Harvesting: Clean + Safe

Gabriele Ludwig, Moderator

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Harvesting: Clean + Safe

Presenters:

Joe Connell, UCCE Butte County

Bruce Lampinen, Plant Sciences, UC Davis

Ken Giles, Biological + Agricultural Engineering Department, UC Davis

Orchard Floor Management & Harvest

Joe Connell, UC Farm Advisor, Butte County

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Orchard Floor Management

Orchard Floor Management

Start with clean strips

- Contact or pre-emergence weed control
- Blow NOW mummies to middles for chopping

Avoid making ruts in wet soil so you can harvest with a clean sweep

Non-Tillage with Strip Weed Control

- Improves orchard access year around
- Provides a firm orchard floor with less dust, easier, cleaner harvest
- Less trunk damage, crown rot, and compaction
- Improves water penetration in most soils
- Improves potassium leaf levels

Consider Brush Disposal

- Chip or shred in Fall, break down before harvest

Non-tillage with Strip Weed Control

- Provides a smooth, firm, weed free surface for harvest
- Pre-harvest herbicide application to the middles promotes rapid nut drying
- Helps preserve food safety and nut quality
- Provides for an efficient pickup operation

Clean by August

Organic Non-tillage

Organic weed control is more of a challenge

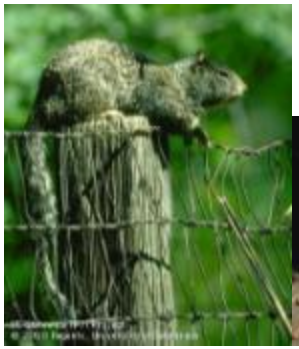
- **Propane flamers for strips or middles**
- **Cover crop residue**

Sub-clover cover crop

Clean and Safe

Wild and domestic animals:

- Minimize potential entry of animals into fields
- Vertebrate control or fencing may be needed
- Contamination risk increases near harvest
- Evaluate field locations in proximity to dairy or livestock operations



Clean and Safe

Human sanitation:

- **Sufficient number of field toilets for men and women**
- **Properly maintained and clean**
  - **Designate a person to be responsible**
- **Document field sanitation practices employee training**

Clean and Safe

Composted manure:

- Potential risk associated with applying composted manure(raw?) to our harvest surface
- Fall application with incorporation into soil after harvest is best
- Better to avoid this use in almonds entirely

Clean and Safe

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Harvest equipment:

- Clean and sanitize harvesting equipment
- Clean and sanitize the huller

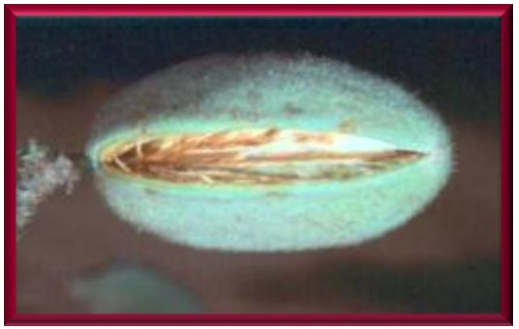
Surface irrigation water:

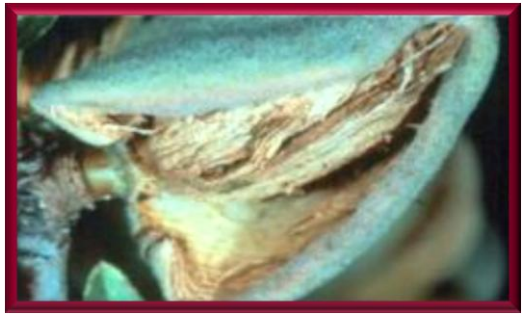
- Has a potential risk of contamination
- Know your water source
- Is there a need for treatment or testing?

Timely Harvest

- **When 100% of lower interior nuts are at hull split with some dry on the tree, harvest can begin**





Timely Harvest

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KERNEL MOISTURE PERCENT & DRYING RATE

50
45
40
35
30
25
20
15
10
5
0

7/17 7/24 7/31 8/7 8/14 8/21 8/28 9/4 9/11

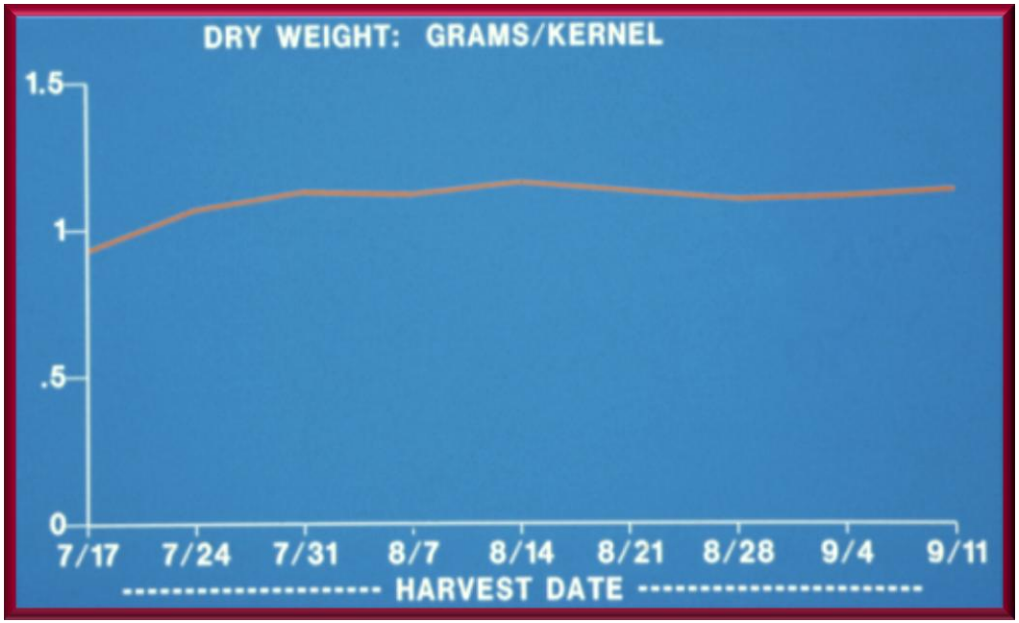
---------- HARVEST DATE ----------

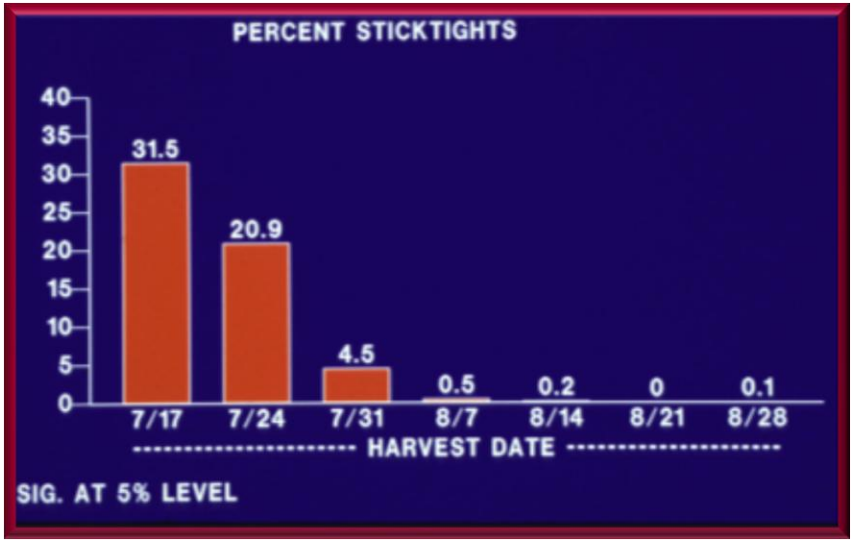
Timely Harvest

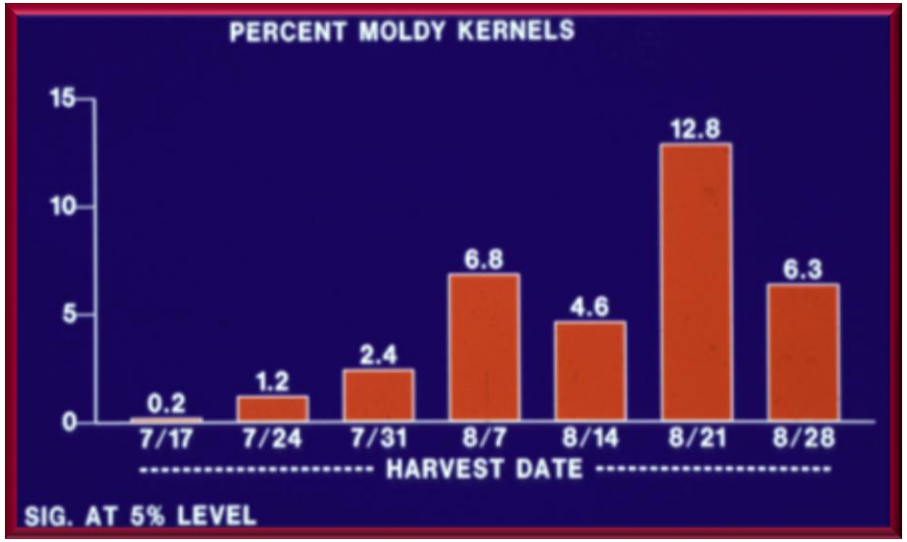
Once you reach 100% hull split:

