Setting up for success: early season storage management

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Goals of Storage

Maintain quality and minimize losses

- Minimize carbohydrate loss – respiration loss
- Provide humidity to minimize evaporation losses
- Provide oxygen (fresh air)
- Remove carbon dioxide
- Remove heat; maintain desired temperature

Others

- Dry out wet potatoes
- Prevent disease spread/breakdown
- Maintain processing quality
- Avoid condensation
- Deal with sub-optimal potatoes, Consequence of sound ones


FOR
SALE

Early Storage Management

Cultivar Dependent

Conditions of early storage period → goals are to favor wound healing and stabilize pile conditions

Conditions at this time will also affect:

- Wound healing
- Fry color
- Weight loss
- Disease development
- Moisture/condensation on tubers
- Quality

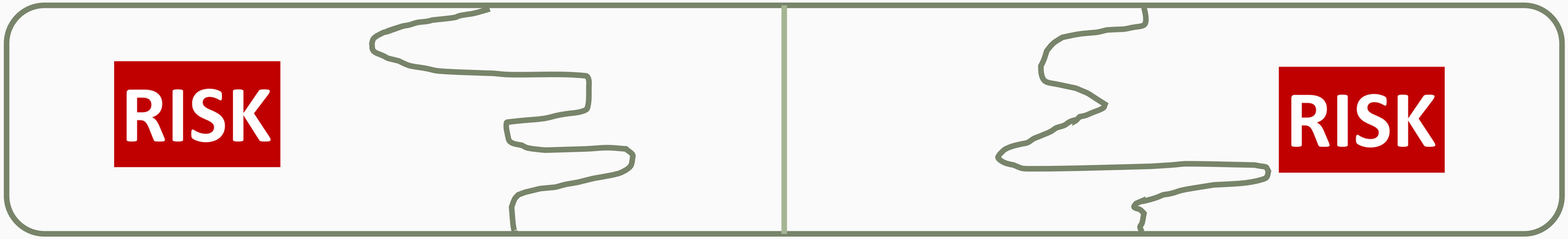
Current industry recommendation:

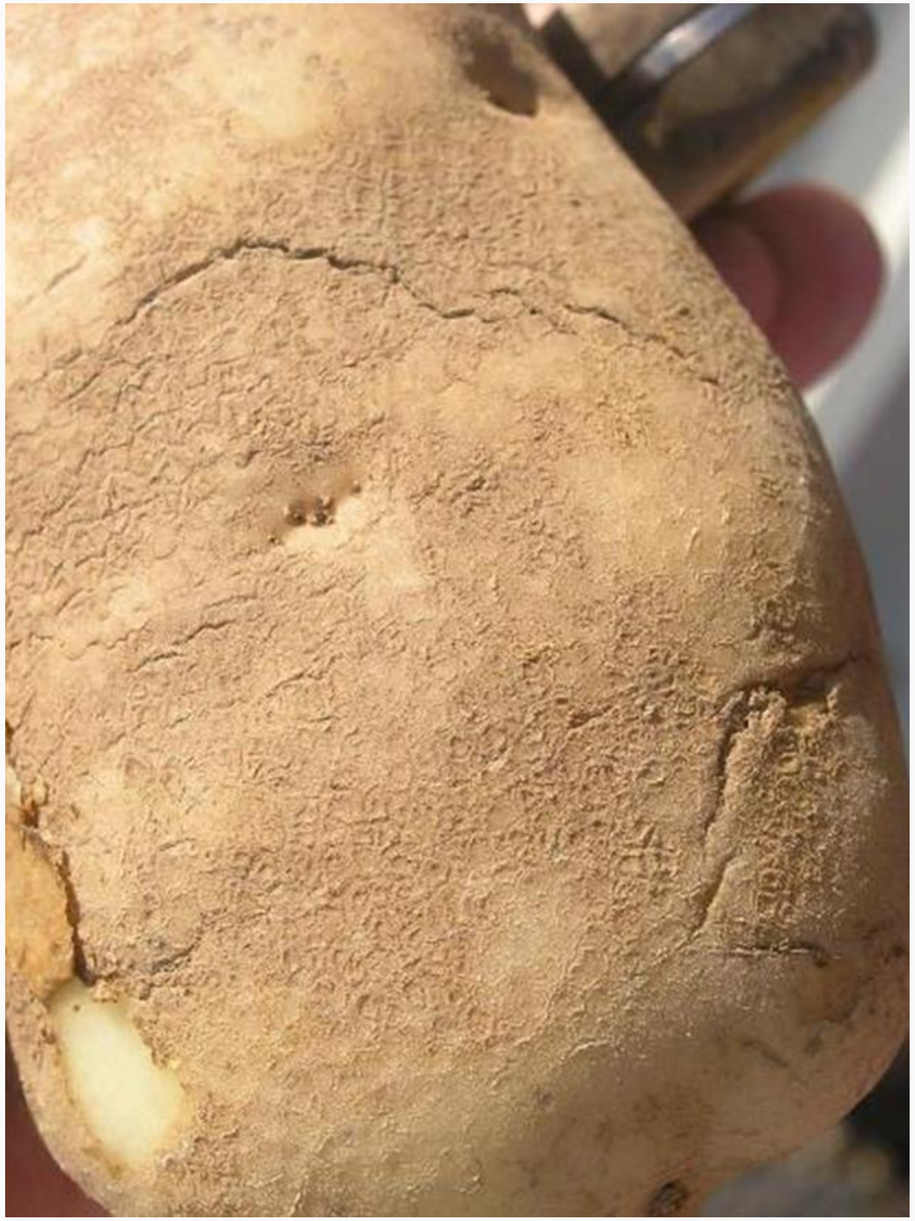
- Harvest with pulp temperatures 45-65°F
- Remove field heat immediately
- Cure at 50 to 55°F* for 2-3 weeks
- Followed by ramping to holding temperature (0.1 to 0.5°F/day)
  - **higher if need for processing quality/pre-conditioning*
- Holding temperature appropriate for market and variety

Current industry recommendation:

- **Harvest with pulp temperatures 45-65°F**
- Remove field heat immediately
  - *Remove heat, heat of respiration, provide oxygen, remove CO2*
- Cure at 50 to 55°F for 2-3 weeks
- Followed by ramping to holding temperature (0.1 to 0.5°F/day)

