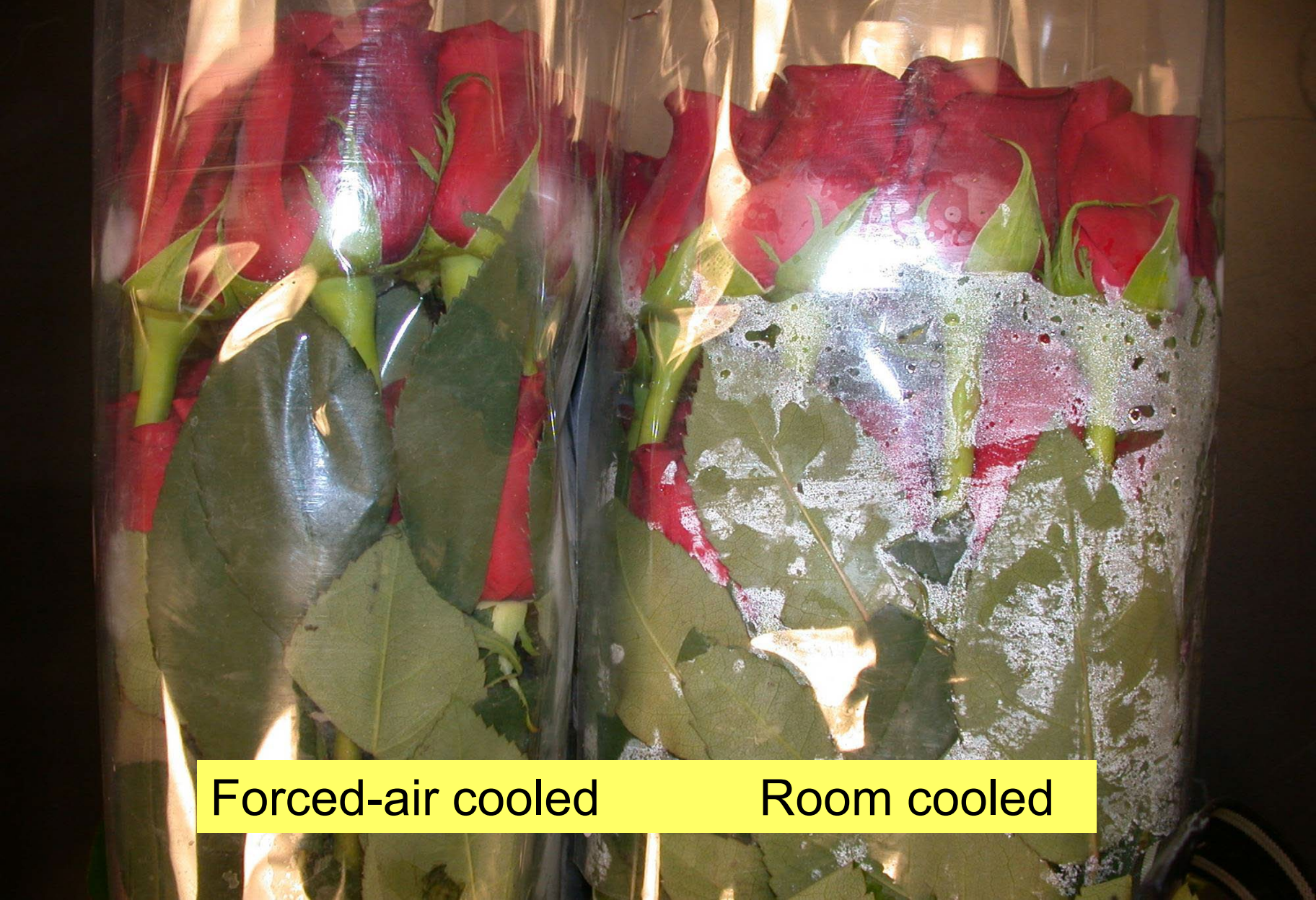
Wet storage experiment

Vase life of Narcissus after 4 days' dry & wet storage



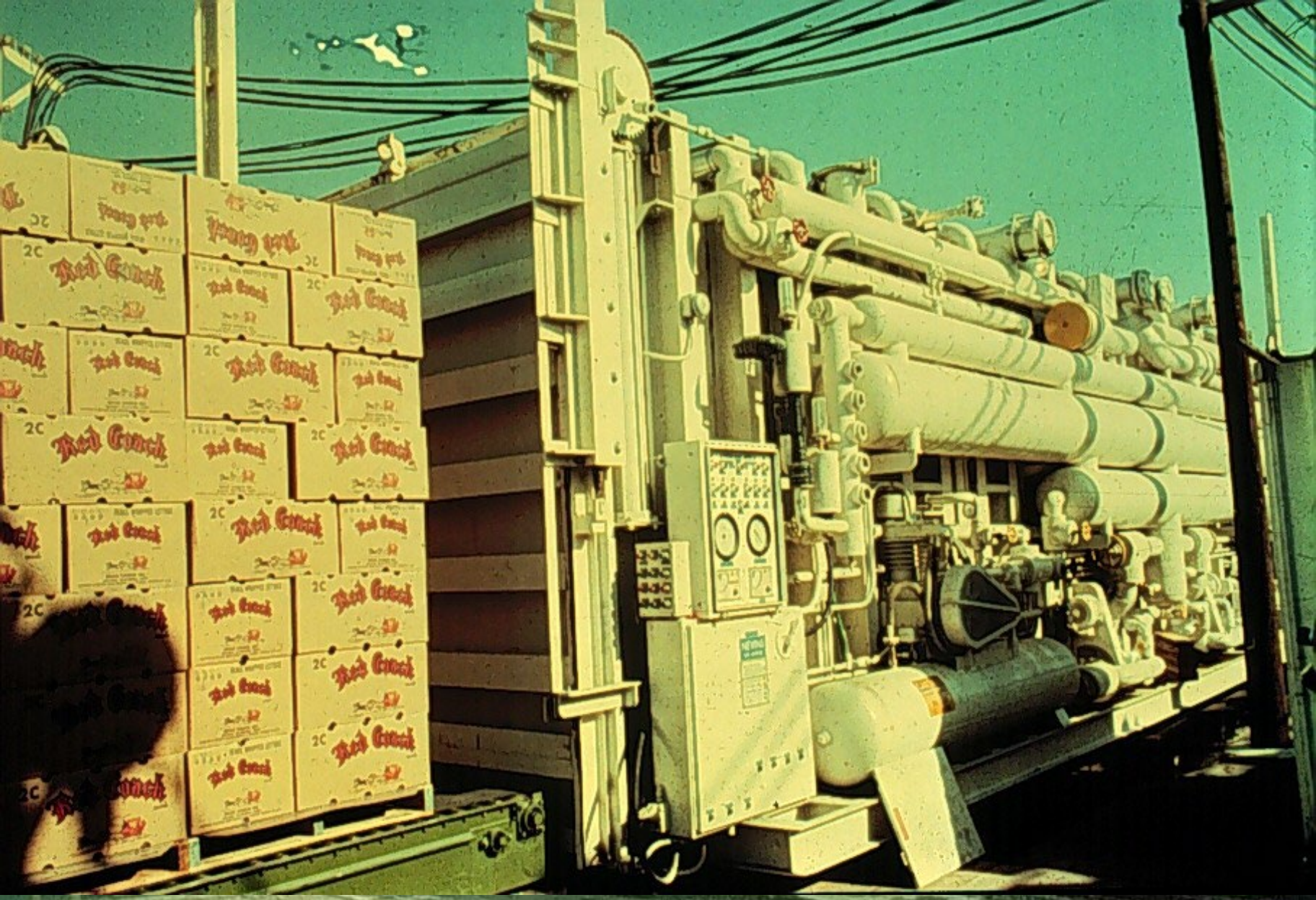
Pre-cooling is important