- Nuts have achieved maximum dry weight of oils and carbohydrates
- Maximum nut removal
- Sticktights and shriveled kernels are low
- Foreign material and chipped and broken kernels are minimized
- With delay, rejects and moldy kernel percentages only increase

Timely Harvest

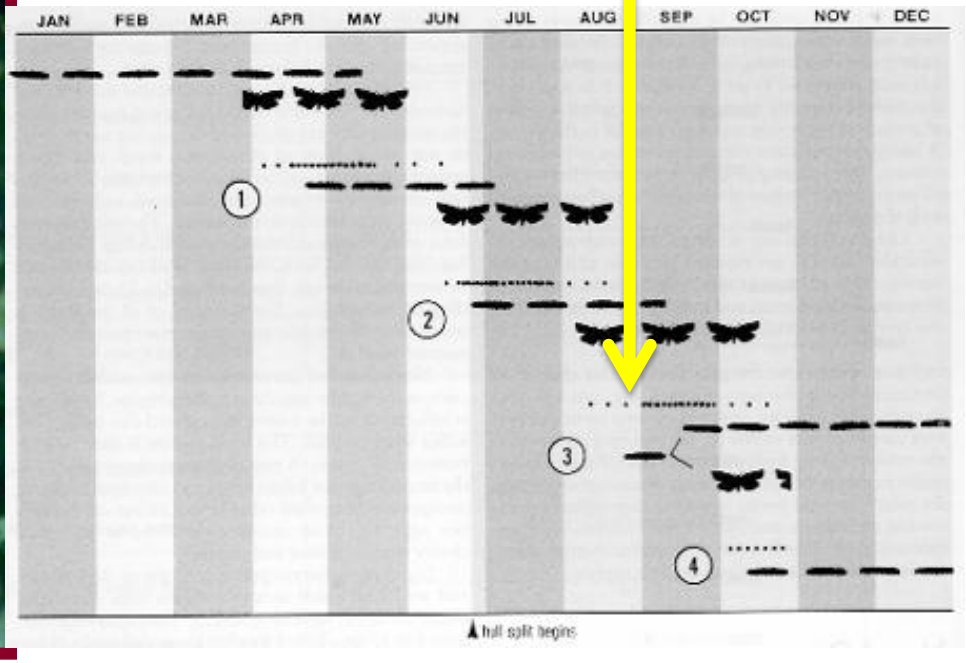






Timely Harvest

- ✓ Beat the 3rd generation NOW egg laying



Timely Harvest

Harvest Too Early

- **Potential increase in sticktights, curled hulls, foreign material, and damage to kernels at the huller**

Harvest Too Early

- Increased potential for ant damage

Southern fire ant

Pavement ant

Starting Harvest Too Late

Increases worm damage and aflatoxin potential

Increase the probability of rain delays

As days shorten, sun angle gets lower, temperatures drop, and drying is more difficult and much slower

- **More ant damage**
- **More worm damage**
- **More nut quality problems**

Don’t go there! Harvest on time!

Thank You

Impact of Orchard Management Practices on Food Safety Risk

Bruce Lampinen, UC Davis

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Orchard Management Can Impact Food Safety Risk in Almond

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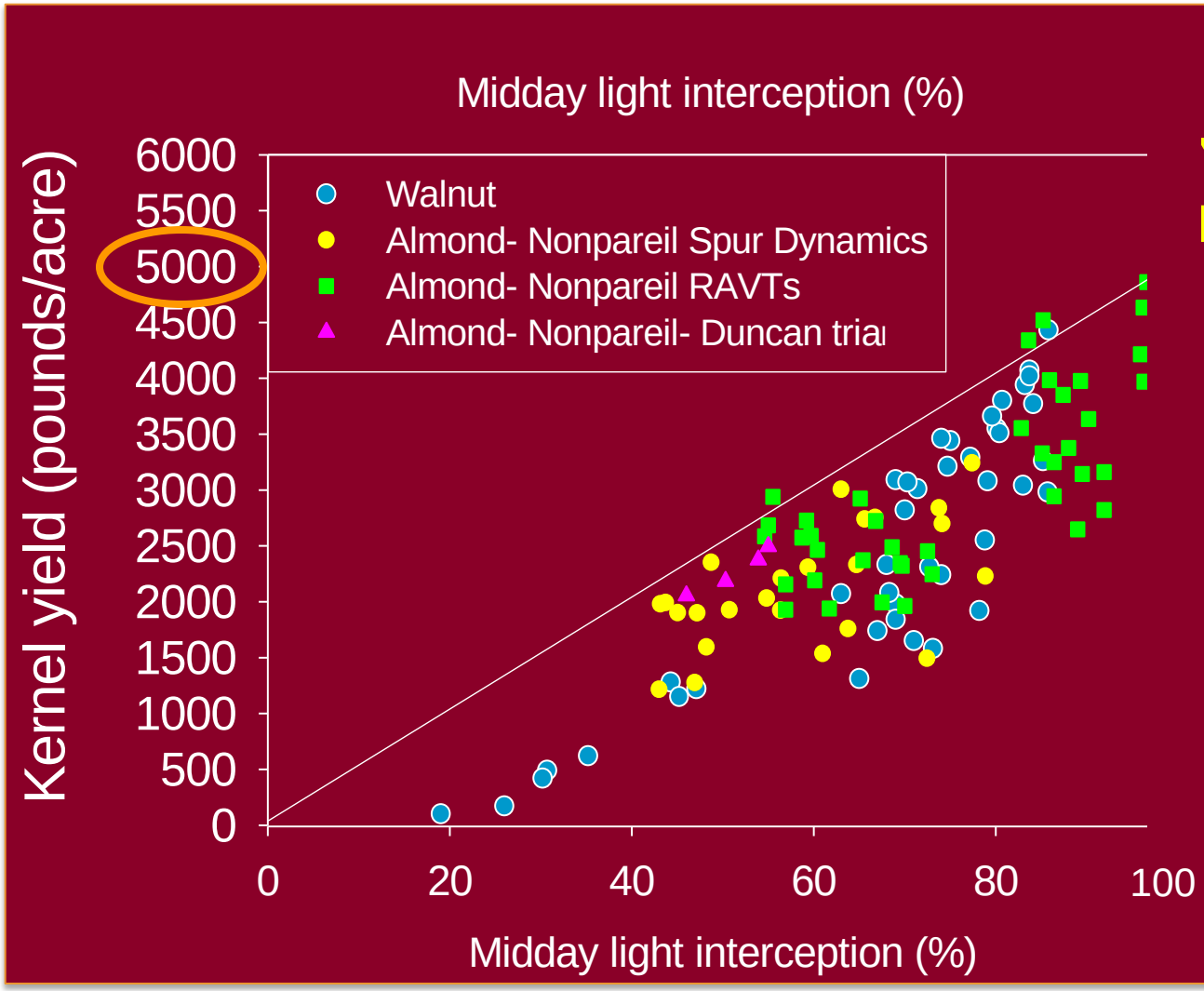
- Heavily canopied orchards likely increase food safety risk due to wetter, cooler conditions on orchard floor
- Heavily canopied orchards make drying of nuts on orchard floor more difficult, particularly for late varieties
- Stockpiling excessively wet nuts increases food safety risk
- Stockpiling nuts with green pollenizer nuts mixed in can cause problems

Mule light bar

640 photodiodes active in PAR range
IR thermometers for soil surface temp
Sub meter GPS- used outside orchard
Radar used within orchard
Campbell Scientific CR3000
Display on dashboard
Adjustable to row widths from ~18-28 feet
Travel about 10km/hr- gives one scan about every 30 cm

Infrared thermometers for measuring soil surface temperature



Yield can be below potential due to:

- **Water stress**
- **Nutrition problems**
- **Poor bloom weather**
- **Disease**
- **Pruning/hedging**

Almond production potential is about 50 kernel lbs of almond for every 1% of midday incoming light intercepted