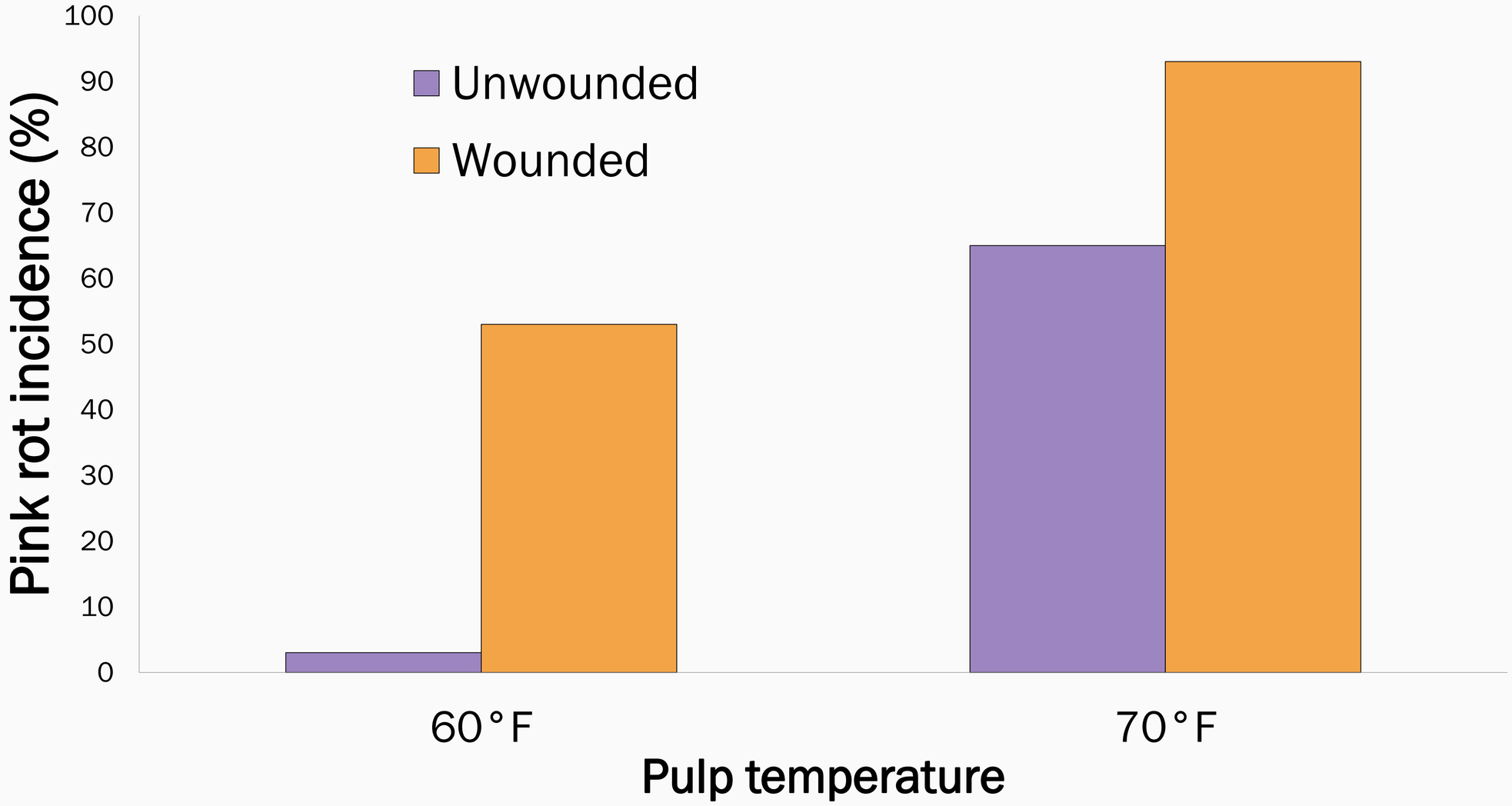
Risk when harvest outside ideal range



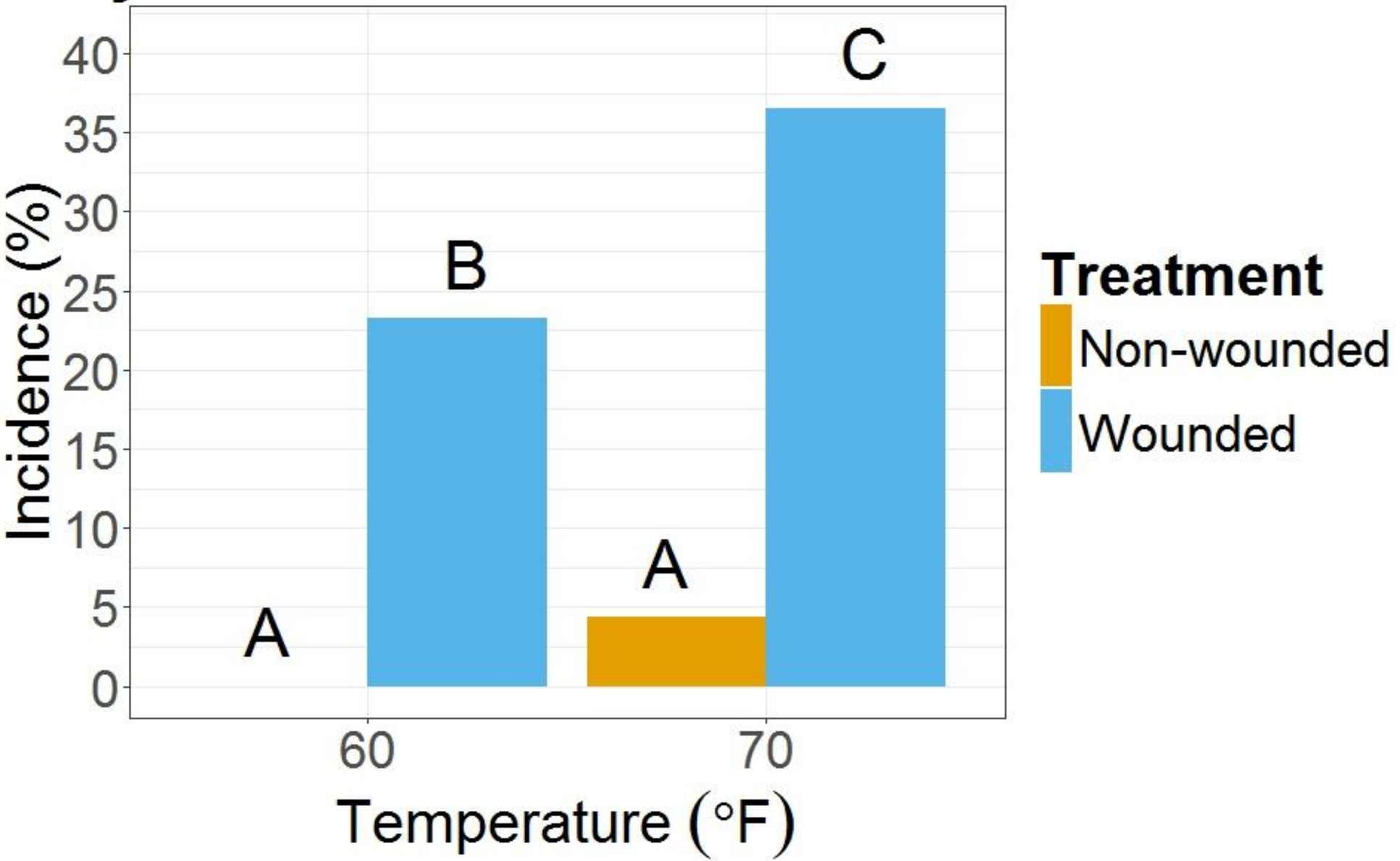


Pink rot

Effect of Temperature on Pink Rot Development



Wounding and Temperature effect on Pythium Leak on Russet Norkotah




310C

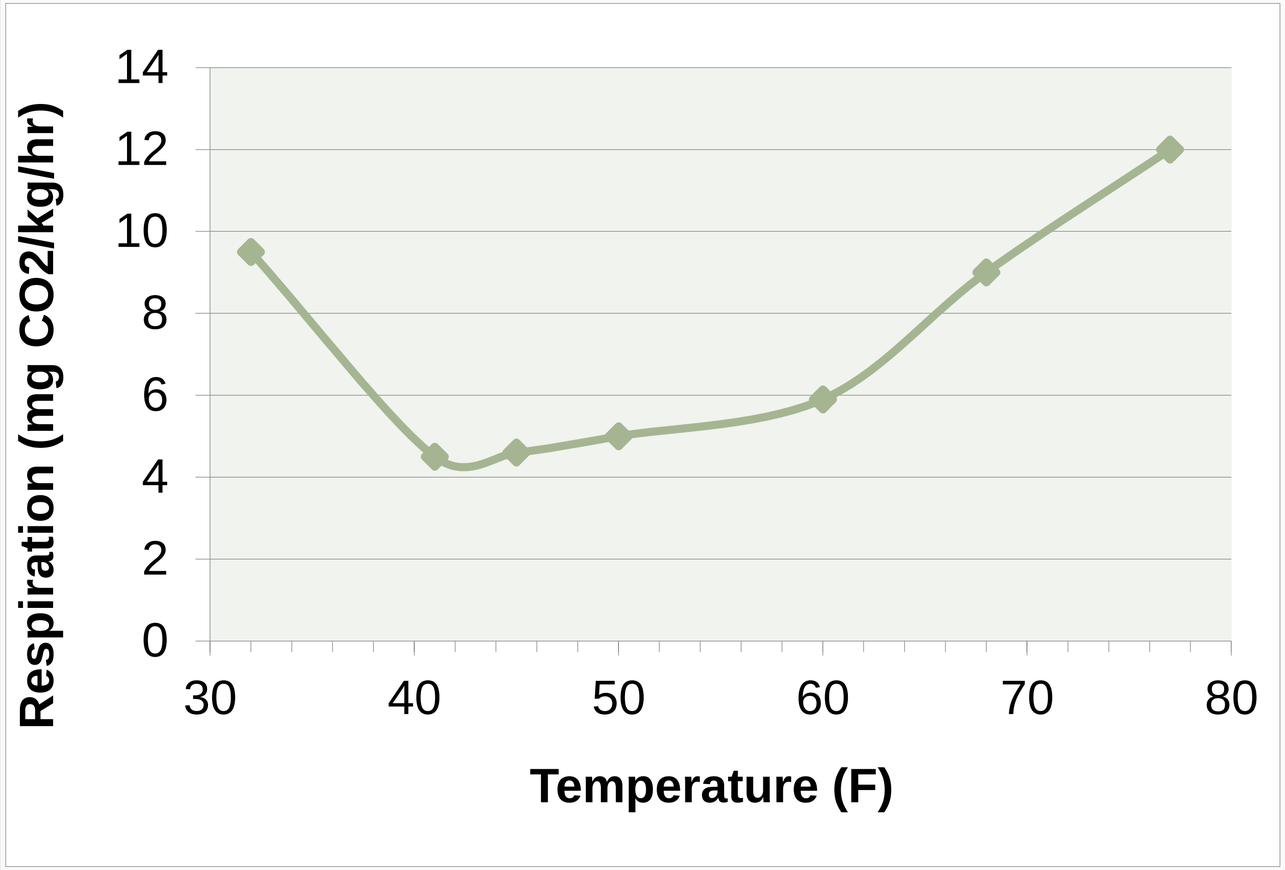
Current industry recommendation:

- Harvest with pulp temperatures 45-65°F
- **Remove field heat immediately**
  - *Remove heat, heat of respiration, provide oxygen, remove CO2*
- Cure at 50 to 55°F for 2-3 weeks
- Followed by ramping to holding temperature (0.1 to 0.5°F/day)


3
NordicAire

RESPIRATION RATES AND TEMPERATURE

- **Highest at harvest**
- Variety specific
- Temperature
- Disease/Stress
- Sprouting



Burton, 1978

If stop harvesting at 65°F…

- Theoretically, if put in storage and no cooling air…
- Respiration:

$$C_6H_{12}0_6 + O_2 \longrightarrow CO_2 + H_2O + \text{energy (heat)}$$

- Heat of respiration = 0.5 BTU/cwt/hour
  - 10 times higher if wounded, immature, diseased, etc.

…65°F turns into 70°F after 12 hours

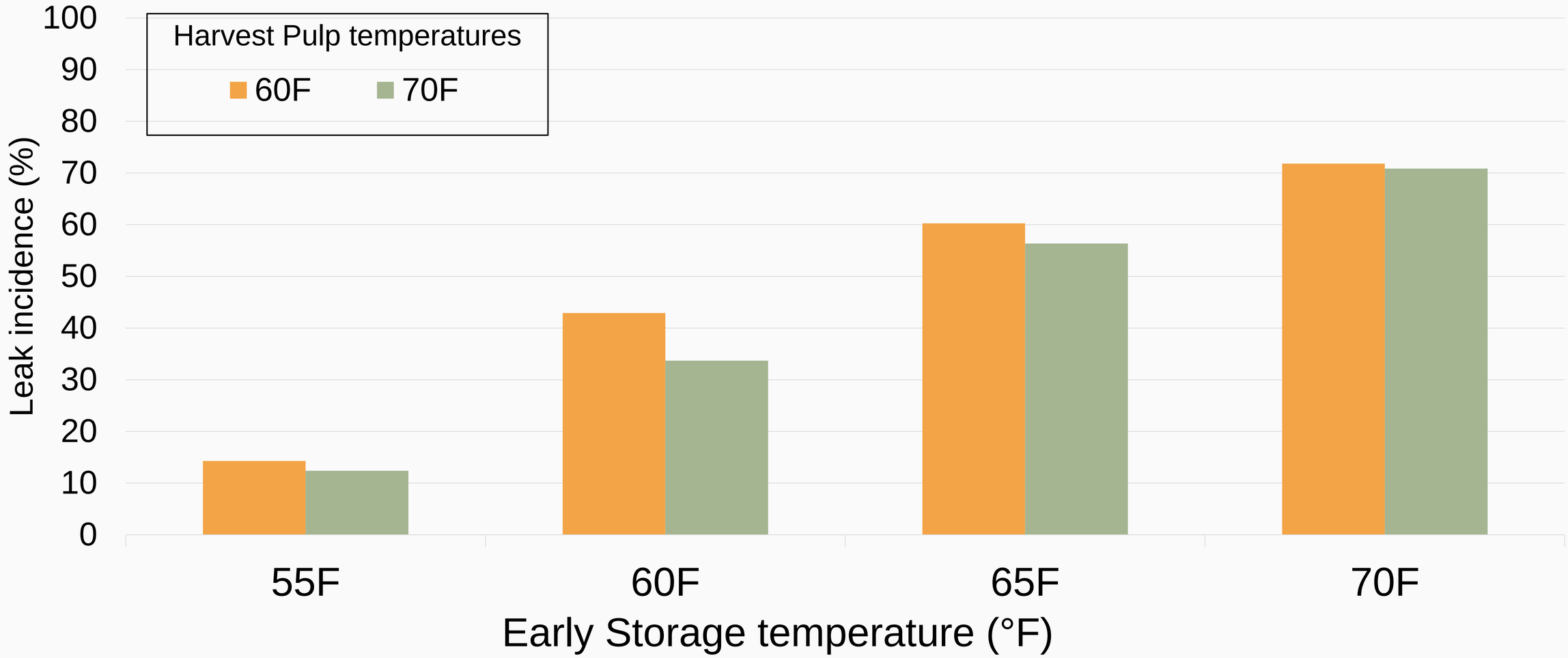
Day 1

Day 2

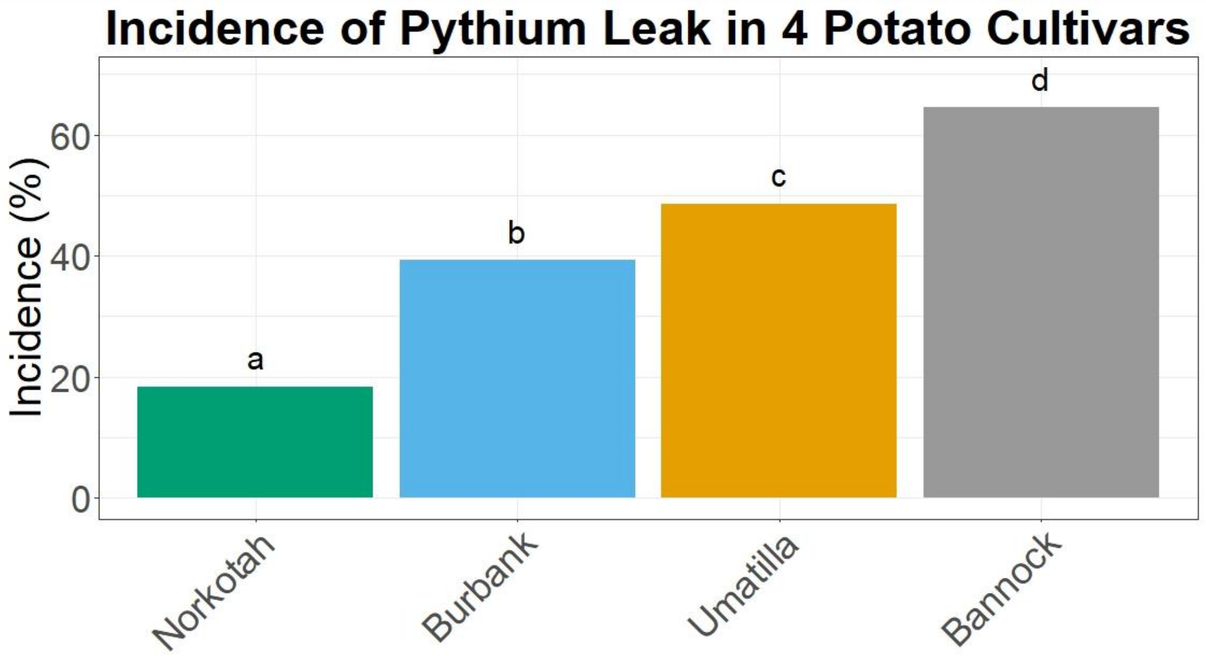
Day 3

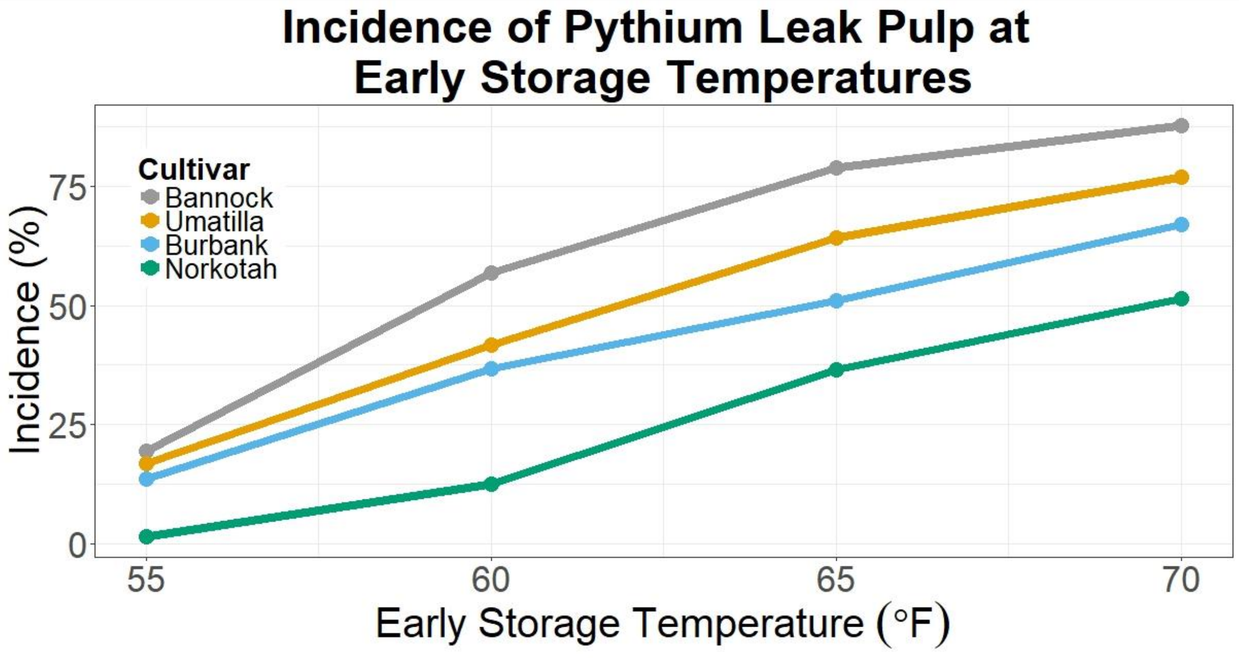
Day 4

Cultivars Inoculated at Pulp Temperatures of 60 and 70°F then Subjected to Different Storage Temperatures (4 days only)