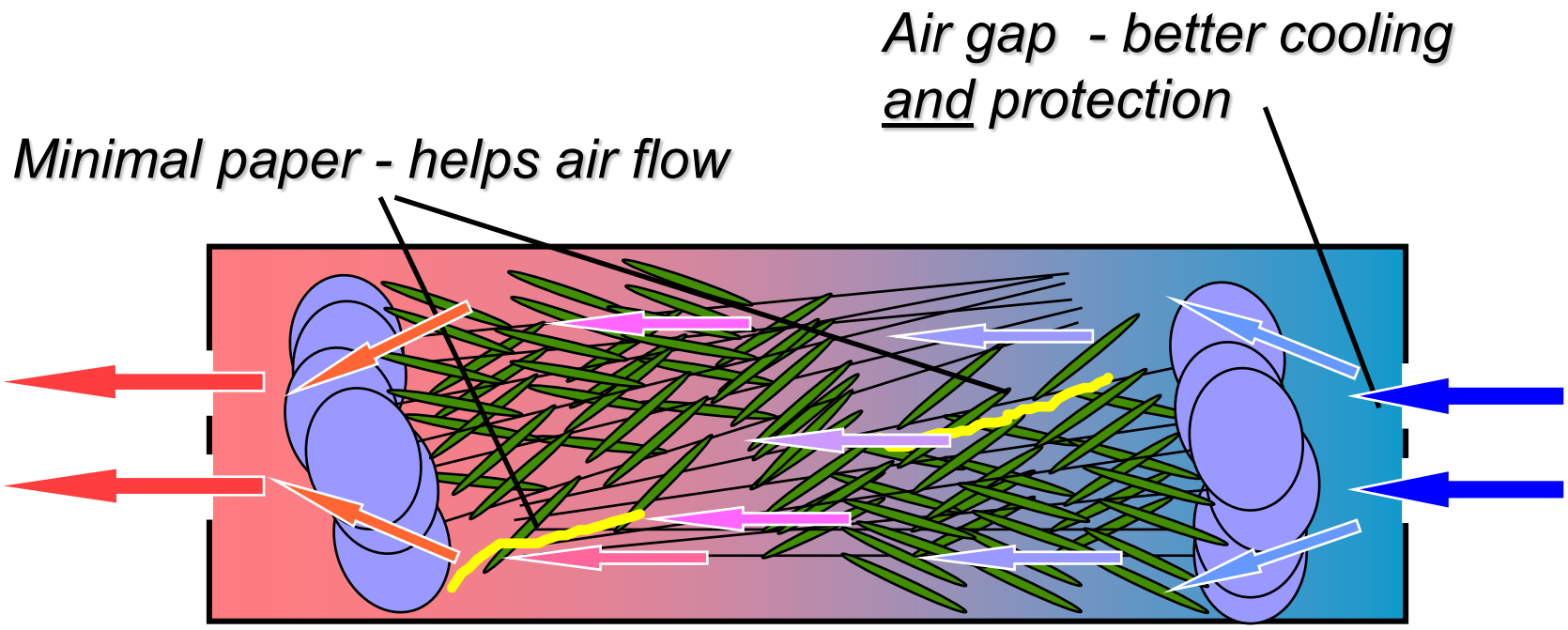

Forced-air cooled
Room cooled

Precooling – forced air is effective and inexpensive


RUSH

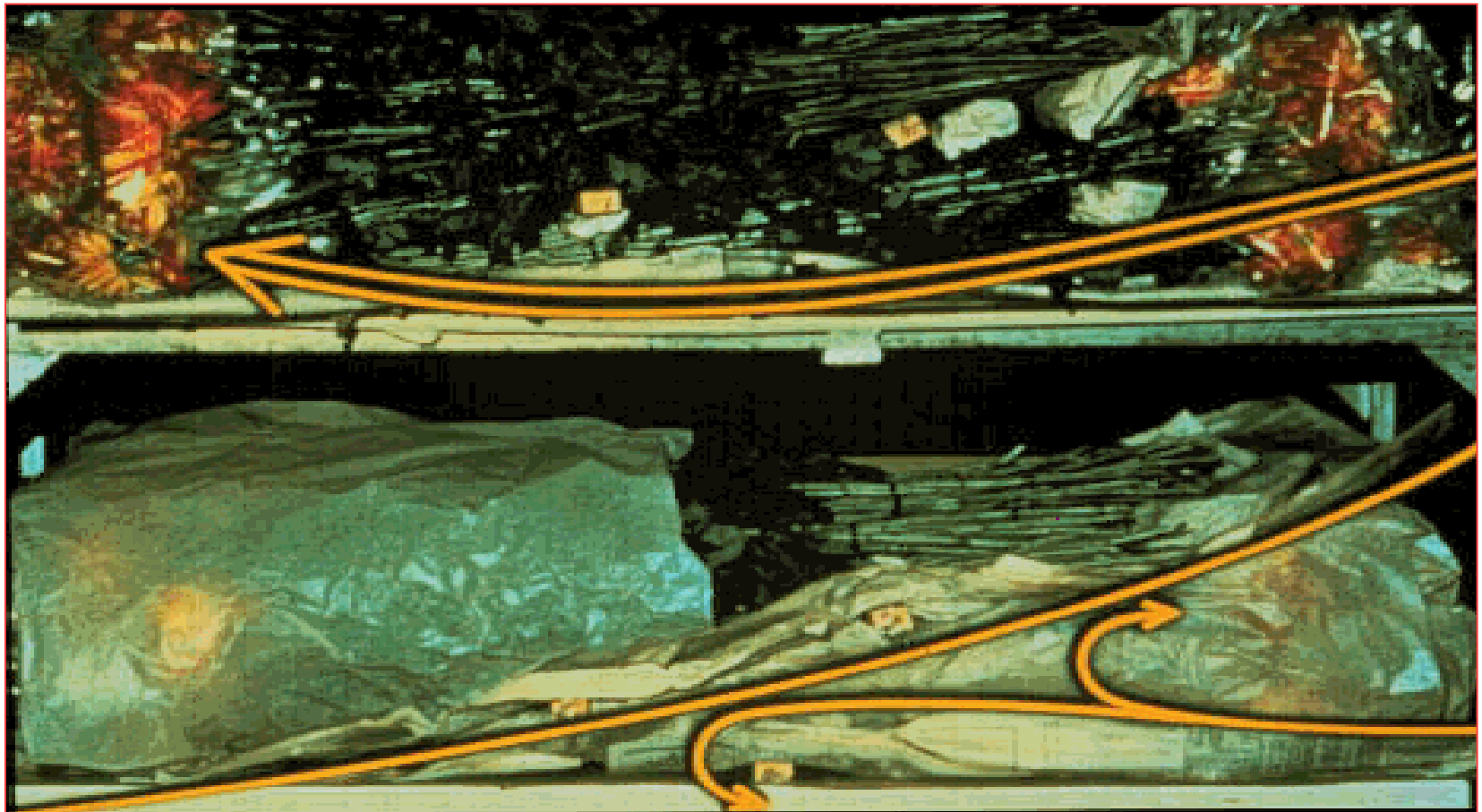

Red Cinch

Good packing = good cooling