28 X 50 = 1,400 lbs/ac potential

48 X 50 = 2,400 lbs/ac potential

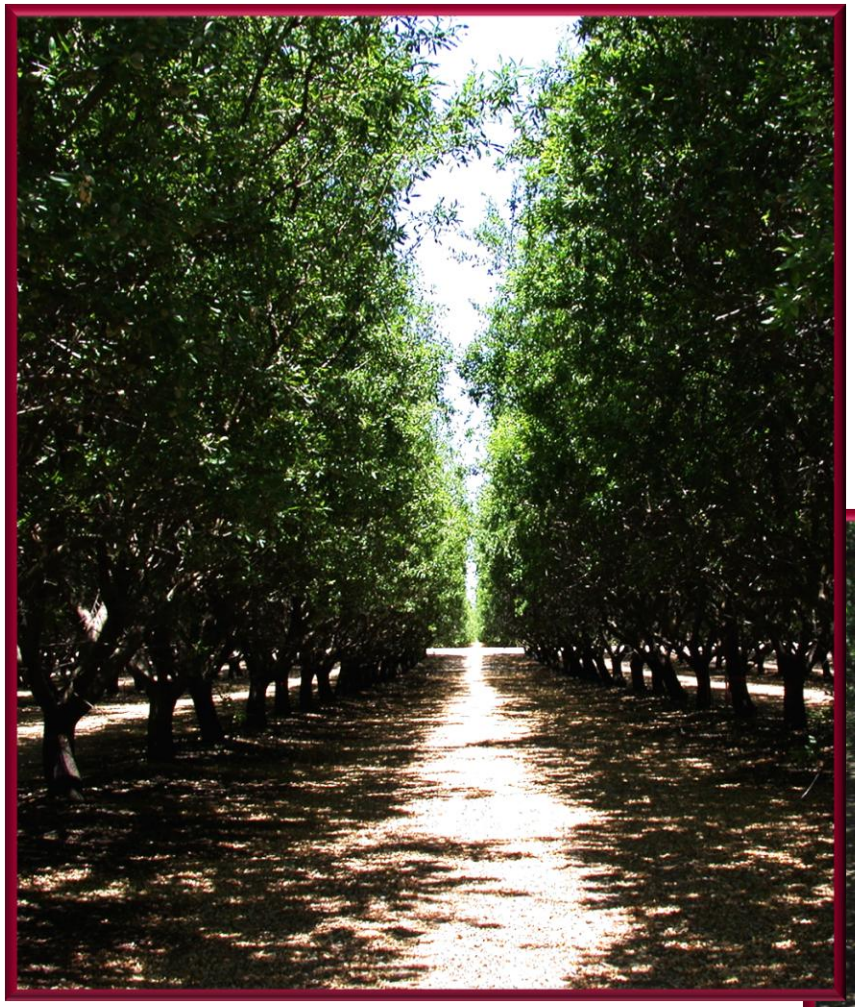
64 X 50 = 3,200 lbs/ac potential

82 X 50 = 4,100 lbs/ac potential

Canopy density as well as canopy size can have large impact on light interception/yield potential as well as food safety risk

Dense canopy letting very little light reach orchard floor under tree (higher yield, cooler temperatures)

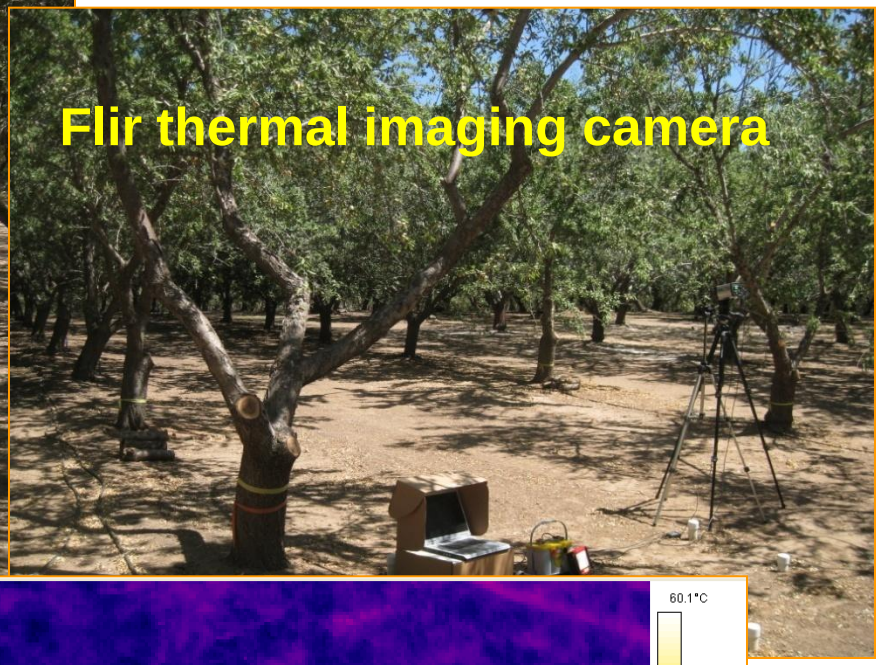
Sparse canopy letting much more light reach orchard floor under tree (lower yield, warmer temperatures)



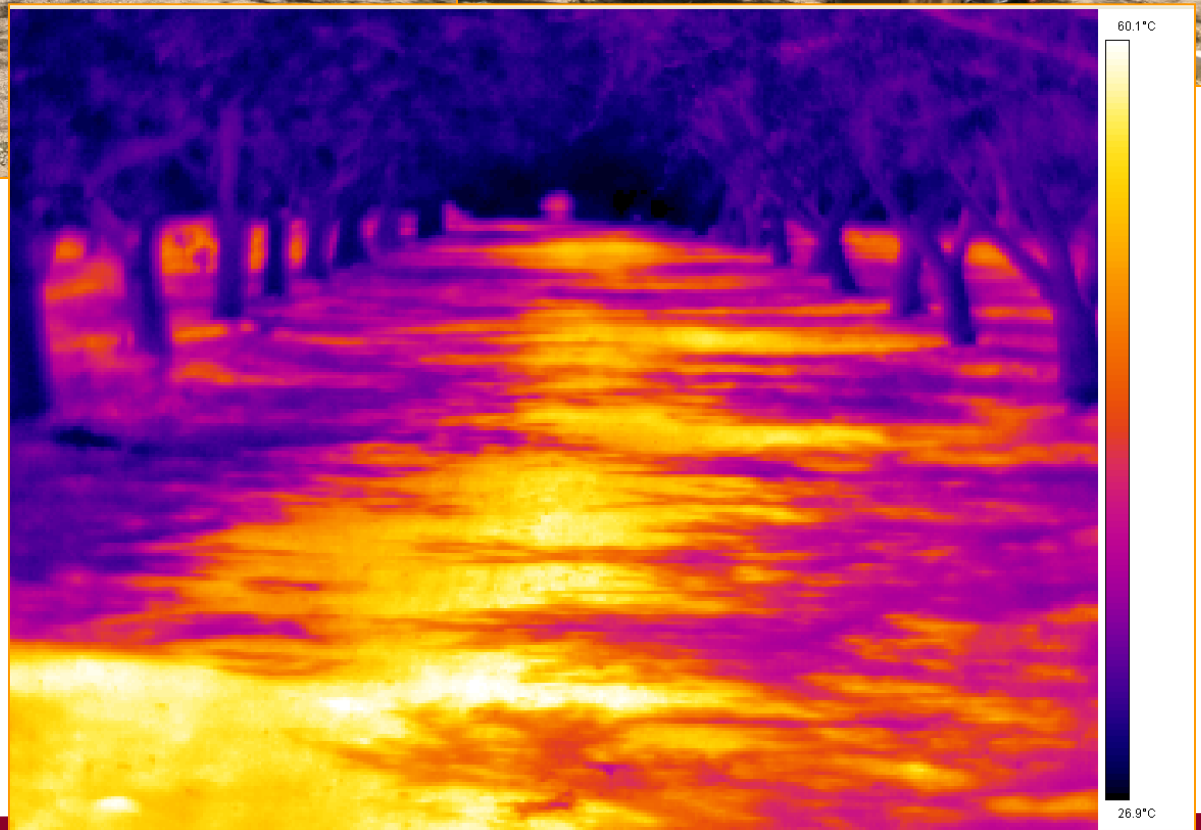
Hedgerow
(mechanical pruning)

More traditional
spacing (hand pruning)