Cultivar and storage temperature on leak





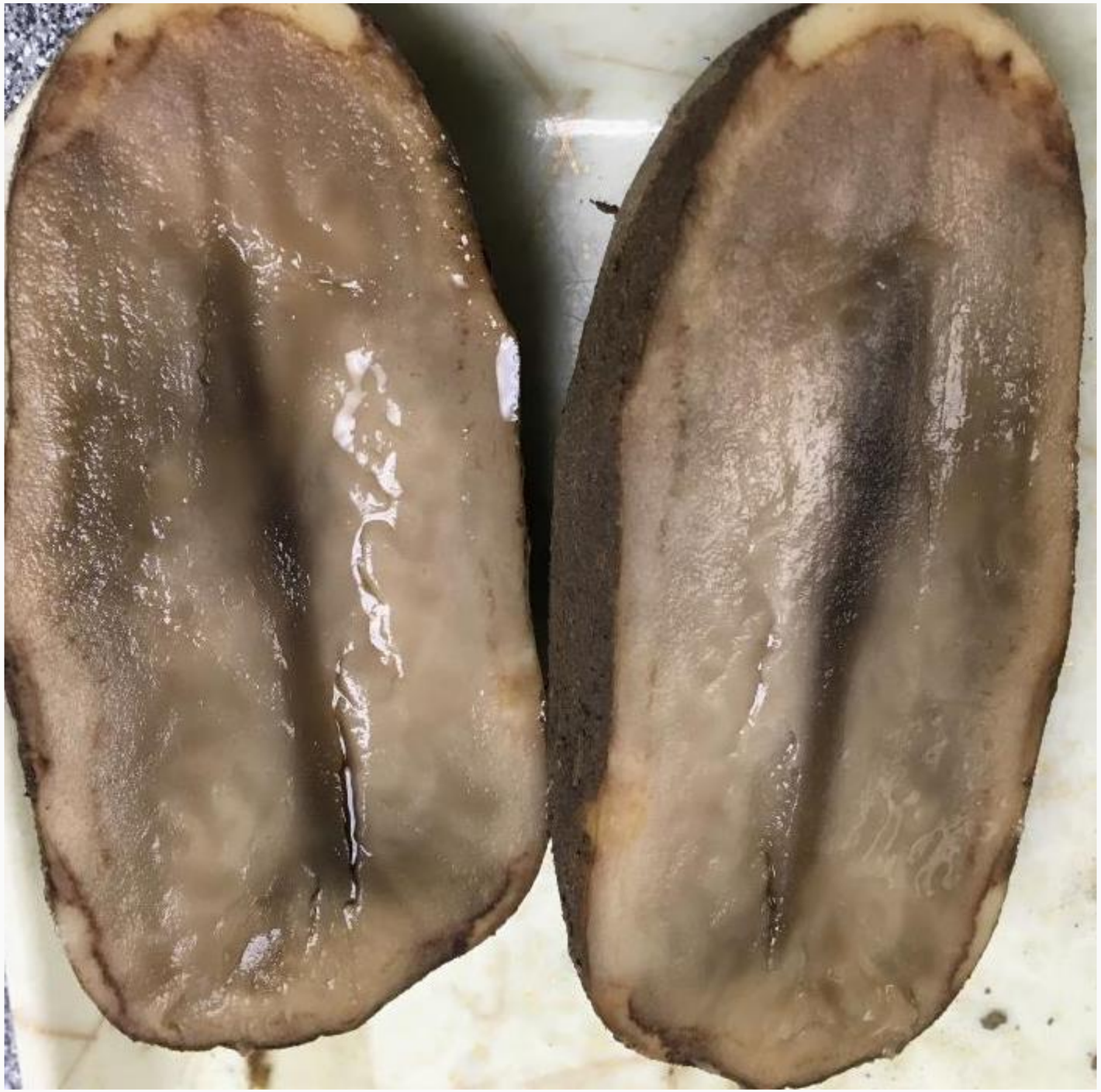
Values followed by the same letters are not significantly different ($\alpha<0.05$) for each graph.

Soft Rot

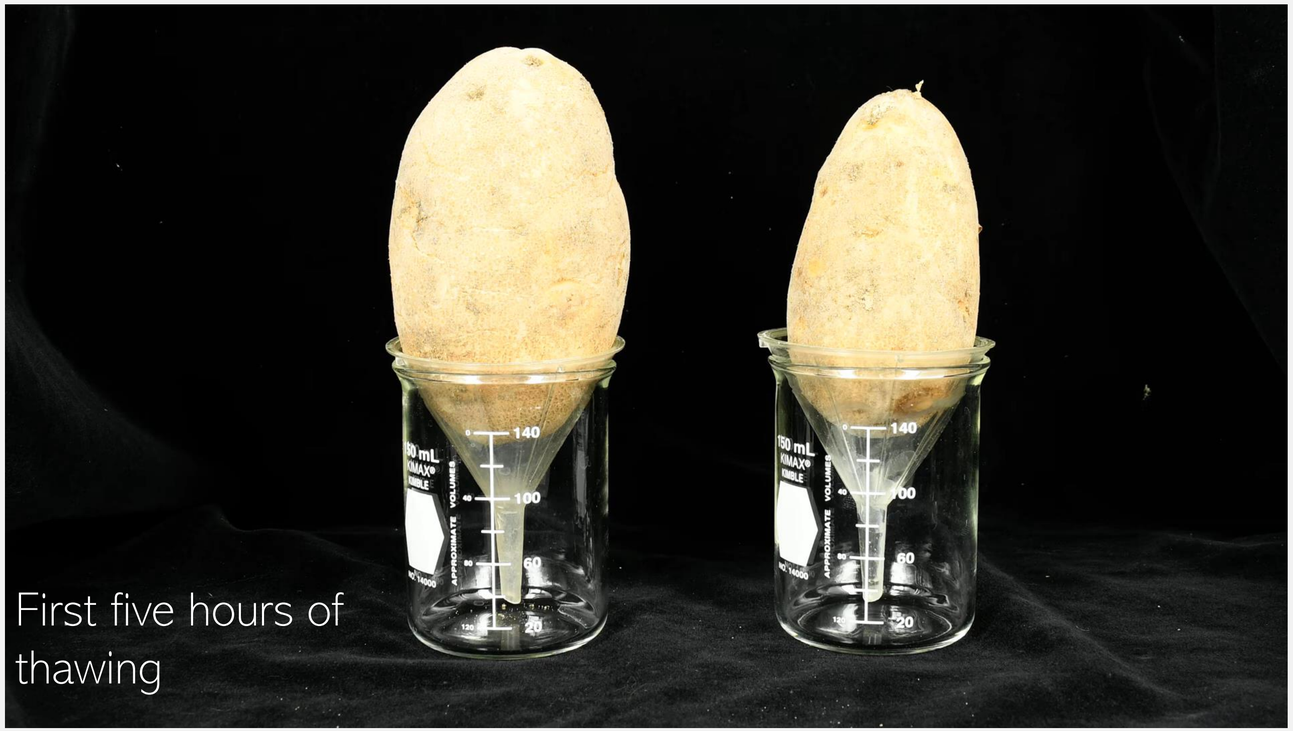
Decrease ability for soft rot to multiply as decrease temperature

- Above 60°F = high level
- Below 60°F dramatic decrease in multiplication

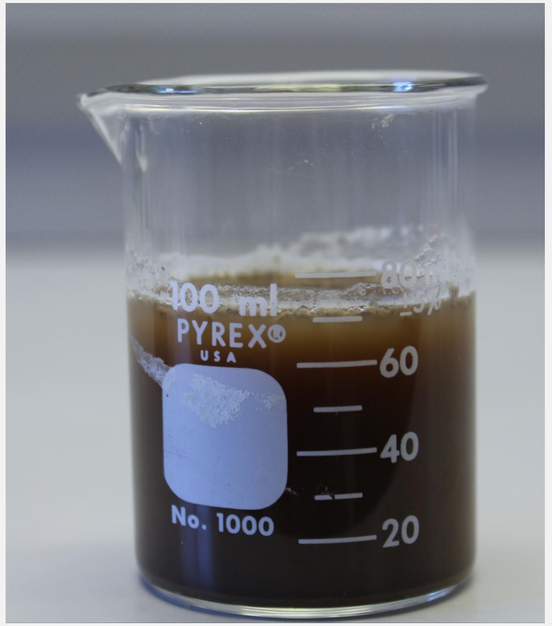
Cool down ASAP- maximize run time



How much liquid?



24 hours later



Russet Burbank
70ml

10% frozen = 560,240 L of water =

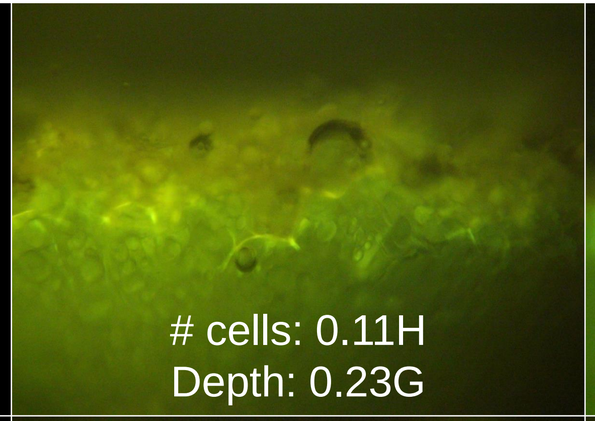
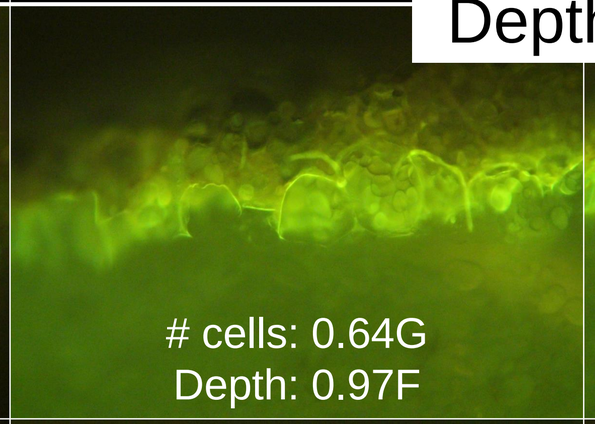
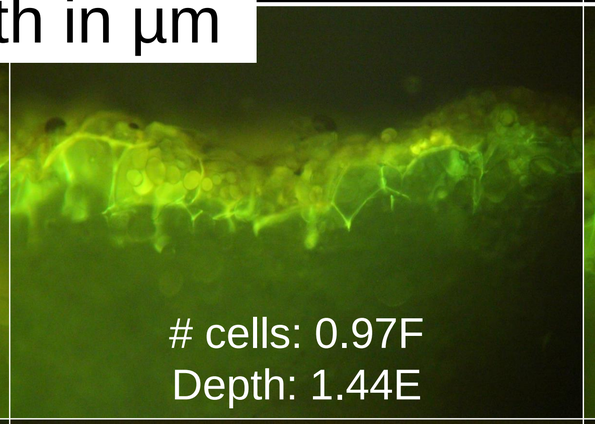
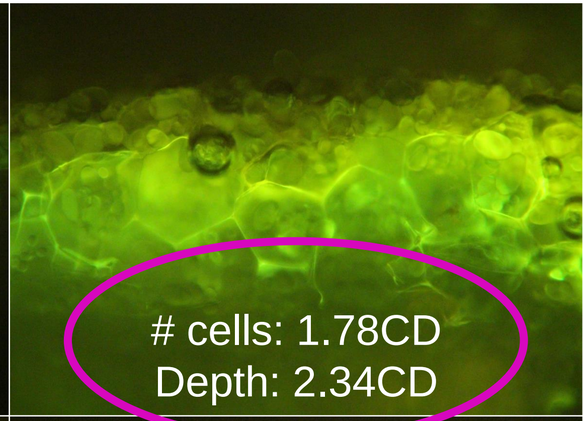
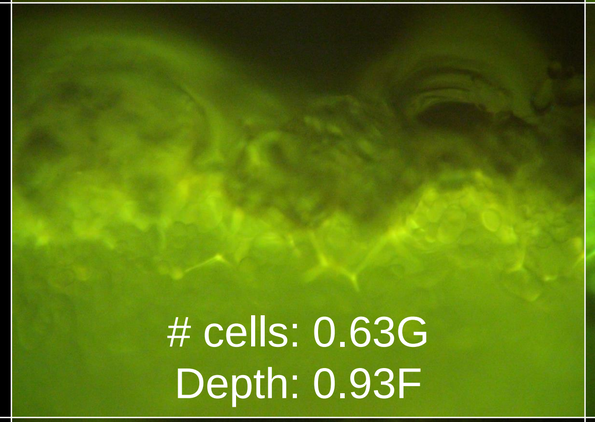
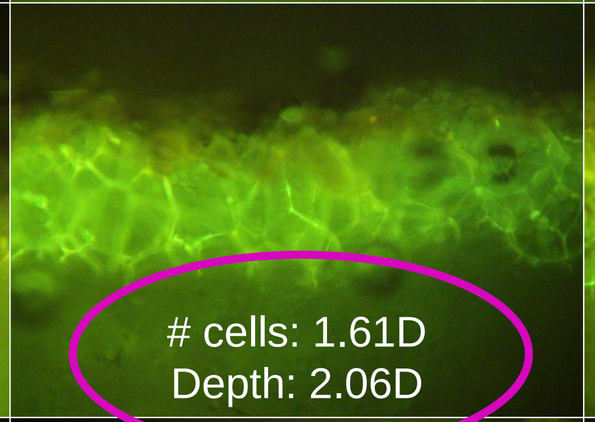
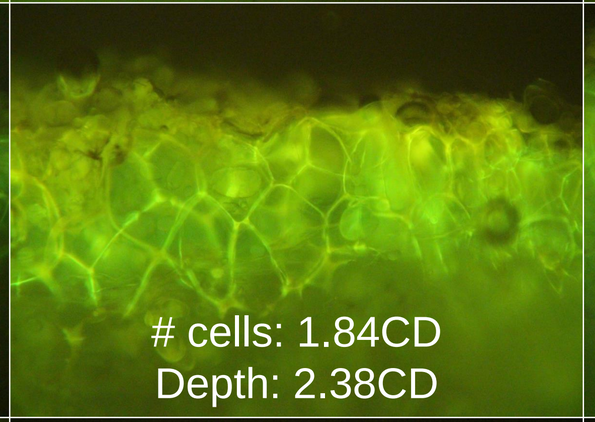
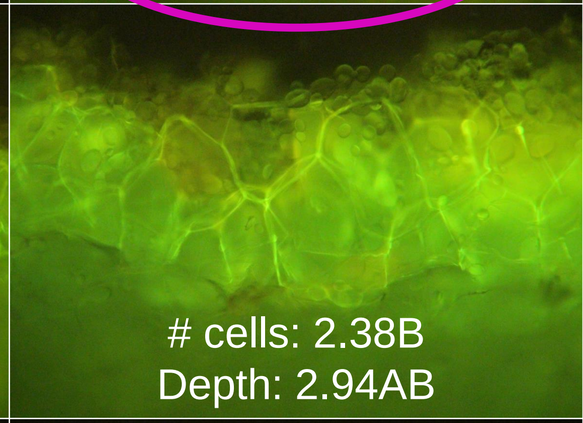
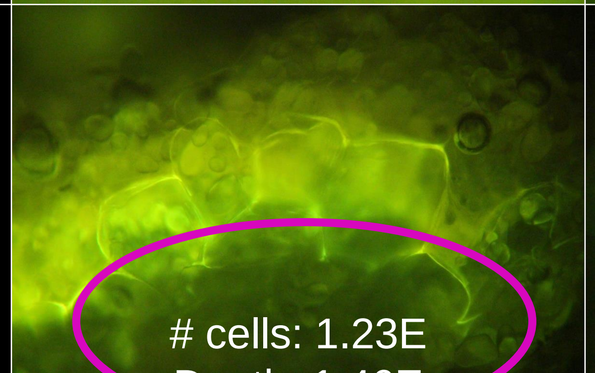
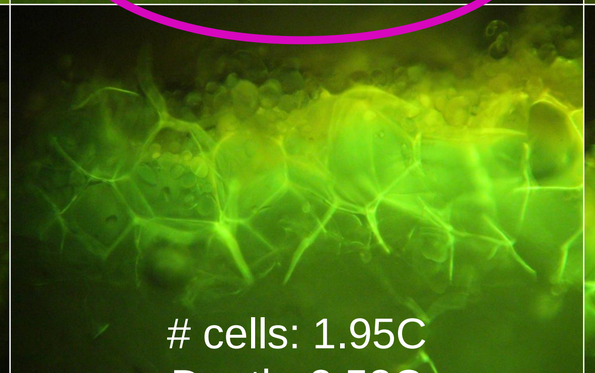
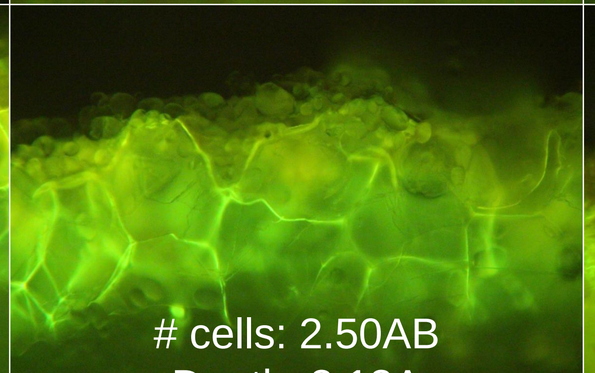
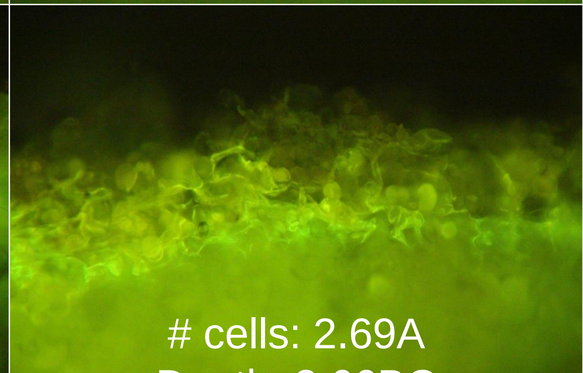
×23