Precooling – watch the details

Precooling – watch the details

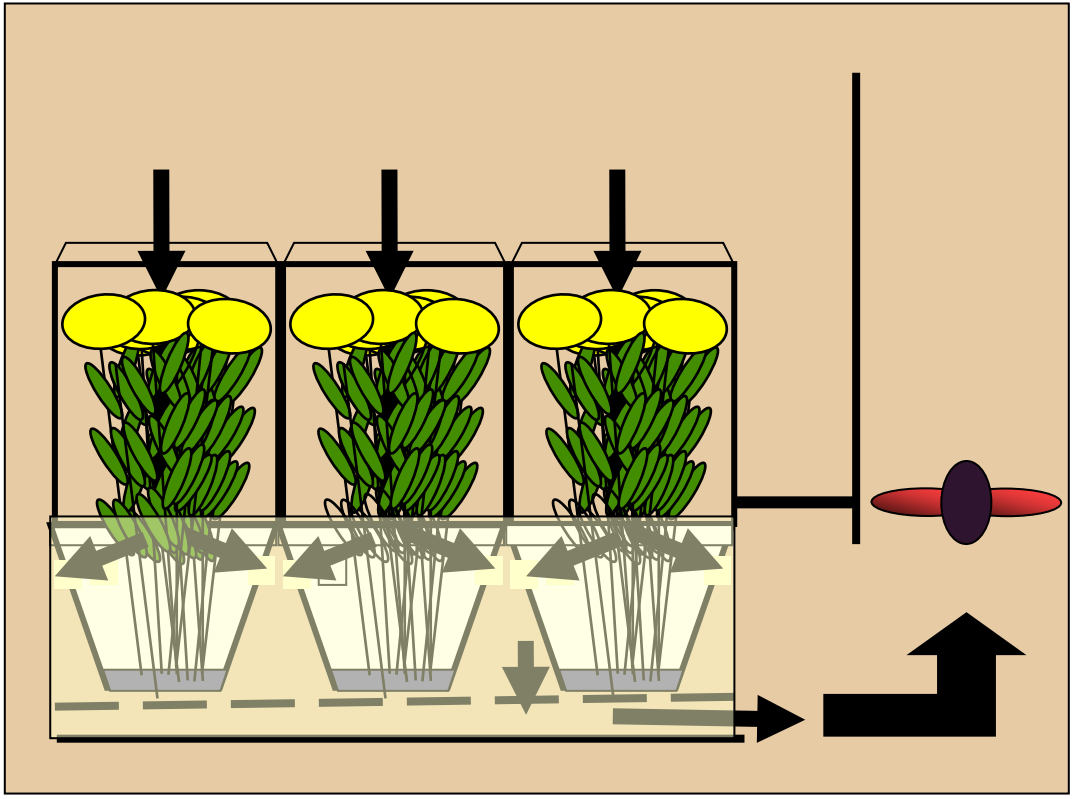


Precooling – watch the details

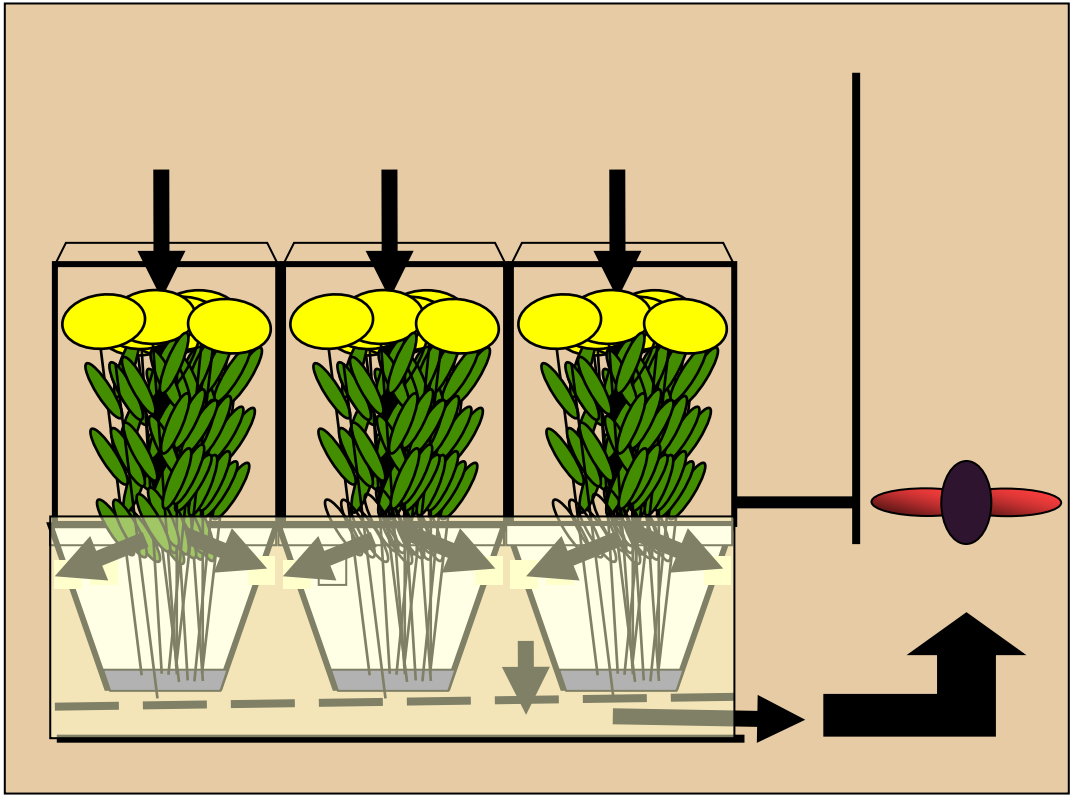

RUSH
FLOWERS
PERISHABLE