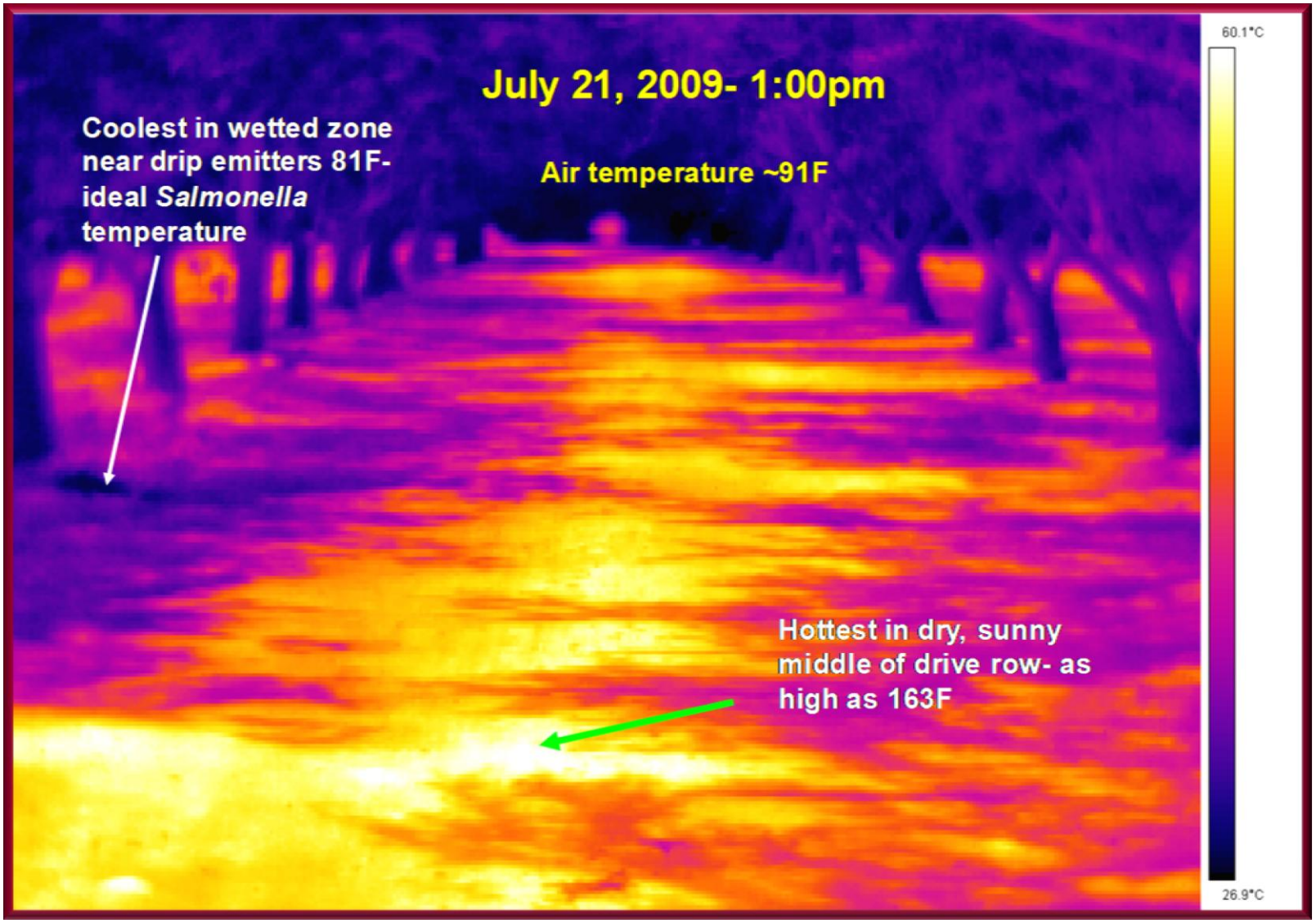
Result of cool, shaded conditions under tree canopy in dense mechanically hedged planting



Thermal imaging of orchard floor temperatures



Sunlight hitting bare orchard floor provides heat to sterilize surface. More traditional planting tends to give more varied light conditions on orchard floor compared to hedgerow



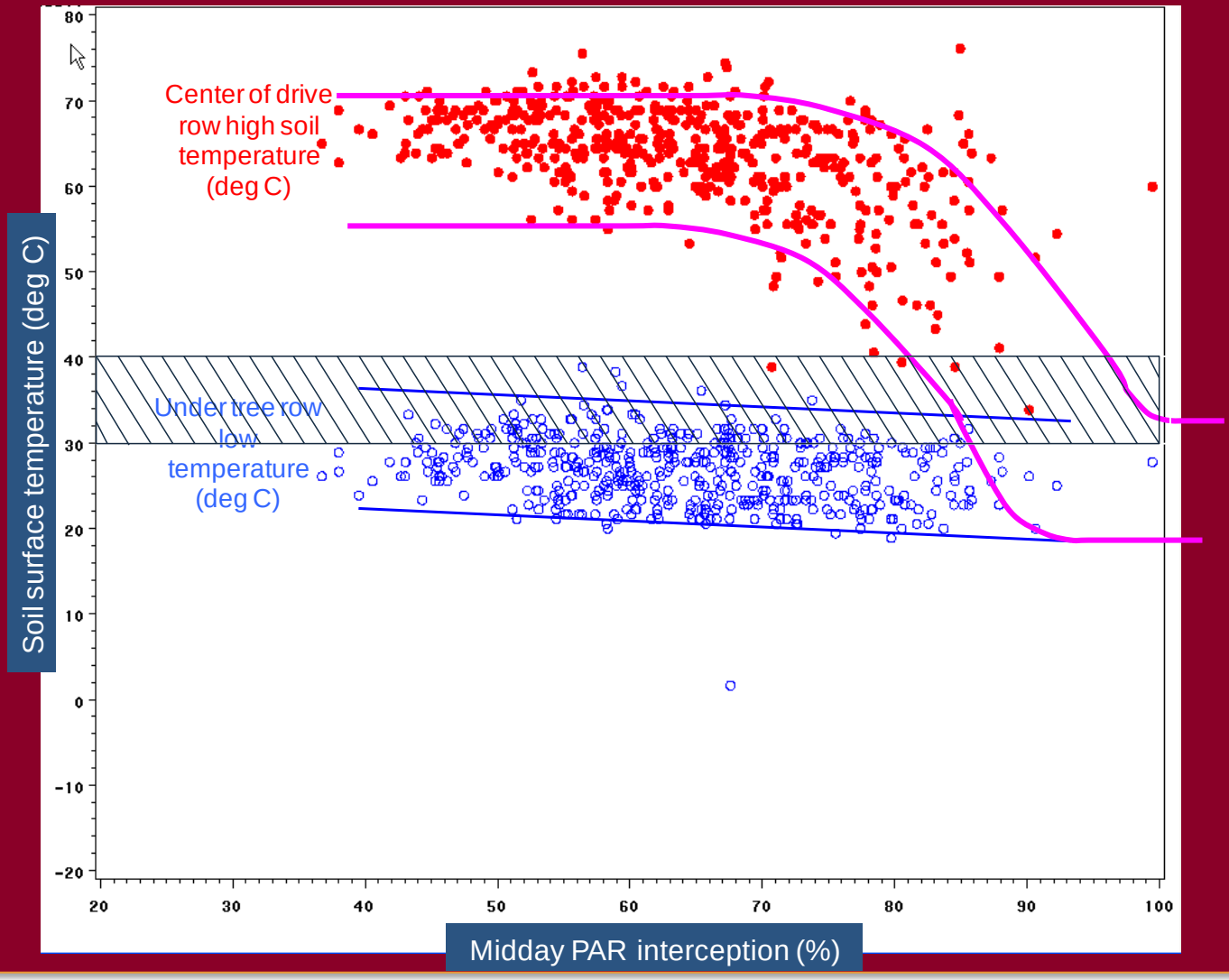
Maximum orchard floor temperature drops off dramatically as midday canopy light interception increases above about 70%.

158 deg F

136 deg F

104 deg F

73 deg F



If your orchard is producing above 3500 kernel pounds per acre (above 70% light interception), you should pay particular attention to food safety risk.


92%


4600 lbs/ac

Sample Nuts From Orchard Floor to Decide if They Are Dry Enough to Harvest.

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From across orchard floor in orchard where they are left to dry as shaken

From top to bottom of windrow in orchard where nuts are dried in windrow

Water Activity Definition

Water activity - a measure of water in the food product which is available for bacterial or fungal growth