Current industry recommendation:

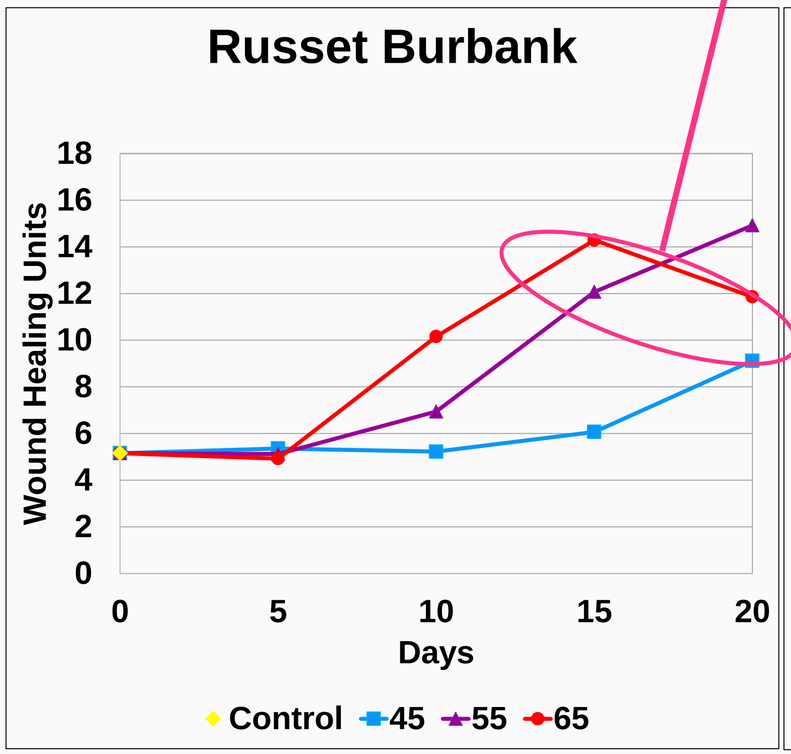
- Harvest with pulp temperatures 45-65°F
- Remove field heat immediately
- **Cure at 50 to 55°F for 2-3 weeks**
  - ***95+% RH***
- Followed by ramping to holding temperature (0.1 to 0.5°F/day)

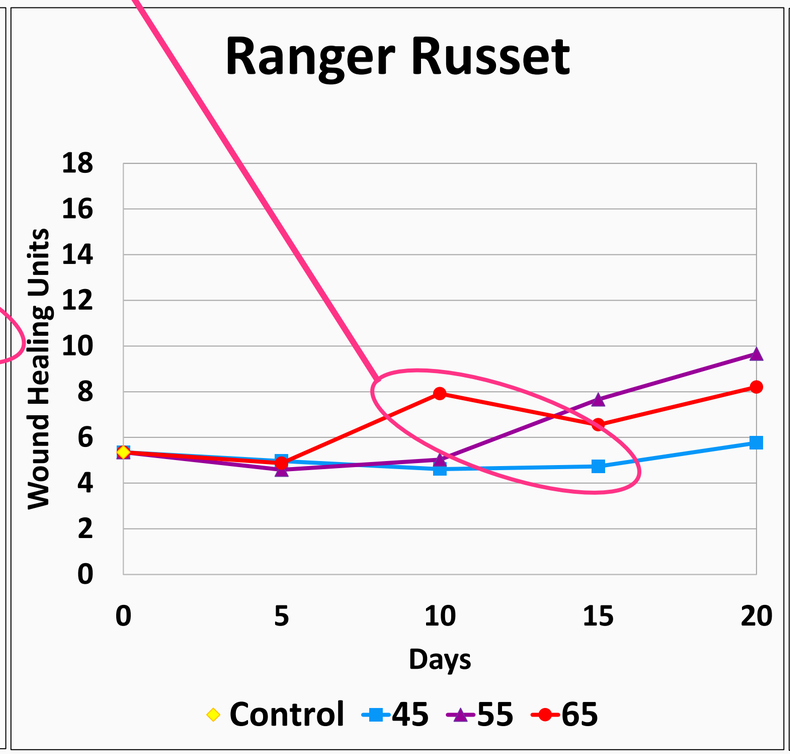
Wound healing

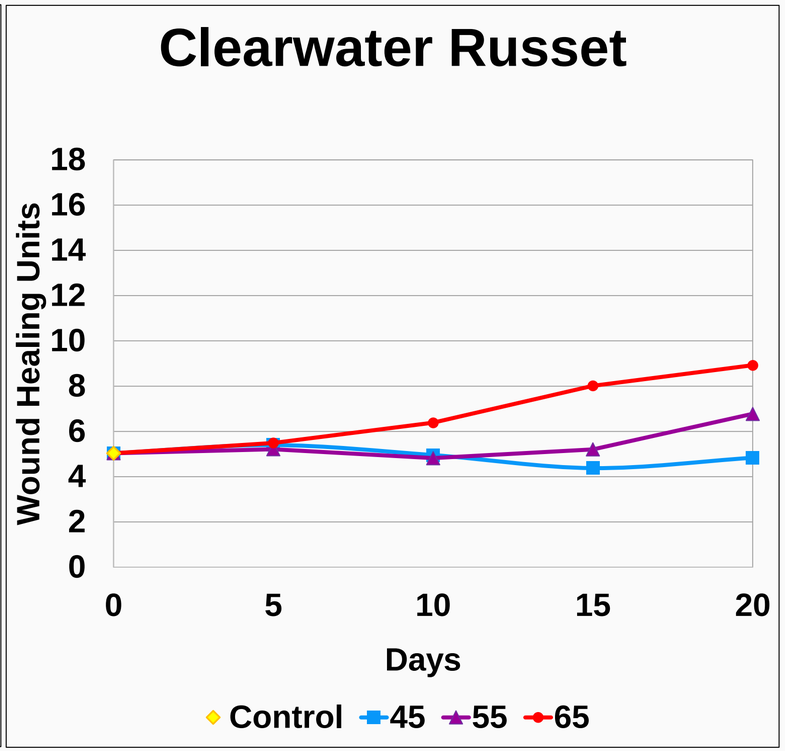
- Goal– minimize water loss and disease control
- Conditions at this time will also affect:
  - Sugars - conditioning
  - Weight loss
  - Moisture/condensation on tubers
  - Quality
  - Disease development
- Regardless, takes time to heal….

Russet Burbank	5 day	10 day	15 day	20 day
45°F	 # cells: 0.11H Depth: 0.23G	 # cells: 0.64G Depth: 0.97F	 # cells: 0.97F Depth: 1.44E	 # cells: 1.78CD Depth: 2.34CD
55°F	 # cells: 0.63G Depth: 0.93F	 # cells: 1.61D Depth: 2.06D	 # cells: 1.84CD Depth: 2.38CD	 # cells: 2.38B Depth: 2.94AB
65°F	 # cells: 1.23E	 # cells: 1.95C	 # cells: 2.50AB	 # cells: 2.69A

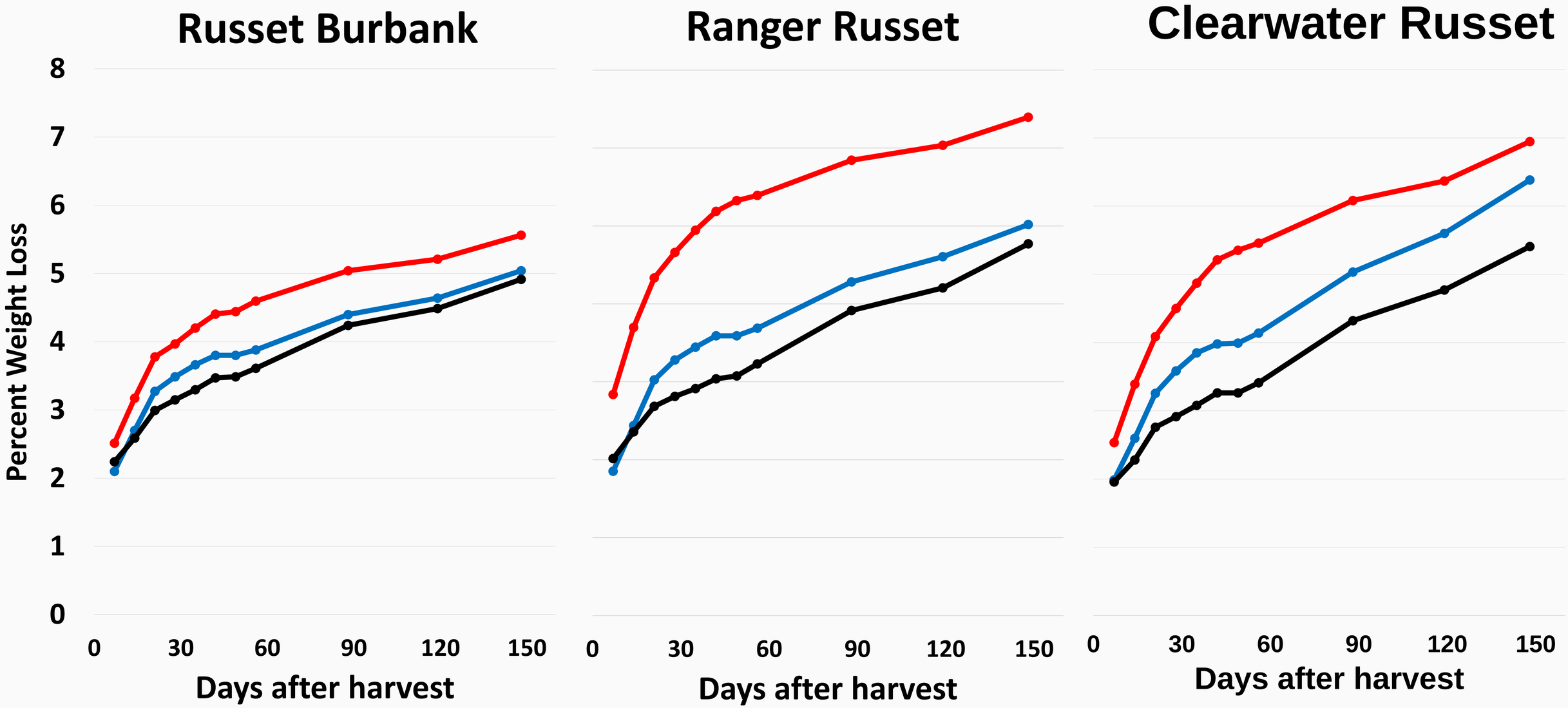
Depth in µm


Russet Burbank
Wound Healing Units
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
Days
Control
45
55
65