STYRO
40 x 20 x 12
CU. IN. 9600
CU. CM. 157,315
CALIFORNIA
FLOWERS
UP

Cooling Proconas

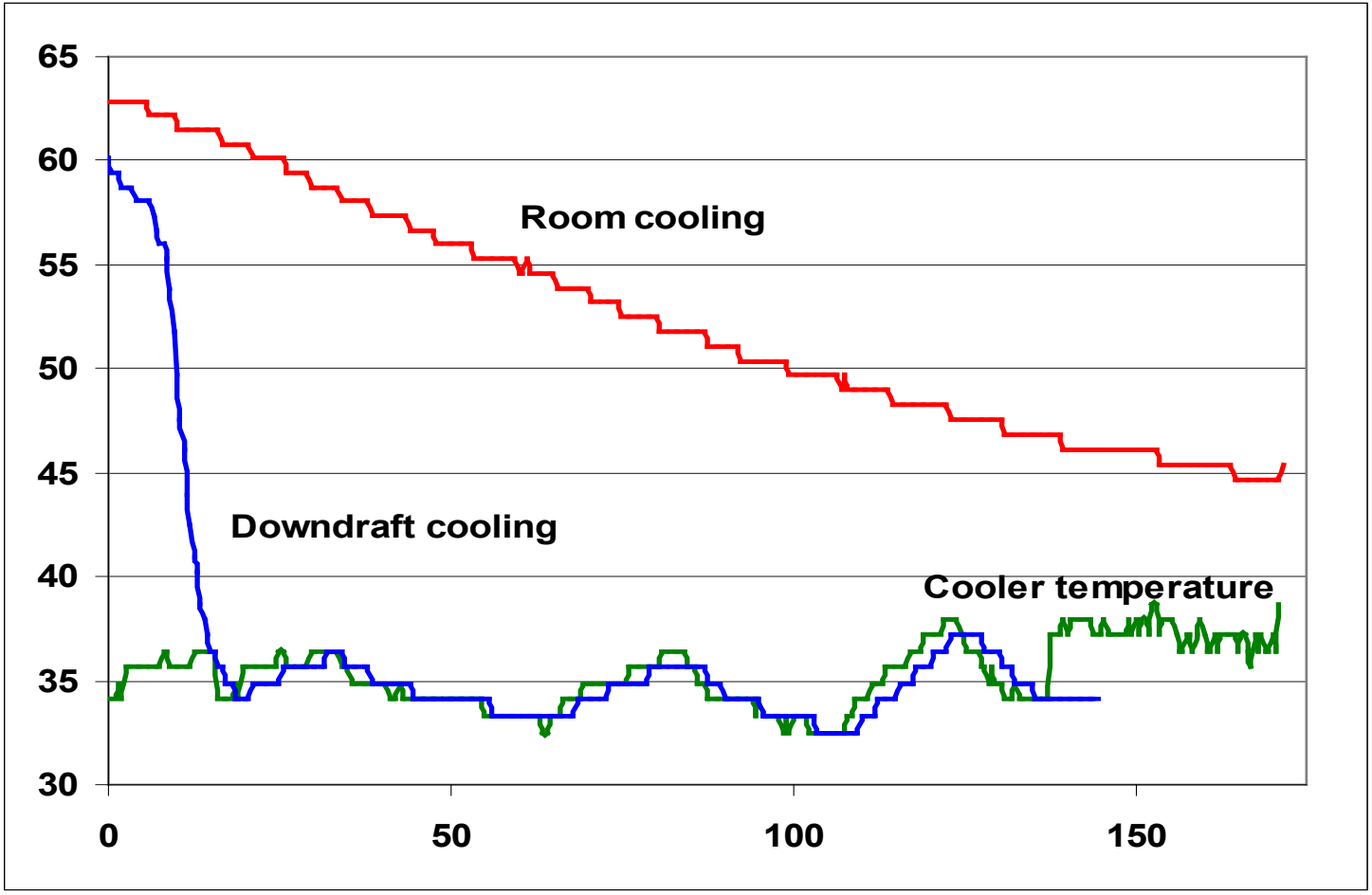
Preccoling Proconas



Preccoling Proconas

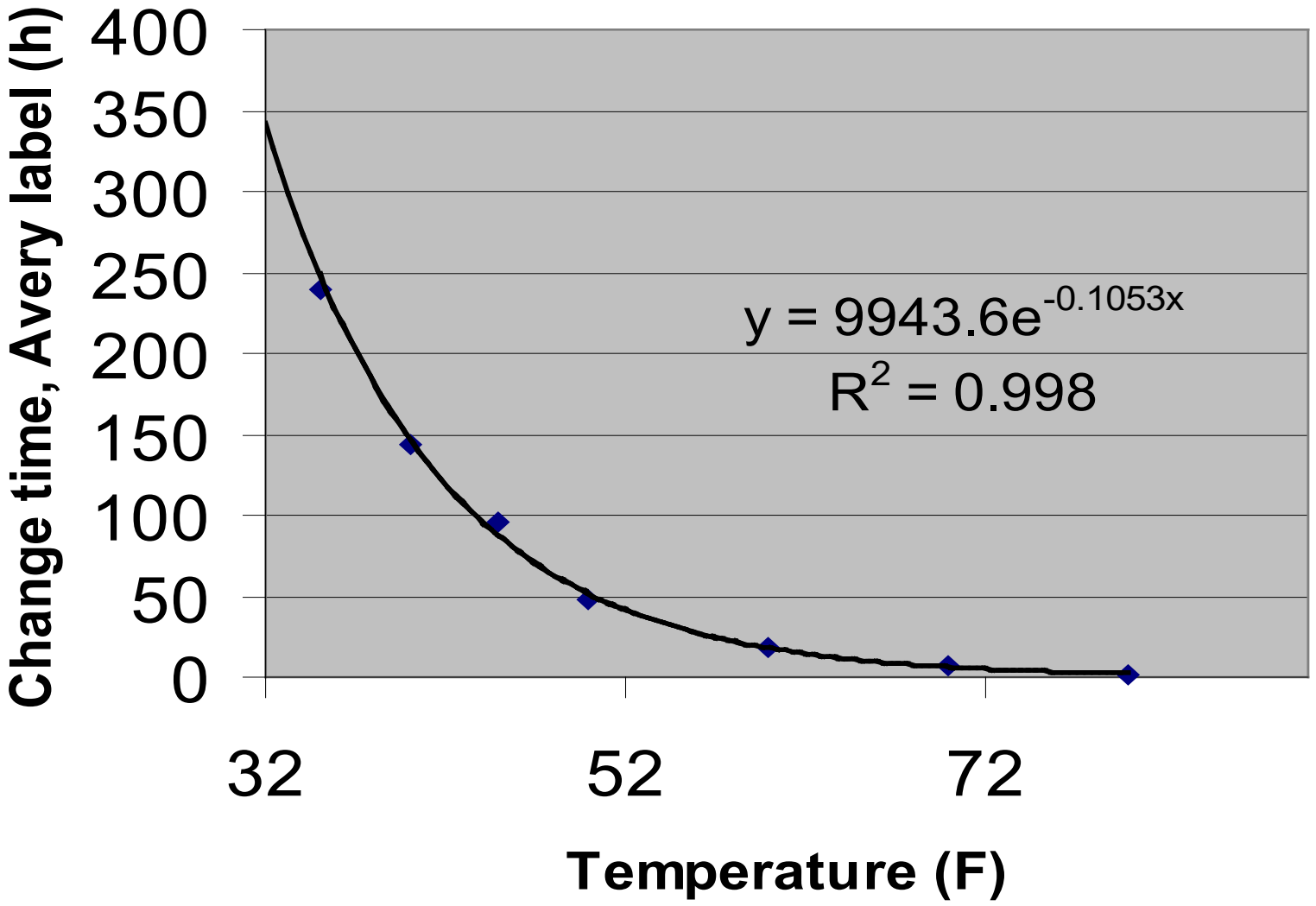