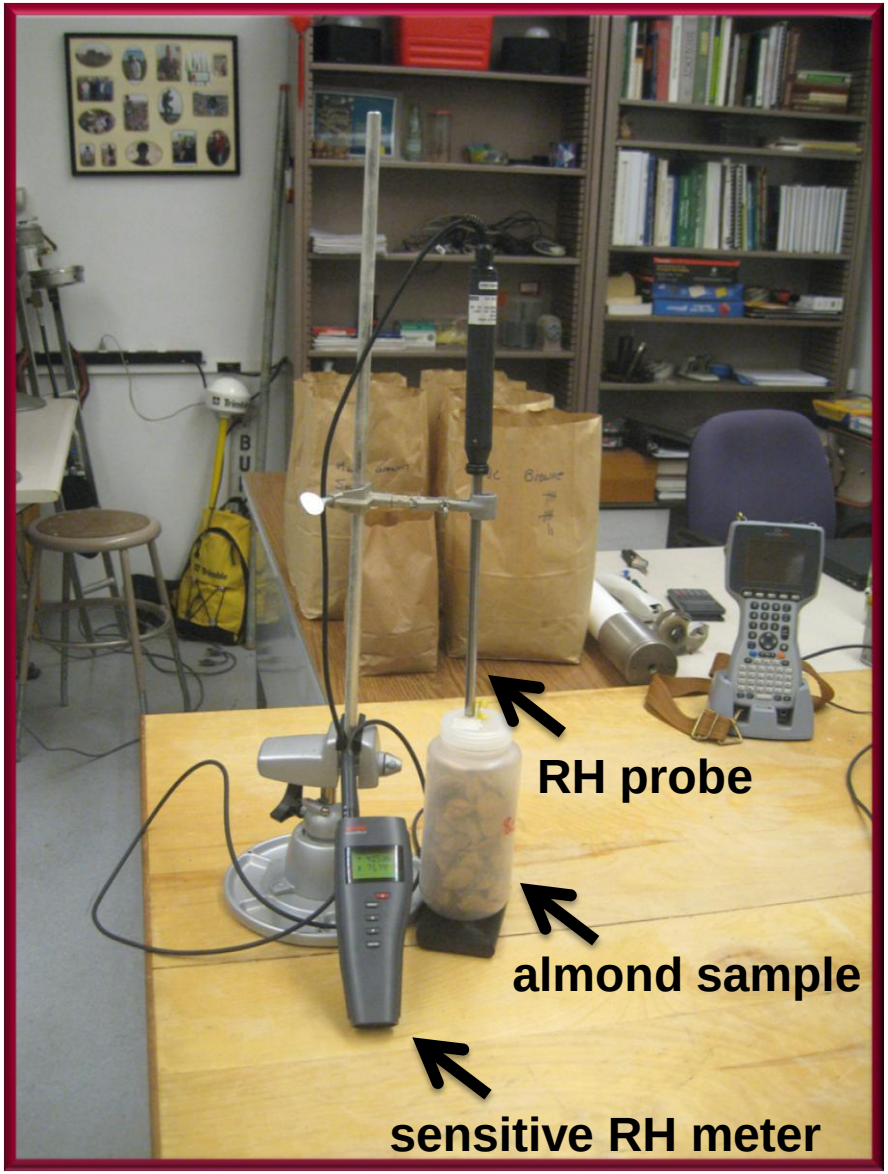
- **It is water activity rather than water content that determines the potential for bacterial or fungal growth**
- **For almonds, a water activity of less than 0.7 is best**
- **A water activity of 0.7 is equivalent to a relative humidity of 70%**

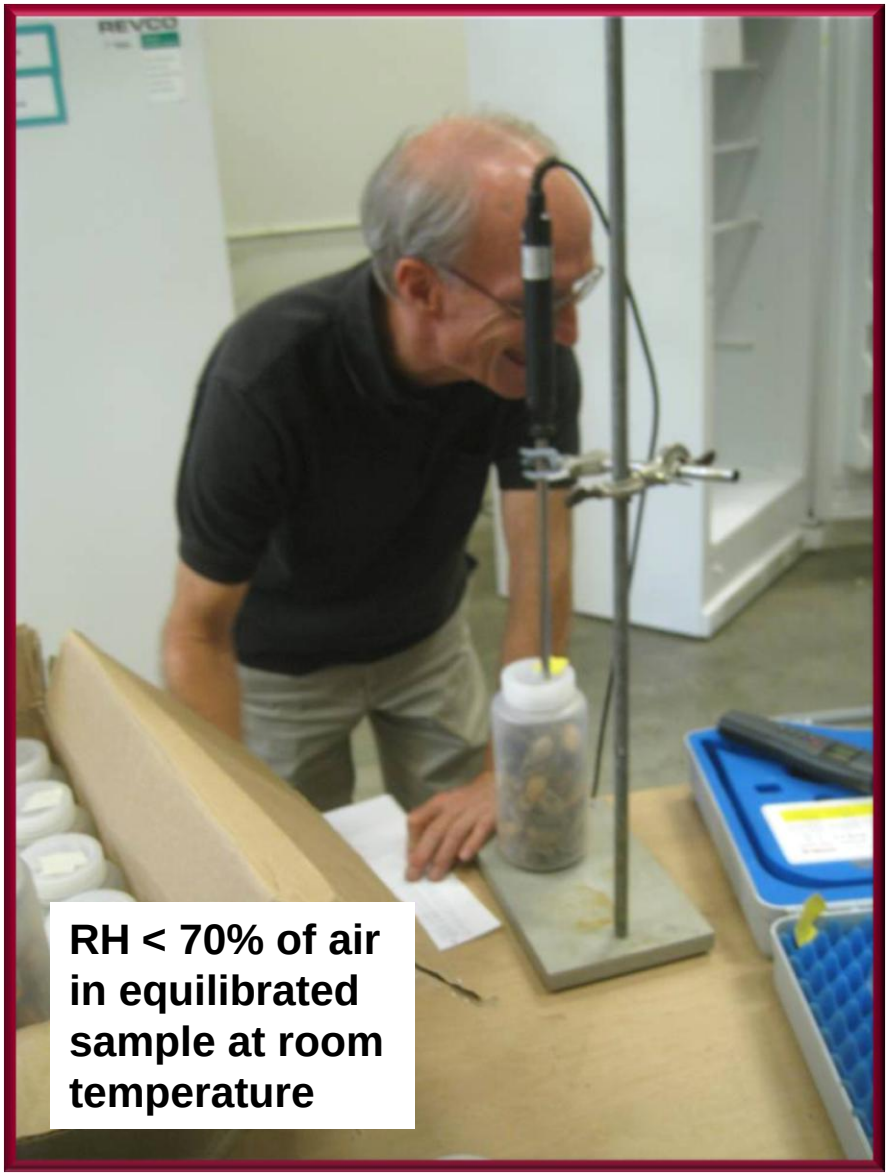
A_w = water activity

a_w values of microorganism inhibition

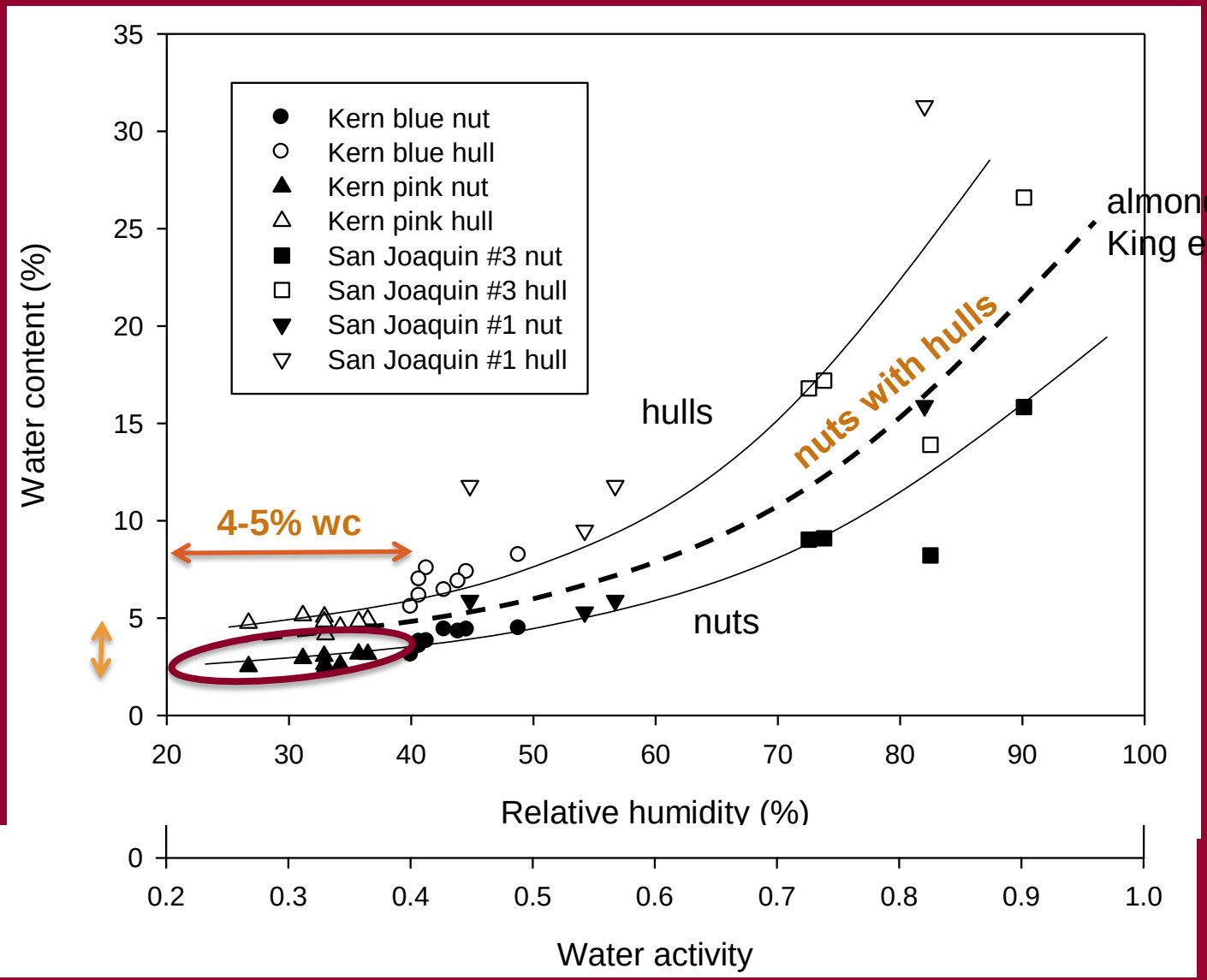
Microorganism Inhibited	a_w
Clostridium botulinum A, B	.97
Clostridium botulinum E	.97
Pseudomonas fluorescens	.97
Clostridium perfringens	.95
Escherichia coli	.95
Salmonella	.95
Vibrio cholerae	.95
Bacillus cereus	.93
Listeria monocytogenes	.92
Bacillus subtilis	.91
Staphylococcus aureus	.86[3]
Most molds	.80[3]
No microbial proliferation	.50