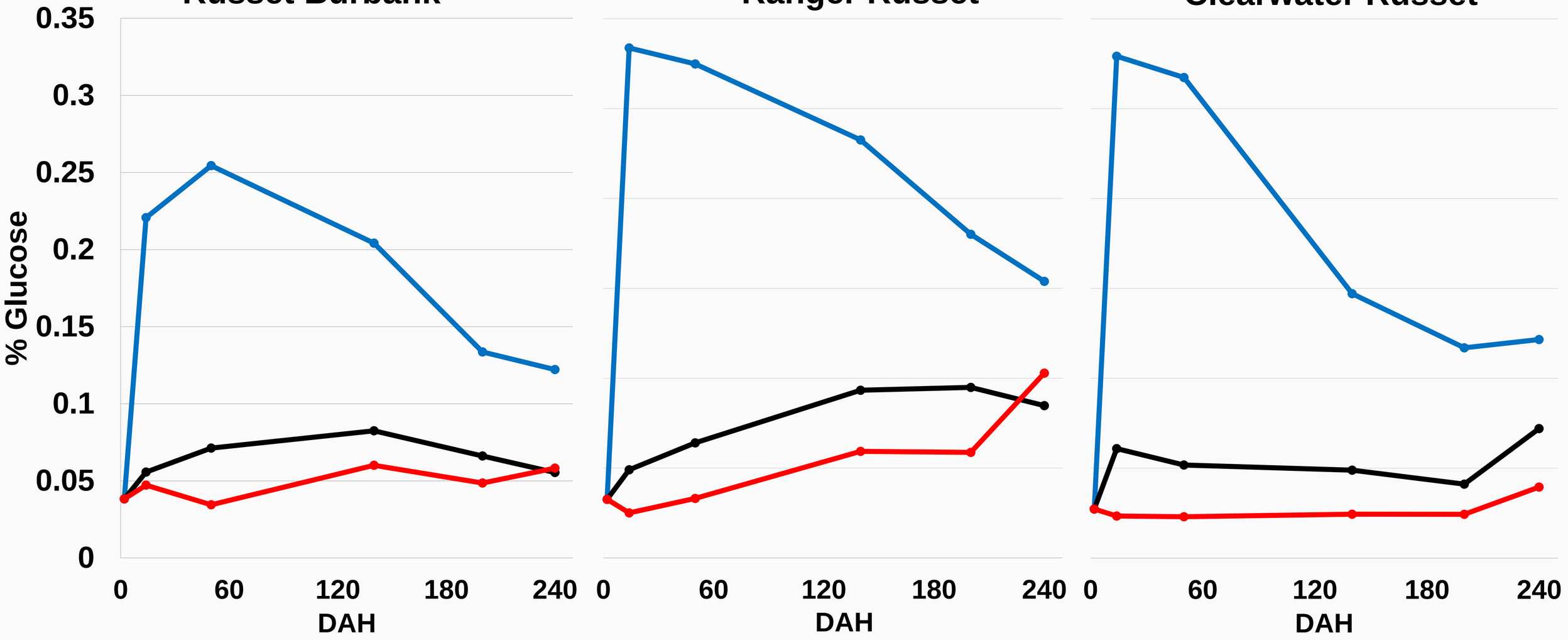

Ranger Russet
Wound Healing Units
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
Days
Control
45
55
65


Clearwater Russet
Wound Healing Units
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
Days
Control
45
55
65

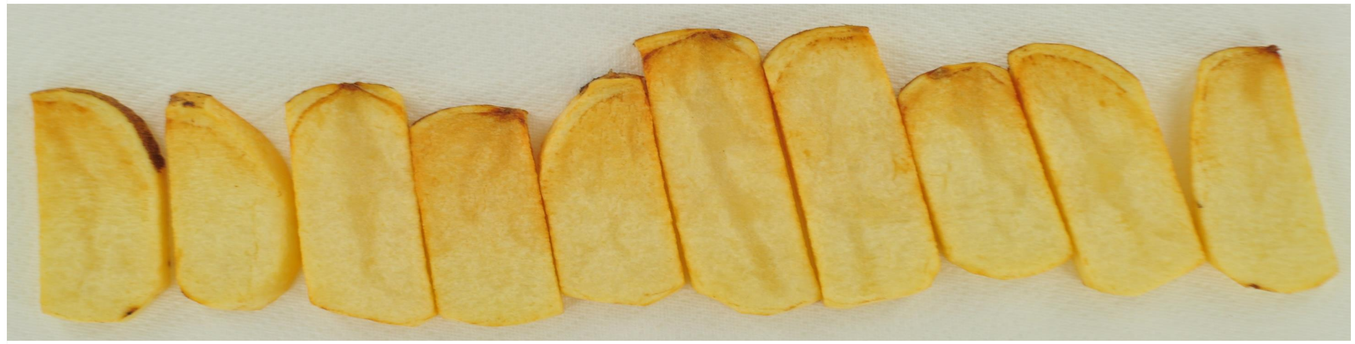
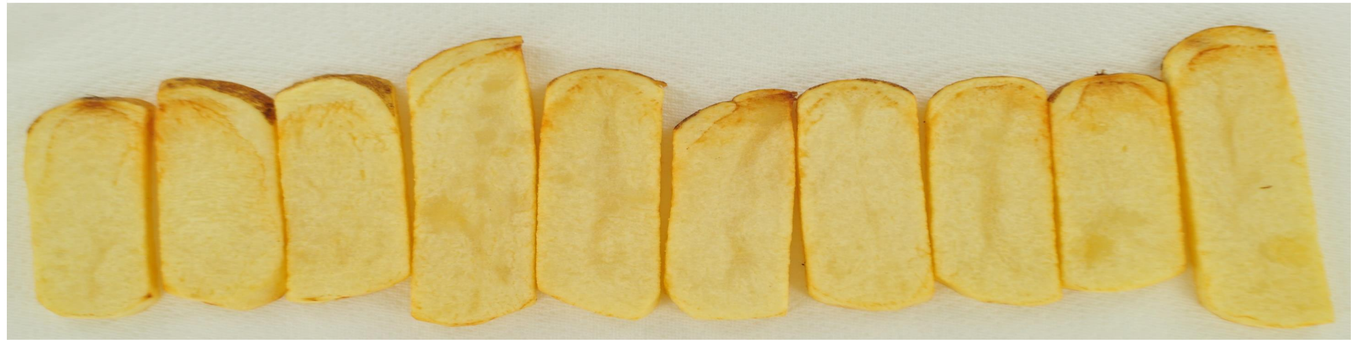
Accumulated Weight Loss Overtime in Storage as Impacted by Curing Temperatures (2 weeks only at beginning of storage- 45, 55 or 65°F)



Percent glucose in storage as impacted by curing temperatures (2 weeks only at beginning of storage- 45, 55 or 65F)

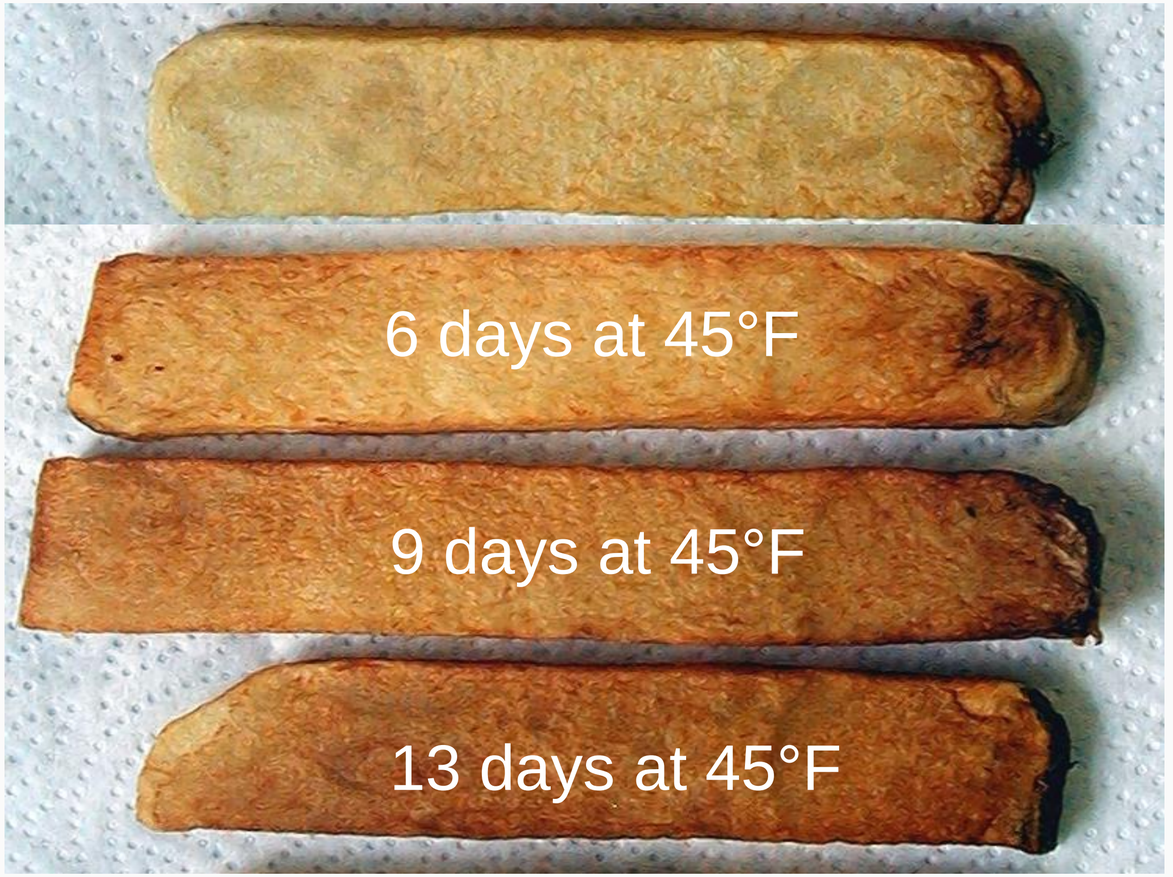


Clearwater Russet Fry Color

Curing Temperature	140 DAH (~4.5 months)
45°F c	
55°F b	
65°F a	

Different letters designate significant differences, P<.05.

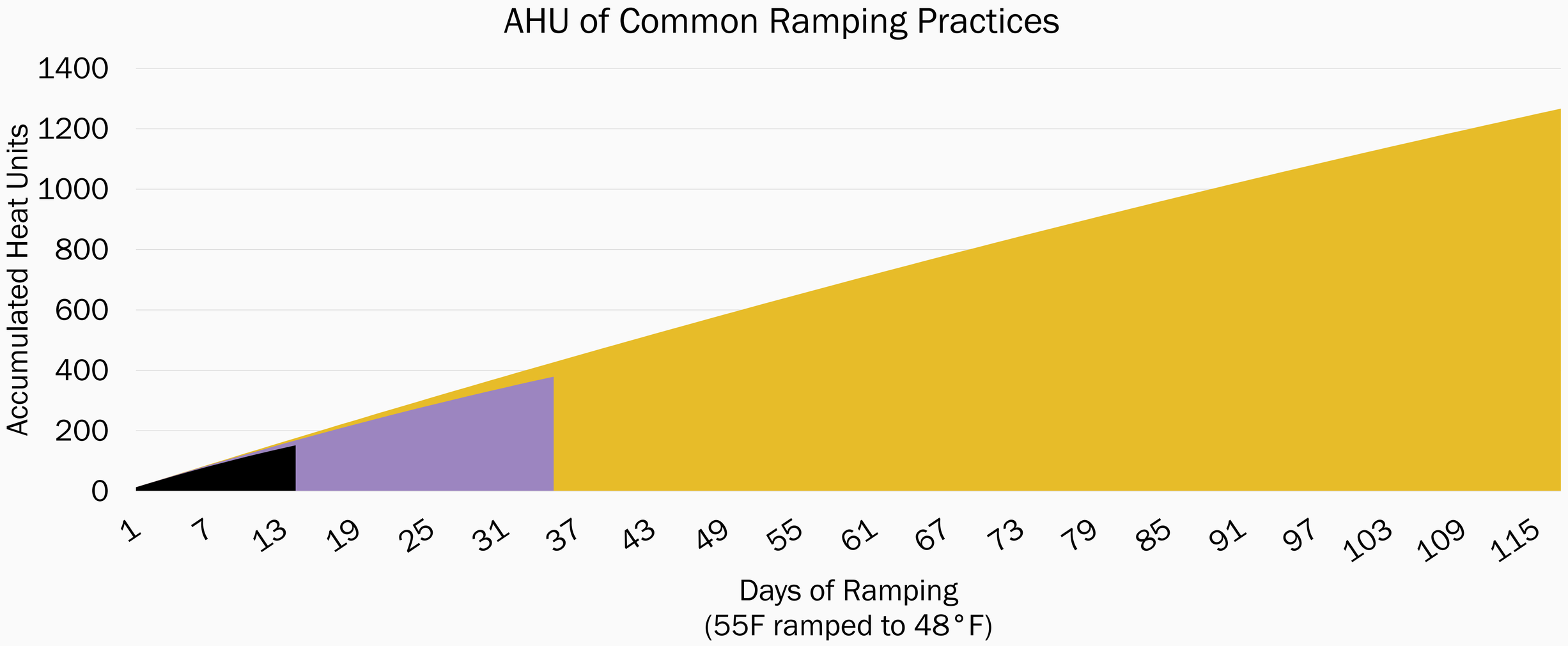
Temperature and Ranger Russet



Early Storage Temperatures

- Standard wound healing recommendation
  - 2 weeks at 50 to 55°F
  - Does not account for time to remove field heat – **Need to FACTOR into curing time (higher temps heal faster)**
- ***Ramping*** after curing…If 14 days at 55°F
  - Ramp 0.1°F/day = total of 65 days above 50°F
  - Ramp 0.3°F/day = total of 30 days above 50°F
- Implications of early storage temperatures on disease, wound healing, weight loss and quality