Works wonderfully



Time-temperature indicators

- Enzyme reaction changes a colored material from green to yellow
- Speed of the reaction depends on the temperature and the amount of enzyme
- 3-dot strips constructed for flower growers and shippers
- 1,2,4 days at temperatures >40 F
- ca. 35 cents per strip

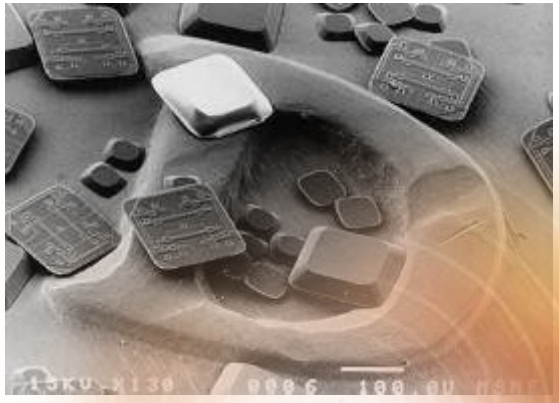

Change time, Avery label (h)
400
350
300
250
200
150
100
50
0
y = 9943.6e-0.1053x
R2 = 0.998
32
52
72
Temperature (F)

Radio Frequency ID

- Product ID, dates, replaces paper labels
- Coupled with temperature and gas sensors
- THERE WILL BE NO SECRETS!