Measuring Water Activity (relative humidity) in An Almond Sample That Has Been Allowed to Equilibrate to Room Temperature





Relationship Between Relative Humidity and Water Content for Almond Kernels with Shell, Hulls, and for Nuts With Shells and Hulls



Stockpiling Guidelines

Do not stockpile if either the hull moisture content exceeds 13% or the kernel moisture content exceeds 6%

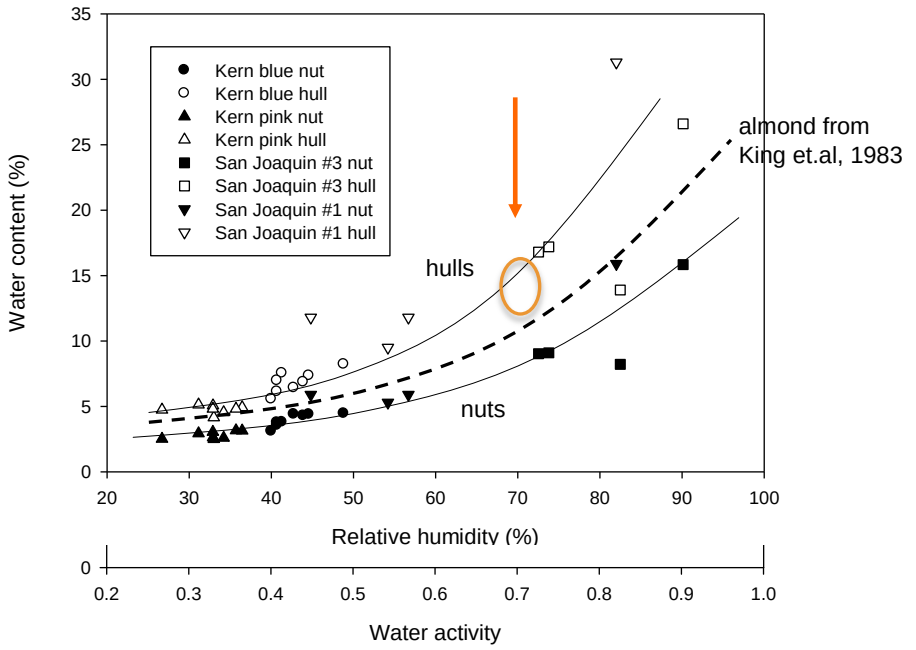
This is equivalent to a sample water activity of 0.7 or a relative humidity of 70%

Hull moisture content

11-12%	**Acceptable (the hull snaps)**
>13%	**Too high**

Kernel moisture content

4-5%	**Excellent**
< 6%	**Acceptable**
> 6%	**Too high**



At end of drying period, ~2% higher moisture content under tree compared to in drive row

For nuts that were dried in windrow, moisture content was approximately 2% higher at bottom of windrow than at top

Nut Drying on Orchard Floor Can Vary Depending on Canopy Size
Be Sure to Sample Across Canopy Size Gradients

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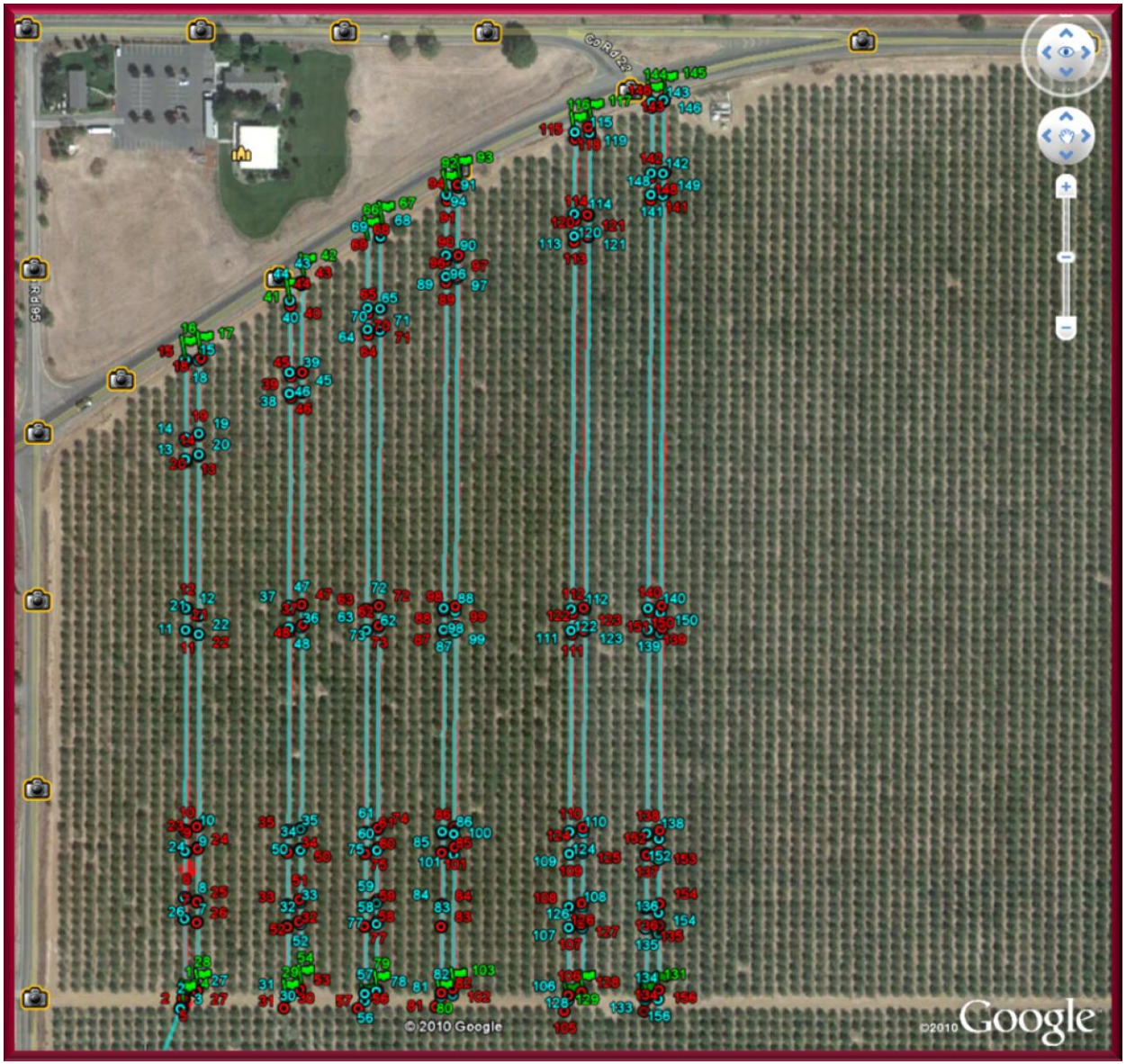
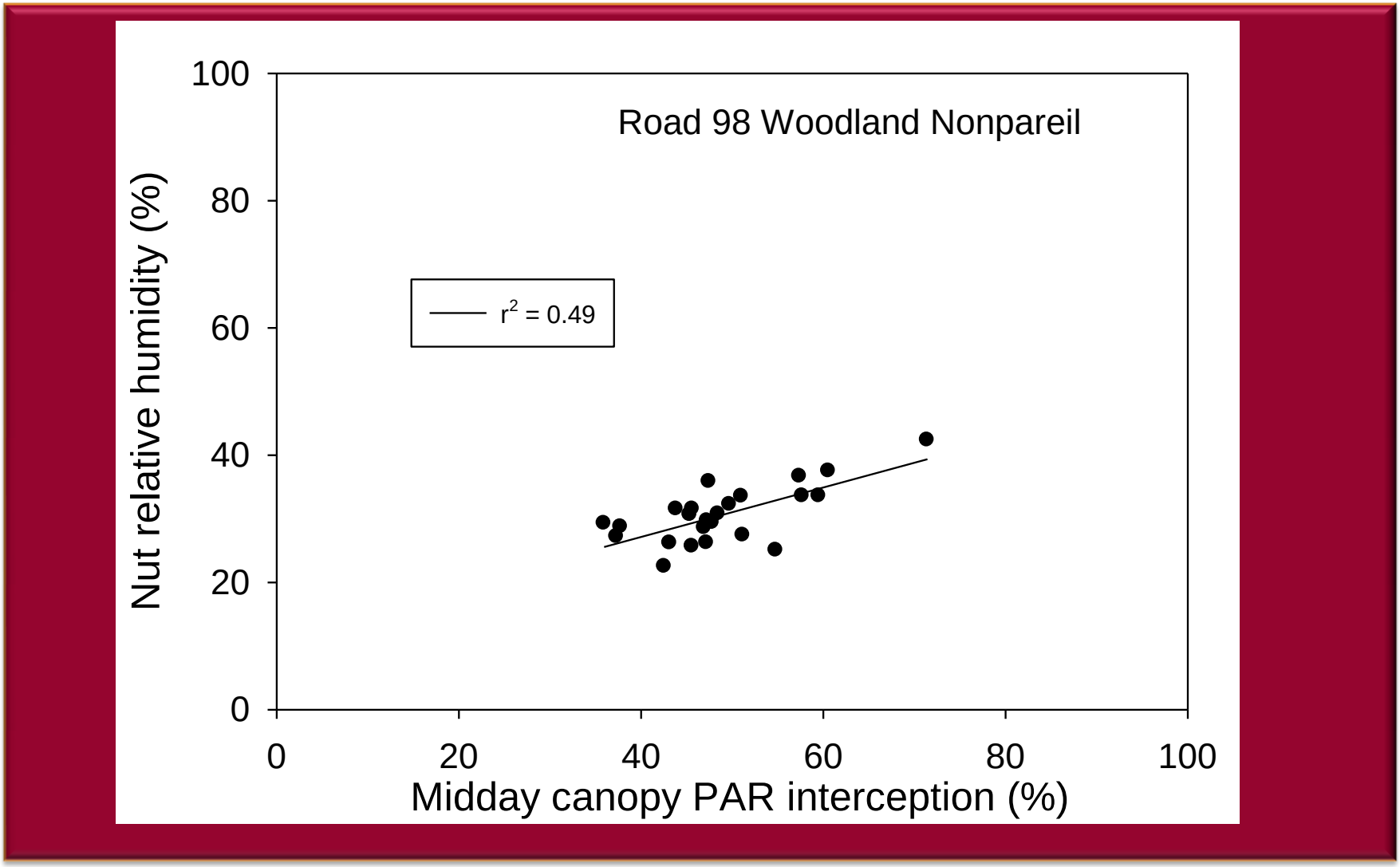