Accumulated Heat Units Difference in Ramping Regimes



Early Storage Management Impact on Soft Rot

- Less development of soft rot from late blight or pink rot infected tubers when
  - Reduce humidity to 80%RH
  - Reduce curing temperatures to 50°F

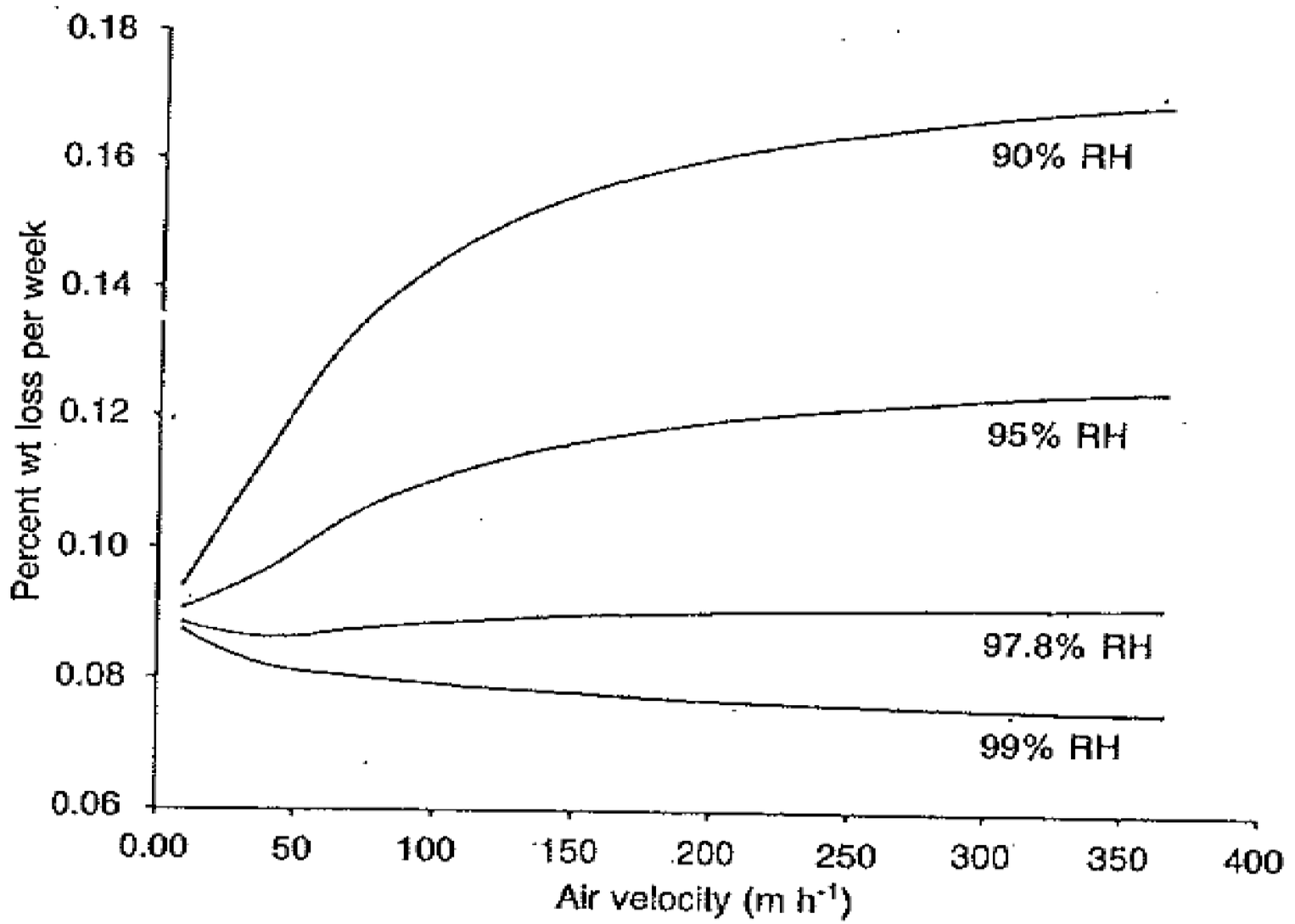


Figure 14.6 Weight loss vs air velocity and relative humidity. (From Hunter, 1985.)

Management decisions based upon…

Single bay storage, one ventilation system

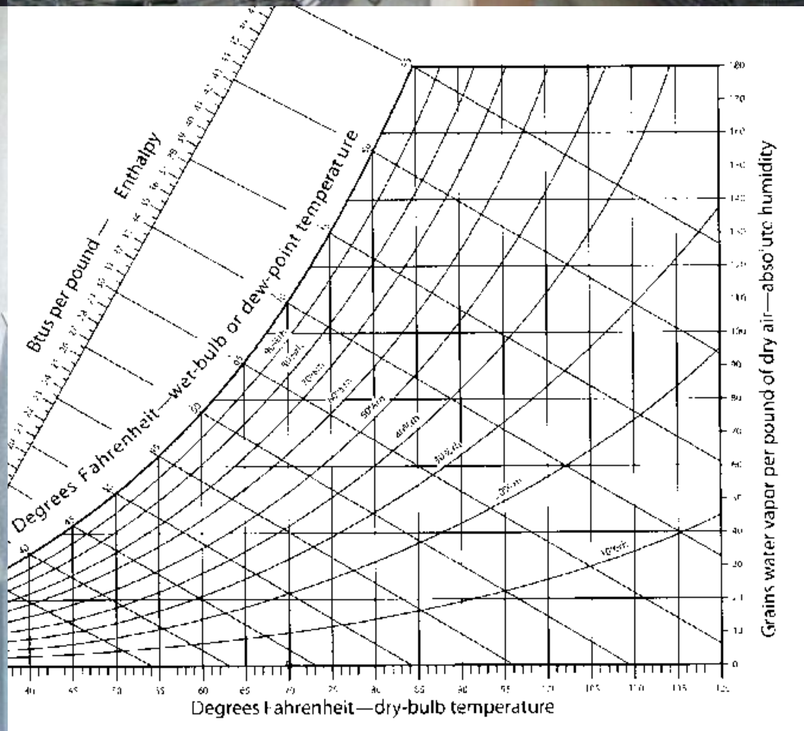
Management decisions based upon…

Split bay storage,

one ventilation system

Shrinkage

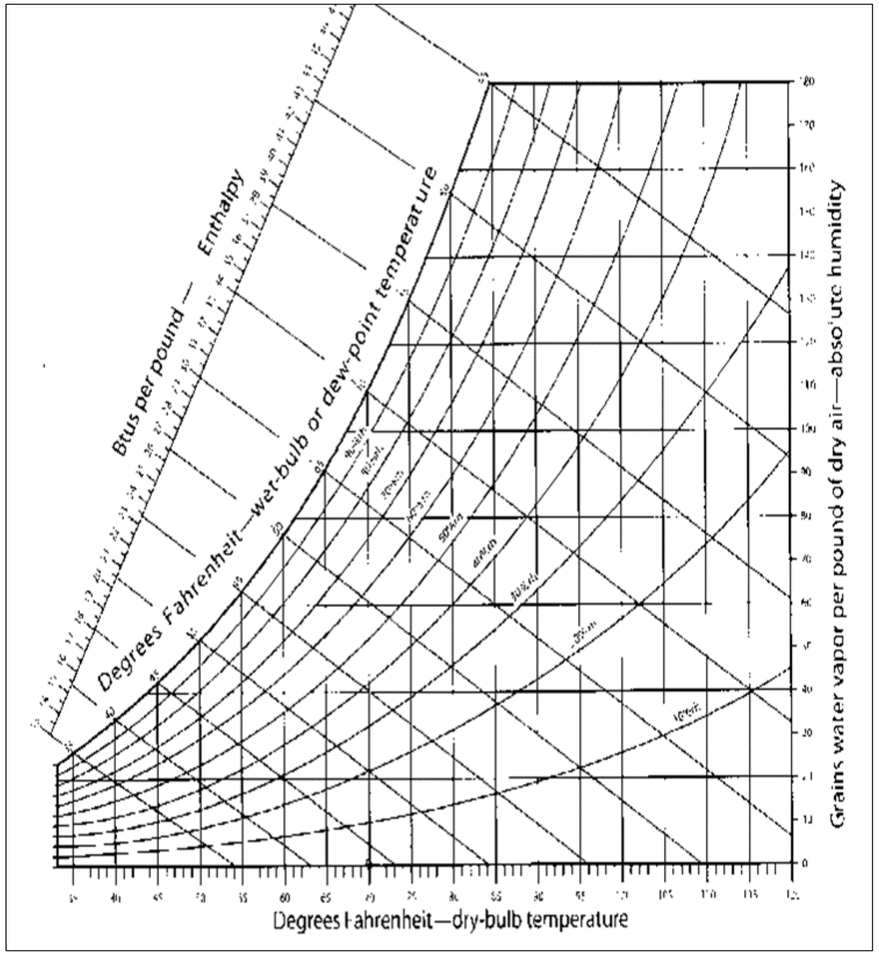
- Weight loss
  - Respiration (releases heat, water, carbon)
  - Evaporation/transpiration
    - Variety
    - Skin set
    - Damage – cuts, shatter bruises, impact damage
  - *Loss due to disease*
- Function of
  - Humidity
  - Ventilation
  - Temperature
  - Vapor pressure difference



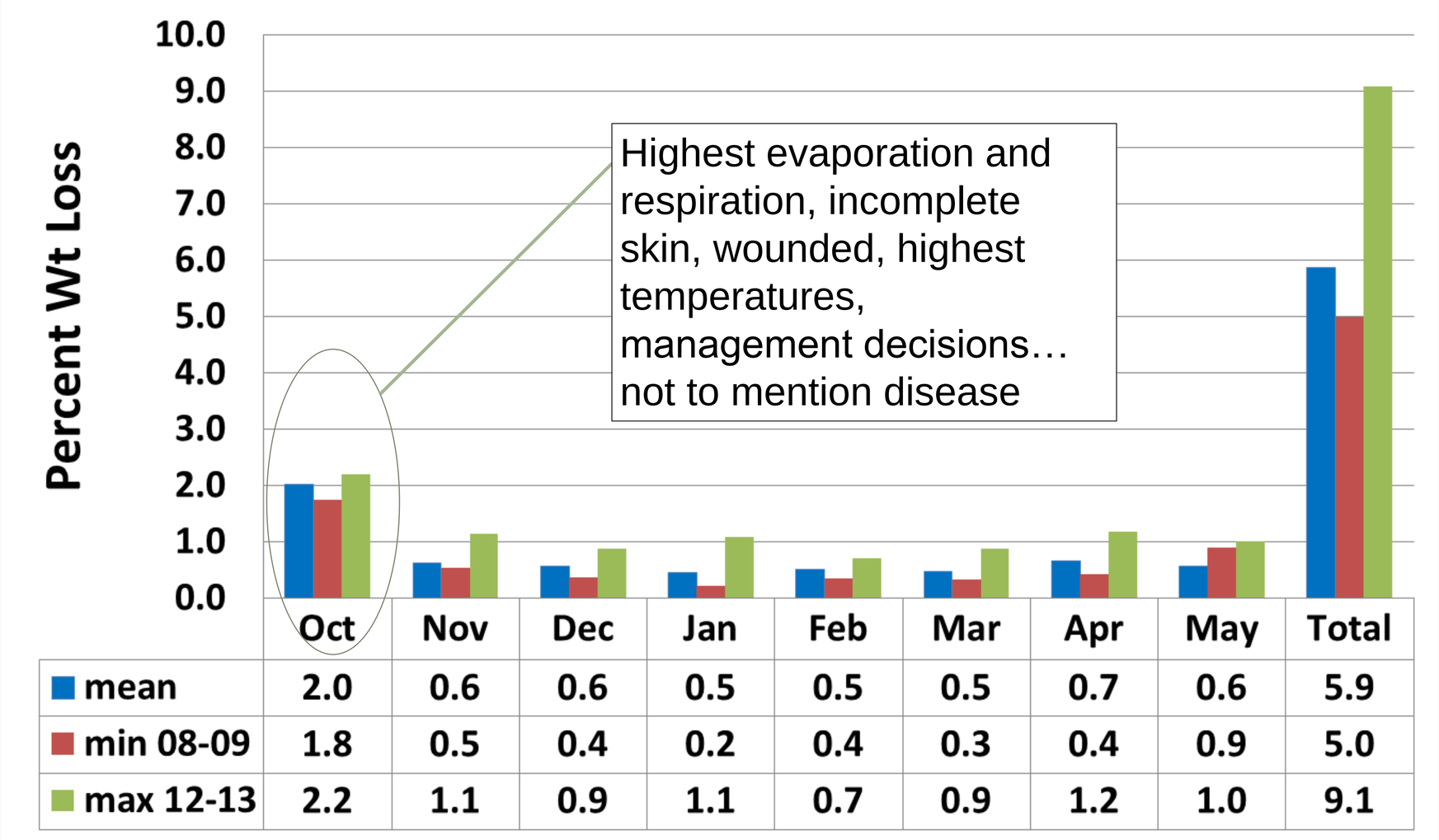
Z **Temperature and humidity**

Y **Temperature and humidity**

X **Temperature and humidity**



Range of weight loss by month in Russet Burbank
mean of 3 temperatures over 8 storage seasons



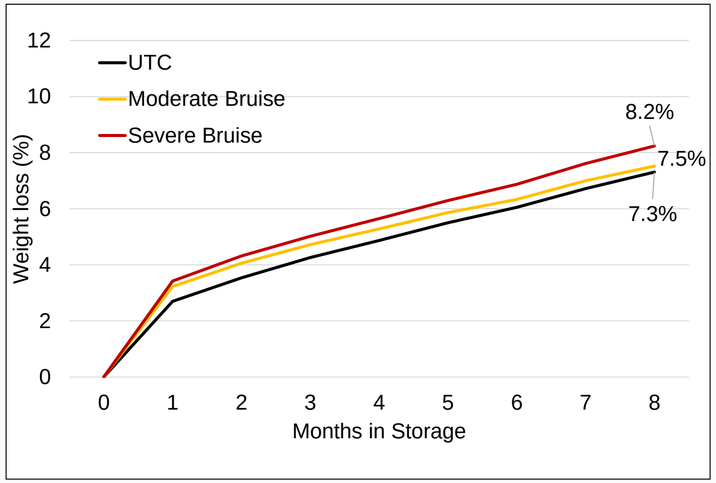
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
mean	2.0	0.6	0.6	0.5	0.5	0.5	0.7	0.6	5.9
min 08-09	1.8	0.5	0.4	0.2	0.4	0.3	0.4	0.9	5.0
max 12-13	2.2	1.1	0.9	1.1	0.7	0.9	1.2	1.0	9.1