TI·RFID
3Com
PalmIII
Dynasys
CyTherm ThermoPort
R-7665
GROUP

Passive Tag RFID Operation



1. Reader sends power & commands to the tag

TAG

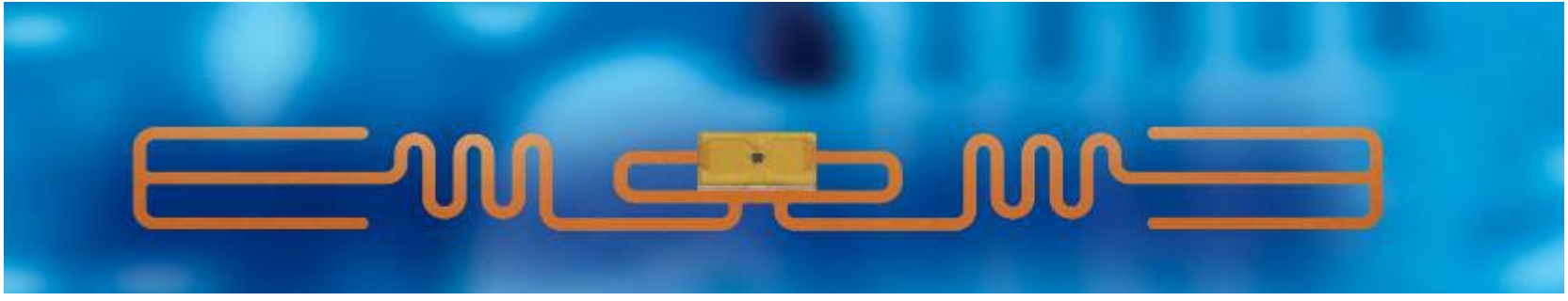
21.203D2A9.16E8B8.719BAE03C

2. Tag responds with data

READER

3. Reader sends data to host

Passive RFID tags



- **Approximate size: 95mm x 10mm**
- **Built into paper labels**
- **Very low cost**
- **Rapidly being adopted by major retailers**
    - **Walmart**
        - **Total adoption by 1/1/06**
        - **4 billion cases/pallets**

Active (battery-assisted) RFID Tag

- **Battery maintains RFID active**
- **Allows continuous environmental monitoring**
- **Temperature monitoring already implemented**

Active (battery-assisted) RFID Tag

- **Battery maintains RFID active**
- **Allows continuous environmental monitoring**
- **Temperature monitoring already implemented**


Infratab Control v106
Product Curve
Reference Temp 5
Reference Life 390
QTEN 3
Sample Rate 12
Temp. Calibration
Reference Temp 25
Reference Count 22905
Resolution 78
Temperature Ranges
Low Limit -30
Entries 0
Low Range -30
High Range 70
Entries 0
High Limit 70
Autorange
Table Contents
Index Temp Ticks Mantissa Exponer
0 -30.00 0 575 5
1 -26.78 516 970 -6
2 -23.55 516 691 -5
3 -20.33 516 986 -5
4 -17.10 516 702 -4
5 -13.88 516 1001 -4
Shelf Life vs. Temperature
Temp Predicted Computed Accuracy
-30.00 18418.47 18238.50 -0.99 %
-29.80 17974.95 17842.12 -0.74 %
-29.60 17510.58 17454.37 -0.32 %
-29.40 17095.43 17075.04 -0.12 %
-29.20 16674.86 16703.95 0.17 %
-29.00 16286.21 16340.93 0.33 %
-28.80 15926.49 15985.80 0.37 %
-28.60 15560.85 15638.39 0.50 %
-28.40 15232.13 15298.53 0.43 %
-28.20 14897.35 14966.05 0.46 %
Apply
In-Range Accuracy 1.34 %
Out-Range Accuracy 1.36 %
Control
Reset
Enable
Start
Program
Restore
Full
Quick
Commit
Calibrate
Get 25
Offset
Slope
Minute Rate 1
Init. Life Left 100
Poll Rate 10
Checkpoints 4
Read Limit
Reader: Awid COM1: Antenna 1
Tag ID: e0040000e0bcc901 (4)
Temperature 19.9
Freshness 99 %
State 6
Display Log
Display Histogram
Life 1 when freshness is < 90 %
Life 2 when freshness is < 80 %
Life 3 when freshness is < 50 %
Life 4 when freshness is < 25 %
Life 5 when freshness is < 5 %
Monitor
Excel
Read Config
Read Time
Custody
Temp 1 when temp is < -10 oC 10 times in a row
Temp 2 when temp is < 0 oC 10 times total
Temp 3 when temp is > 25 oC 4 times in a row
Temp 4 when temp is > 50 oC 2 times total
Time 1 when elapsed time > 60 minutes
Time 2 when elapsed time > 120 minutes
Power 1 when power brownout occurs
Power 2 when power blackout occurs
Histogram
start
Infratab Control 105
Infratab Control v106


oke


Coke

Questions?