Nuts in lower light interception parts of orchard dried more rapidly than those in high light interception parts of orchard



Stockpiling- currently studying potential impacts of stockpile conditions on food safety

Photo 1. Temperature and relative humidity sensor placement In stockpiles in 2007 season. Sensors were approximately in the middle of the stockpiles long dimension in line with the yellow measuring tape.

Large humps on top of piles leads to valleys where condensed water can collect and contact nuts leading to mold growth

Flattening tops of piles leads to less concentration of condensate. Orienting piles with long axis in north/south direction is also beneficial

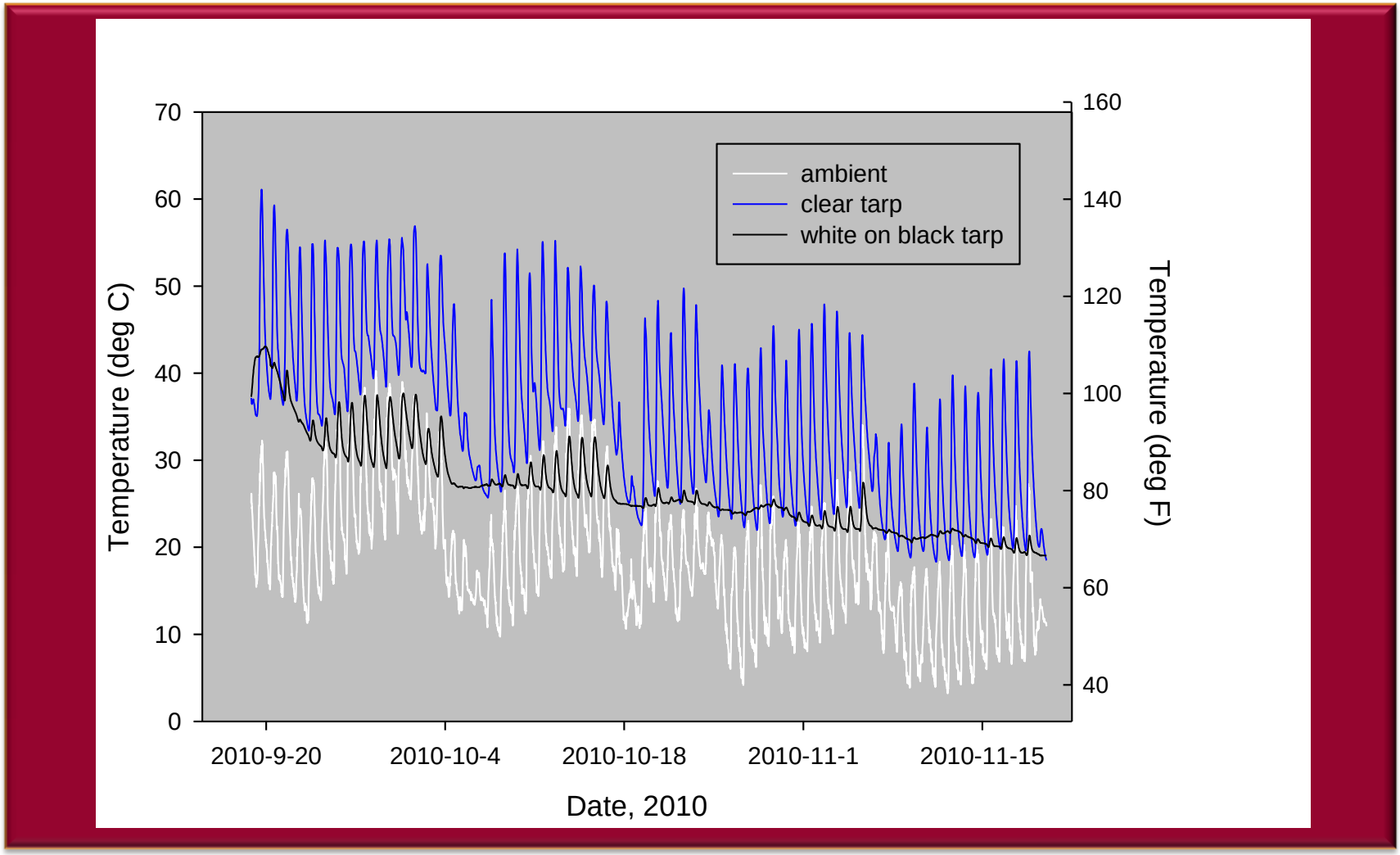
Impact of Different Tarp Materials on Stockpile Conditions

White

Clear

White on black

Impact of Different Tarp Materials on Stockpile Conditions



White on black tarp ran up to 40 deg F cooler than commonly used clear tarp and had much smaller day to night temperature fluctuations

Impact of Different Tarp Materials on Stockpile Conditions

Clear tarp north end

White on black tarp north end

Smaller temperature fluctuations under white on black tarp led to less condensation problems and correspondingly less mold growth

Conclusions

Food safety risk should be assessed in relation to orchard planting design and canopy structure

- Hedgerow planting tends to lead to dense shade under tree row and may increase food safety risk
- More conventional tree spacing leads to more varied light/temperature patterns across orchard floor
- Any orchard producing above 3500 kernel pounds per acre likely has increased potential for food safety related problems

Food safety risk during harvest/stockpiling:

- Make sure nuts are adequately dry before stockpiling
  - Sample nut moisture content (water activity) in a systematic way across orchard before beginning harvest operation
- Choose appropriate tarp materials to minimize condensation potential

Thank You

Harvesting and Visible Dust

Ken Giles and D. Downey, Bio. & Ag. Eng., UC Davis

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Almond Production

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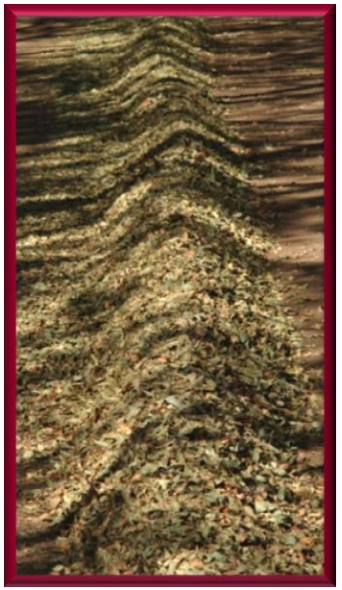
Over 700,000 acres in production