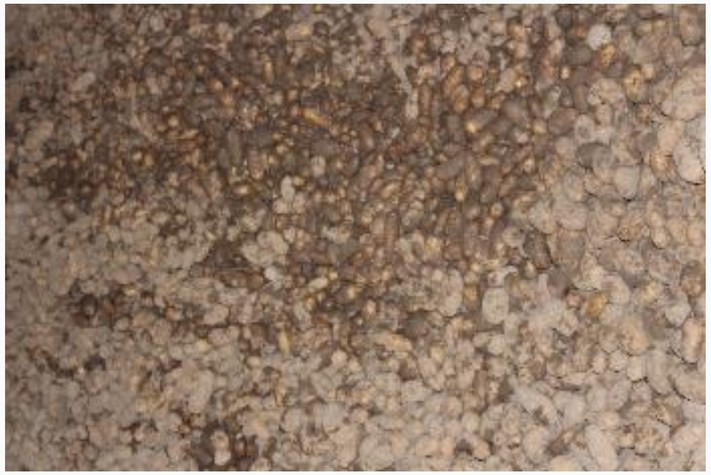
Shrinkage

- Weight loss per week (ASAE EP475.3):
  - **L = (A +0.1S)D**
    - A = 0.7 first 2 weeks; 0.2 remainder of storage season
    - S= % of sprouts by weight
    - D= Vapor Pressure Difference = Ps(1.00-RH);
      - Ps= saturation pressure of water at avg temp of potato
      - RH = relative humidity

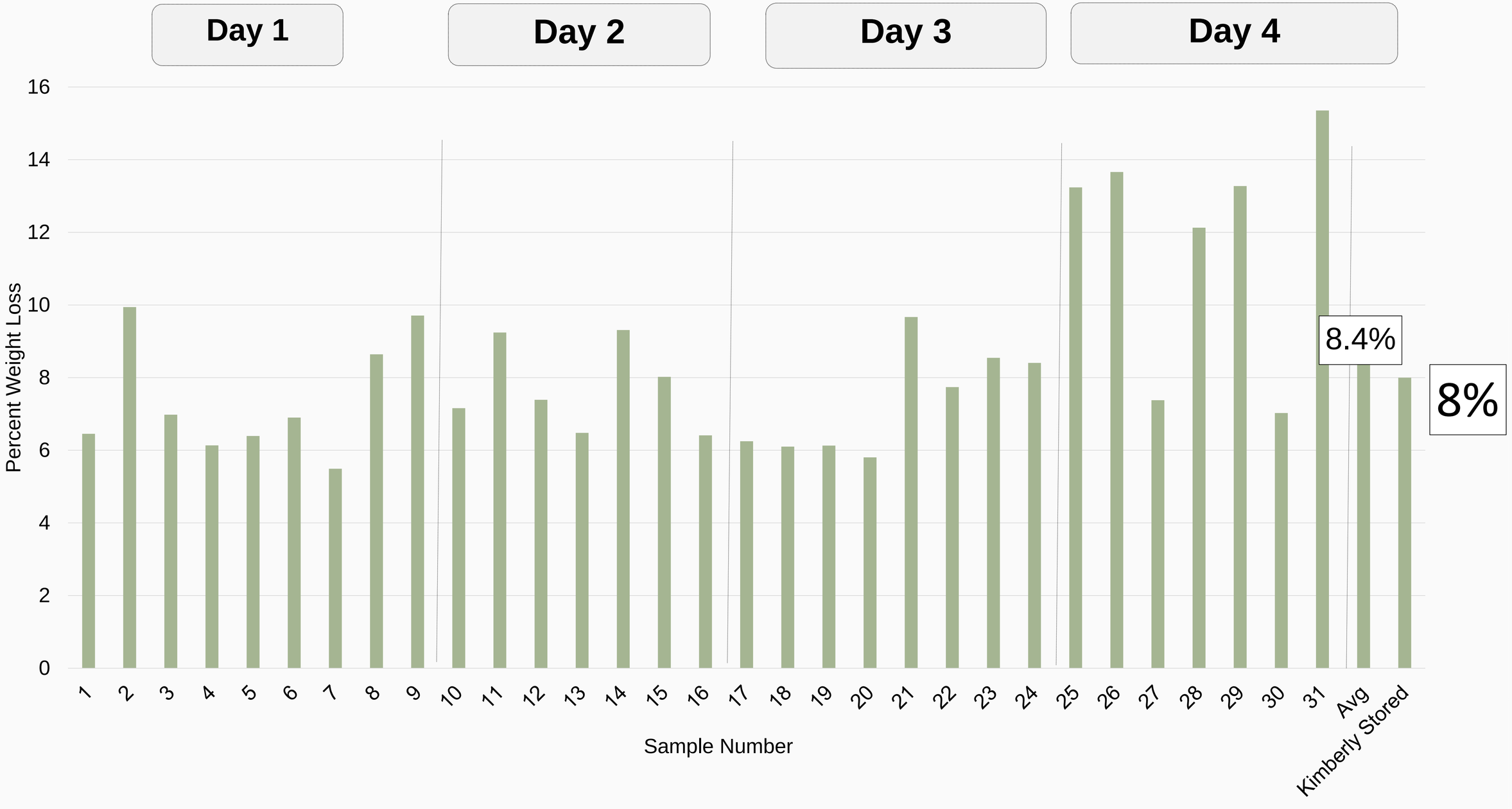
Total % weight loss		
UTC	4.5	a
Moderate Bruise	5.1	b
Severe Bruise	5.0	b

Accumulated % Weight loss





Russet Burbank- weight loss after 254 days in storage



Overall Shrinkage

Cultivar	Days in Storage	% Weight Loss
Russet Burbank	254	8.4
Russet Burbank	272	9.9
Russet Burbank	279	6.3
Ranger Russet	42	3.9
Clearwater Russet	290	8.1
Clearwater Russet	251	5.2

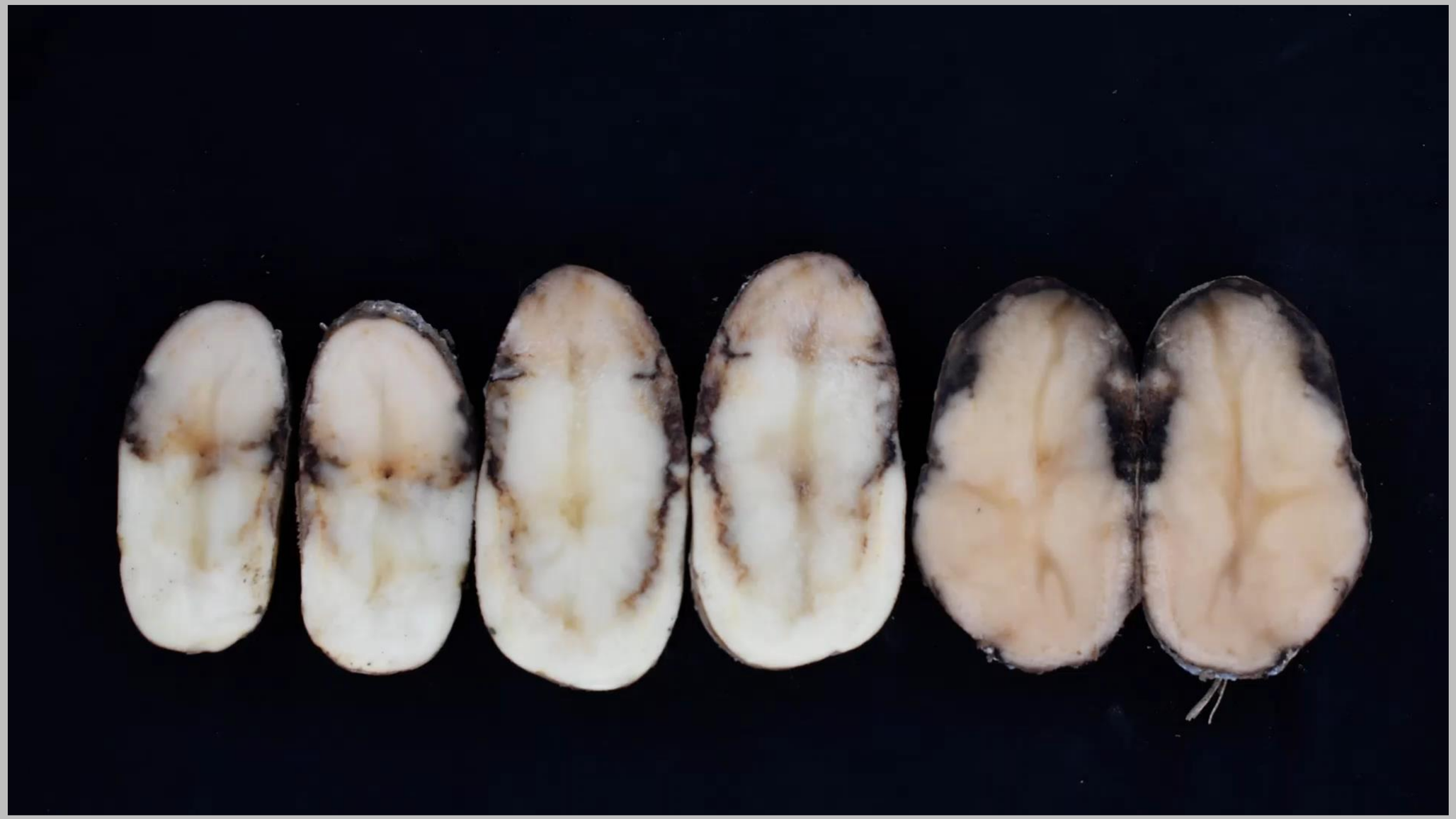
Direct Losses

- Shrink- weight loss
- Diseases and disorders

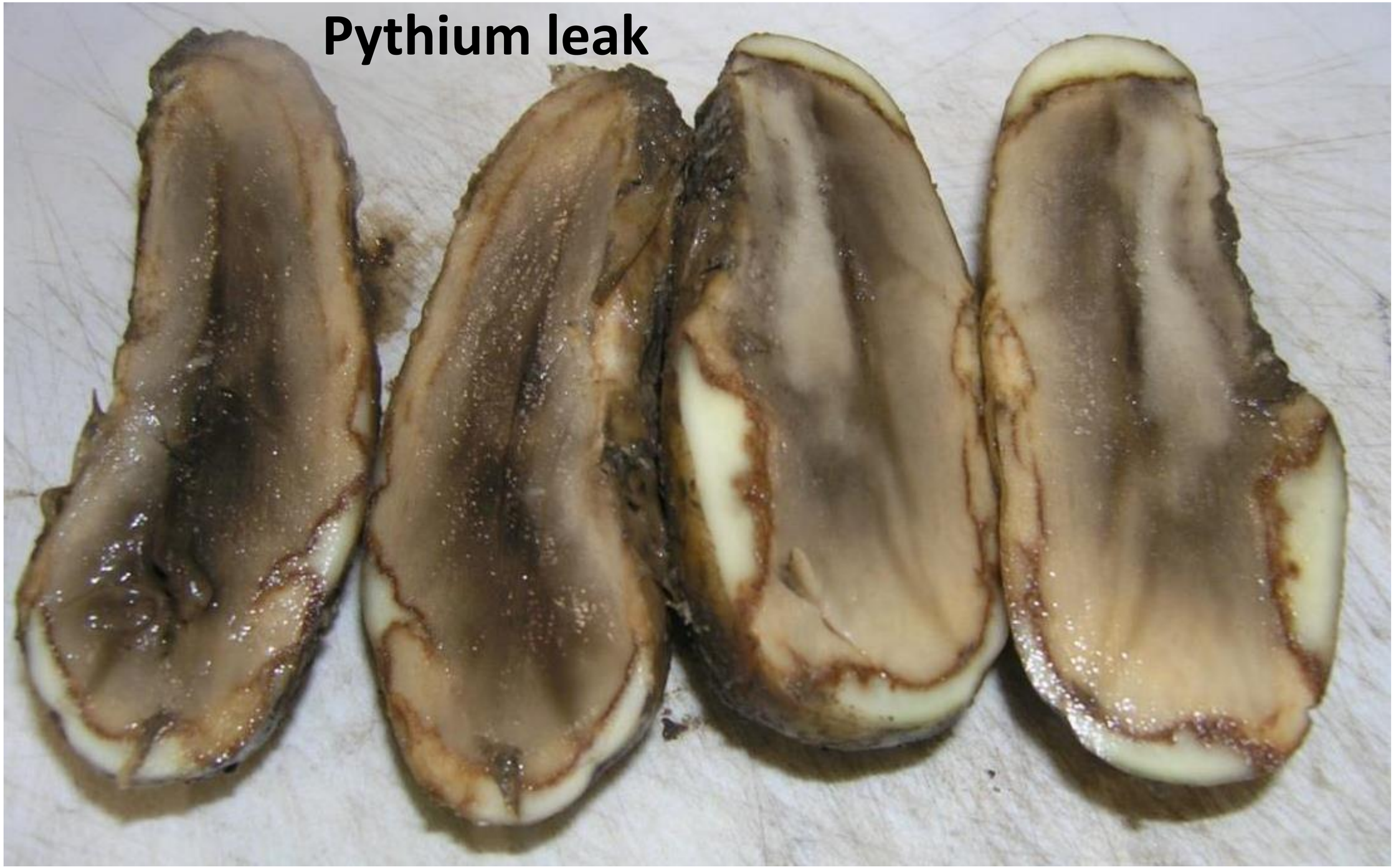
Identify what the issue is

- Current management
- Future avoidance

Pink rot



Pythium leak




150 mL
KIMAX®
KIMBLE
140
100
60
20


140
100
60
20


310C


480 PSI @ 73° F. PVC 1120
ASTM D2672

PINK ROT

Untreated control

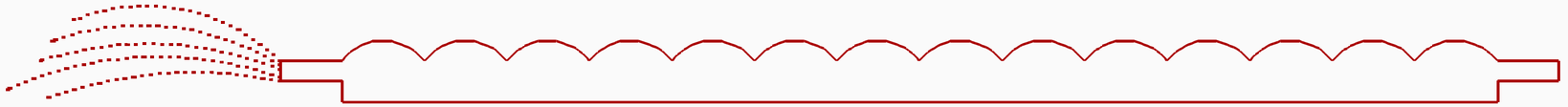
Hydrogen Peroxide
Peracetic Acid

Phosphorous Acid
(Phosphite)

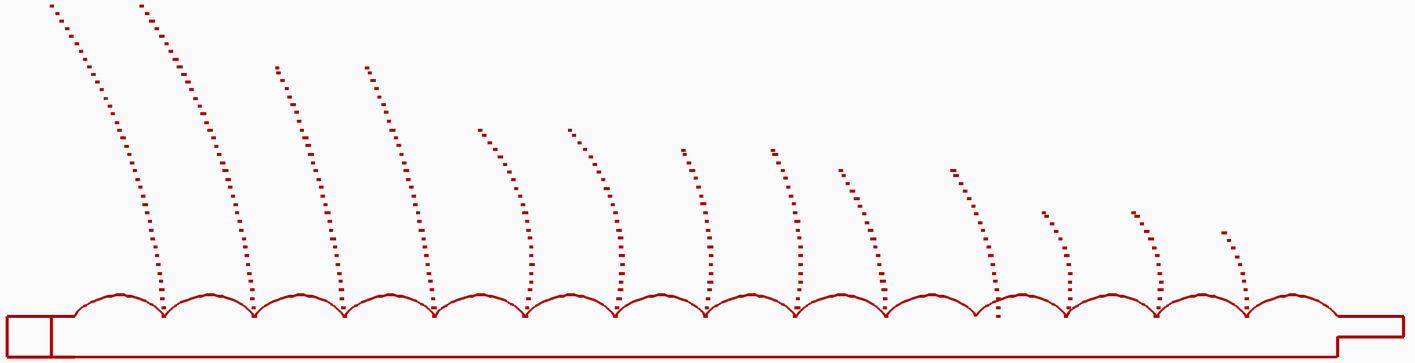
Late Blight

UTC

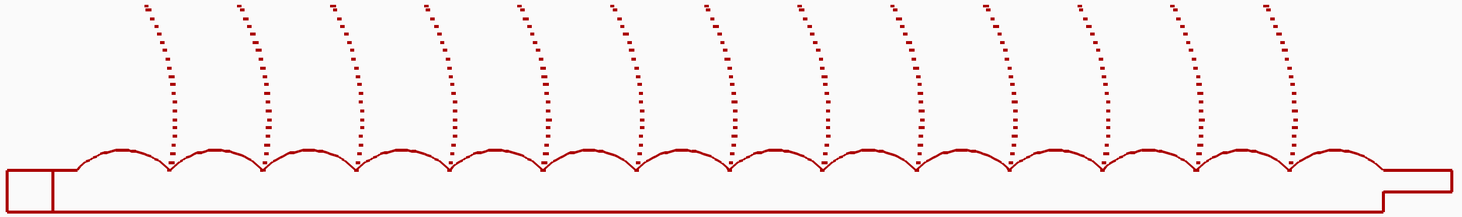
Phos Acid
12.8 fl oz



Sprinkler hose without endcap



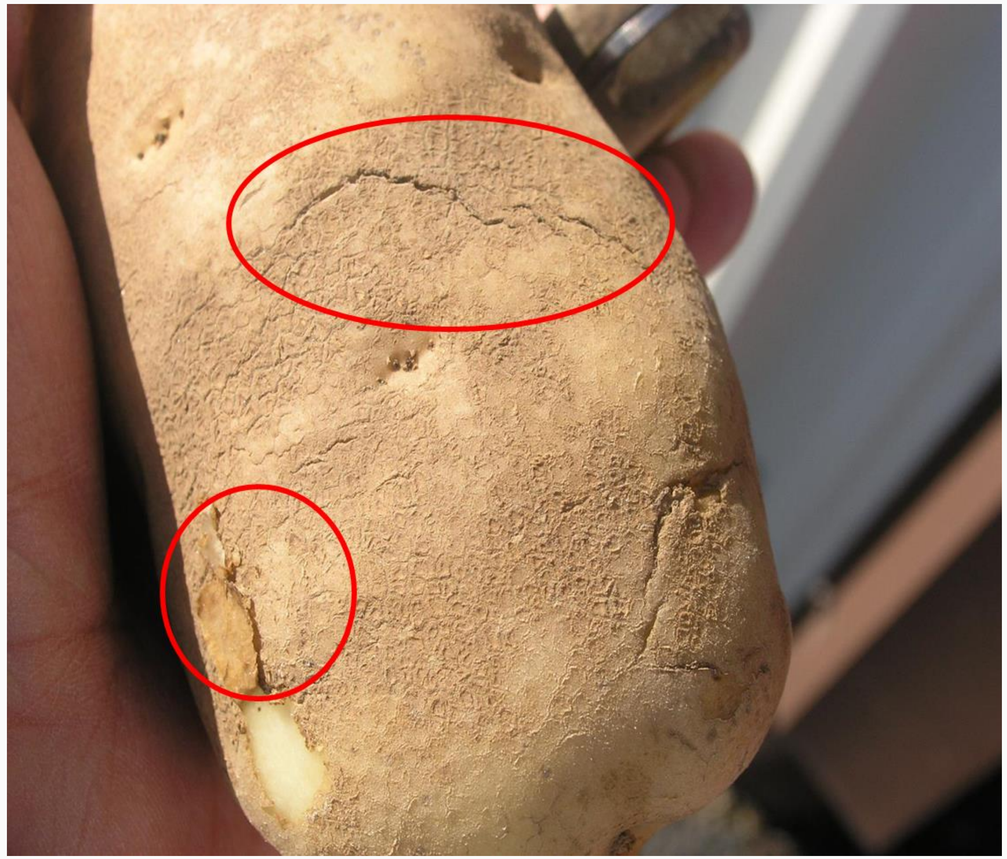
Sprinkler hose - too many holes / too large

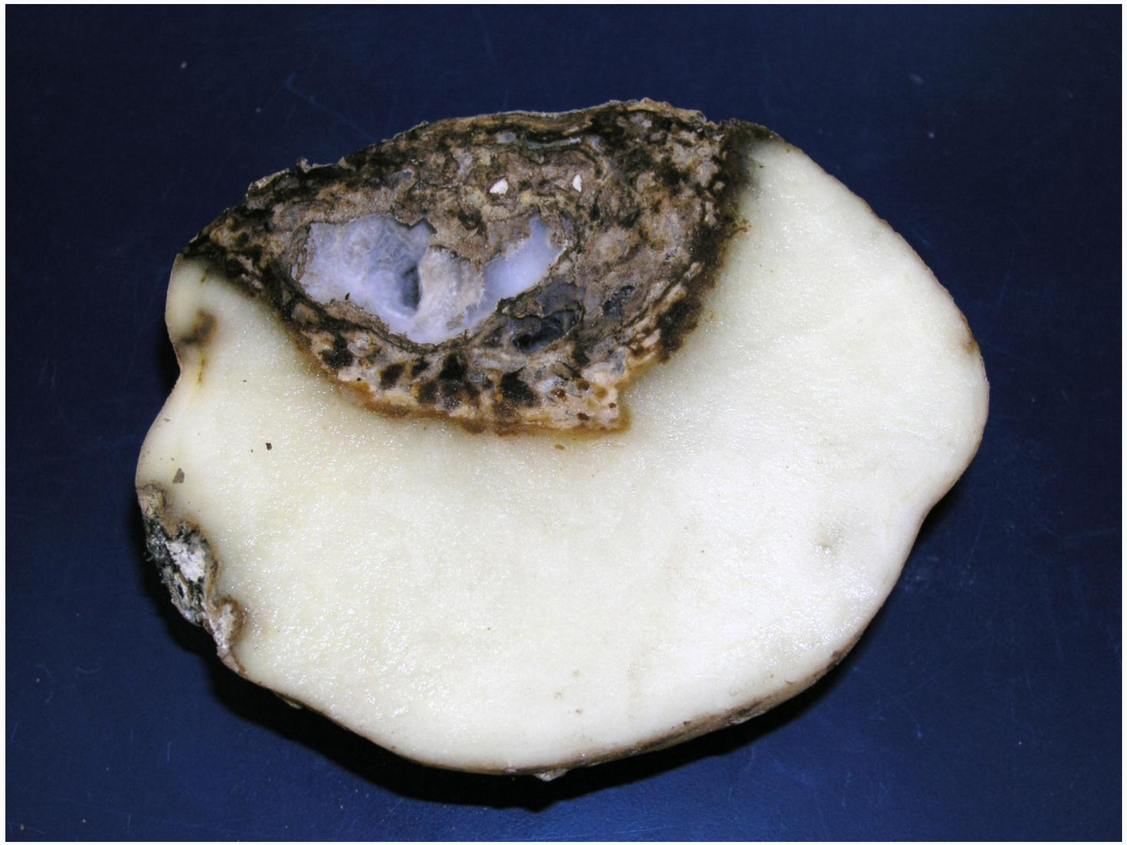


Sprinkler hose - correct holes / uniform distribution

Water (or air in storage)

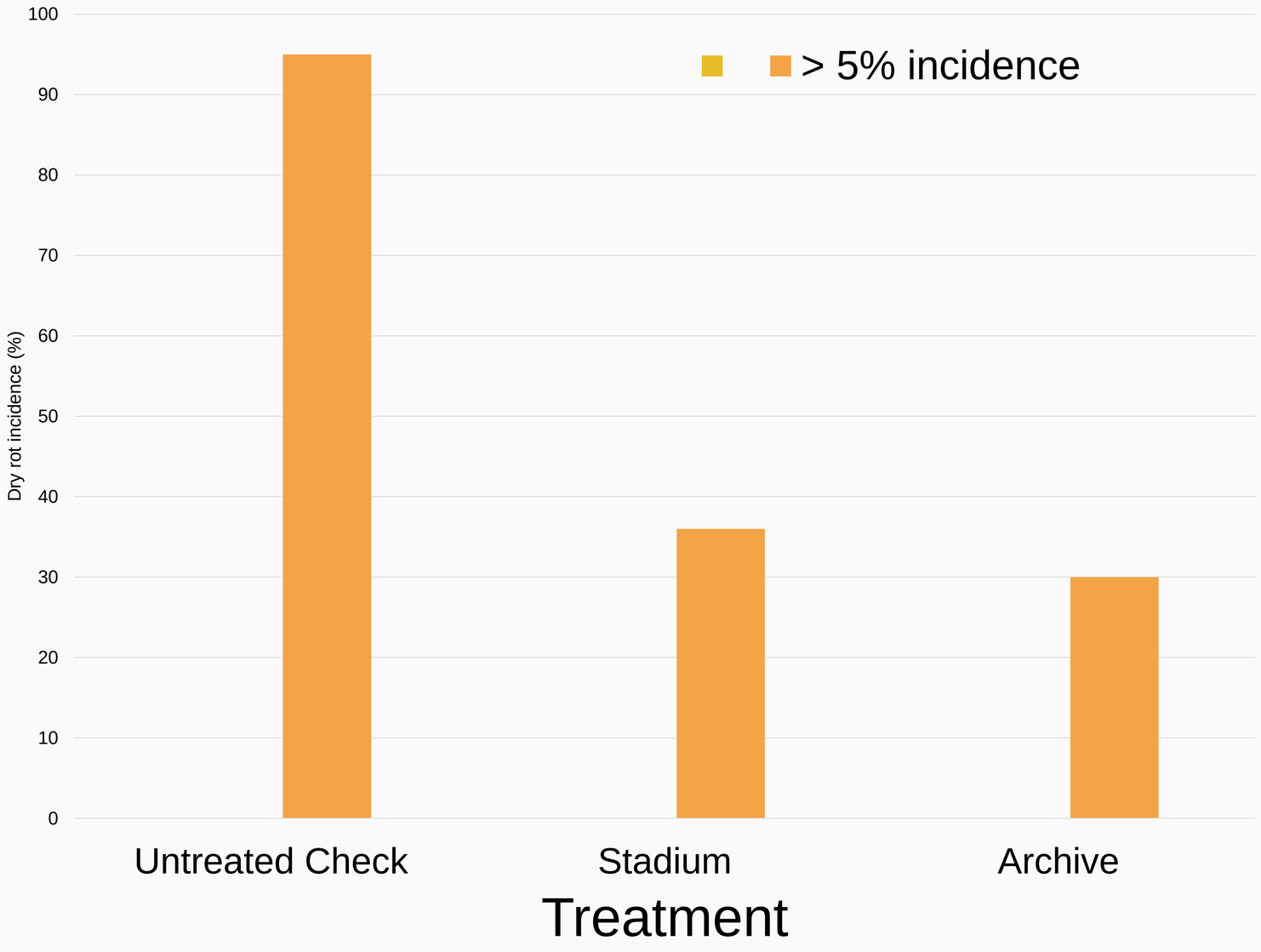
From Roger Brook, MSU





Fusarium dry rot

Post-Harvest Spray for Dry rot



Untreated Check

Stadium

Archive


FOR
SALE

Take home messages

Info from field to storage

Squiggly lines – not absolute on 45 to 65F harvest pulp temperatures

- Variety and condition specific

Early decisions in storage set stage for the remainder of the storage season

- Weight loss
- Disease
- Fry color

Minimize shatter bruise and warm temperatures

Complexity of humidity and temperature for disease management

Diagnose the issue/disease --management options