- Significant for California's economy
  - Number 1 horticultural export in U.S.
  - California's number 1 agricultural export

Air Quality Concerns

- San Joaquin Valley
  - PM10 attainment under NAAQS (not so with state)
  - PM2.5 non-attainment (federal and state)



Collaborative Work

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Funding from ABC on ways to minimize visible dust

- Industry assistance with equipment and testing conditions
- Overlapping field studies with Texas A&M (TAMU) during their PM10 and PM2.5 air quality measurements

Visible Dust

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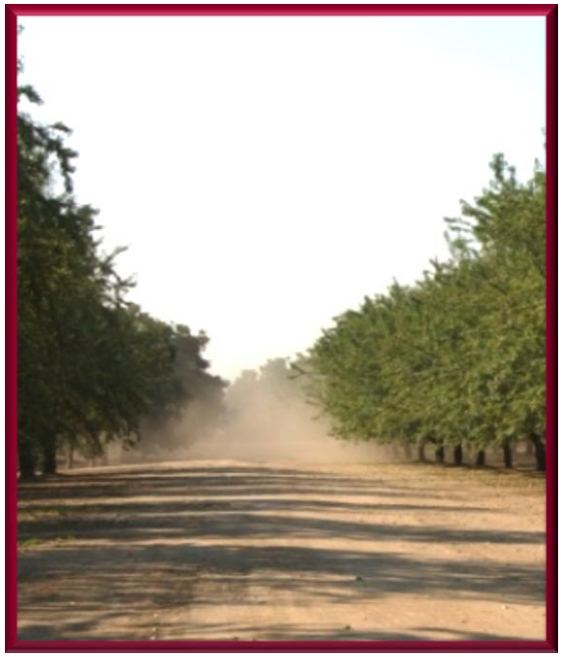
Cause and effect

- Why care
- Steps to reduce dust
- Energy concerns
- Time in field concerns



Harvesting

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Sweeping

- Causes visible dust release to ambient environment
  - Management tools to minimize

Pick-up Operations

- Causes visible dust release to ambient environment
  - Management tools to minimize
  - Quality of harvested product concerns

Sweepers

Conventional Sweepers

- Head height
- Wire versus rubber tines

Conventional versus Reduced-pass Sweepers

- Product recovery in windrow
- Time-in-field versus fuel consumption

Sweepers

Sweeper head height and pick-up operations

- Standard setting at ground surface vs. 1/2” lower
  - In orchard dust decreased 33% with standard setting

Sweeper tine material and pick-up operations

- Wire vs. rubber
  - In orchard dust decreased 35% with wire tines

Sweeper and Product Recovery

Conventional vs. Reduced-pass

- Greater than 99% recovery
  - end of rows not included

Mass per tree lbs	Nuts per tree prior to sweeping	Nuts left after sweeping	Nut Recovery %
North orchard - Conventional sweeper			
51.02	4898	6	99.88
(4.04)	(573)	(3)	
South orchard - Reduced pass sweeper			
25.87	1914	5	99.74
(5.11)	(504)	(5)	

Sweeper Efficiency

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Conventional vs. Reduced-pass

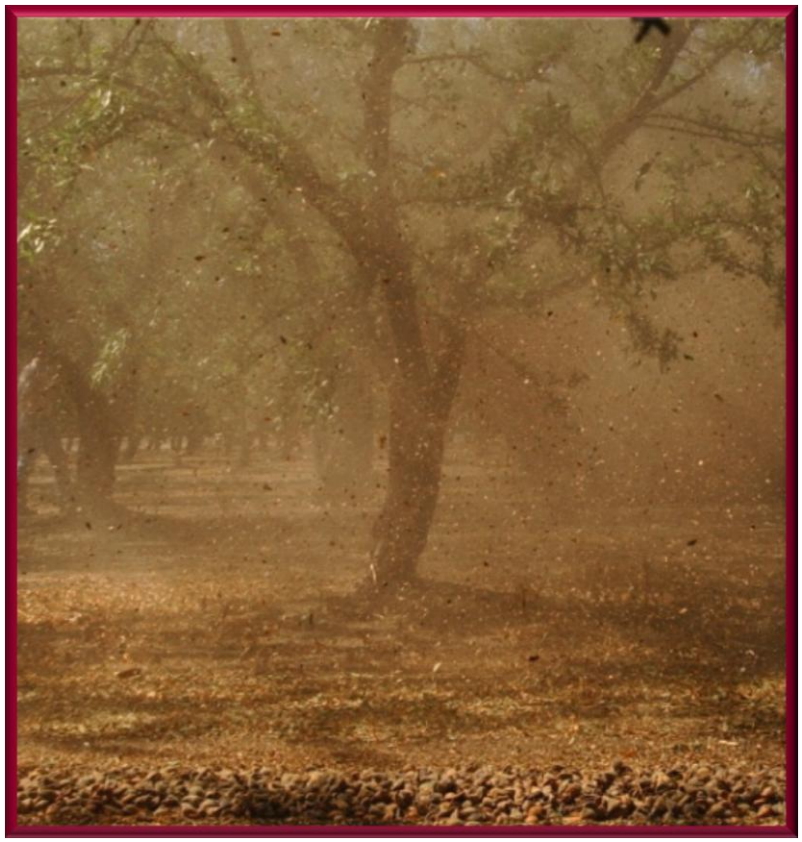
- Reduced-pass - more time efficient
- Reduced-pass - slightly more fuel efficient

Ground Speed mph	Time in test block h	--------- Fuel consumed ---------- Per engine hour Gal/h	Per unit area Gal/ac
North orchard – conventional sweeper			
3.35	1.42	1.53	0.34
(0.46)	(0.11)	(0.32)	(-)
South orchard – reduced pass sweeper			
2.67	0.94	2.09	0.30
(0.12)	(0.03)	(0.09)	(-)

Harvesting Product

Pick-up operations and dust

- Soil type
- Ground speed
- Tree rows
- Separation fan speed
- Design tools



Harvesting and Soil Type

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Loose soil

Compact soil

Ground Speed and Visible Dust

Harvesting at 5.5 mph

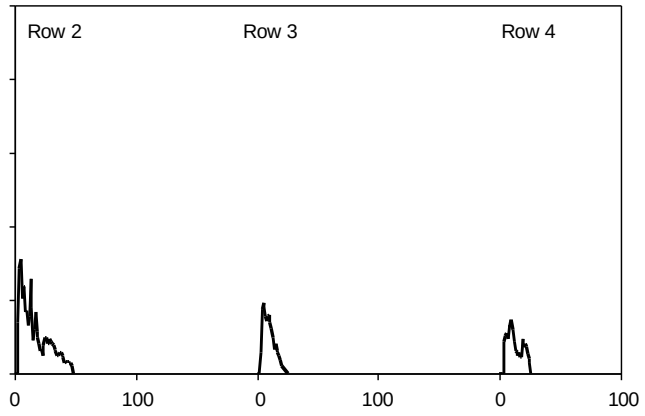
Harvesting at 1.5 mph

Visible Dust and Tree Rows

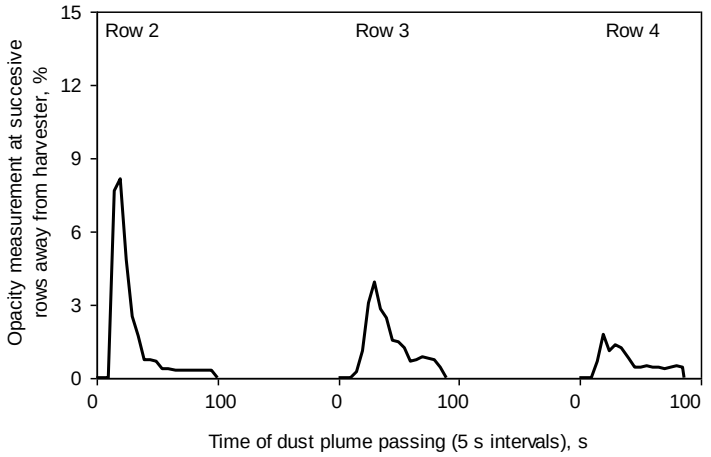
Natural benefits of orchard rows reduce visible dust near orchard boundaries/sensitive areas

- **Air discharge directed inward reduces visible dust**

Harvesting at 2 mph



Harvesting at 4 mph



Separation Fan Speed

Standard vs. reduced fan speed

- Is there a trade-off regarding product quality

Separation Fan Speed

At low fan speeds (715 and 0 rpm) visible dust is dramatically reduced

- **However harvested product quality is unacceptable**

Separation Fan Speed

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Standard speed vs. a 15% reduction

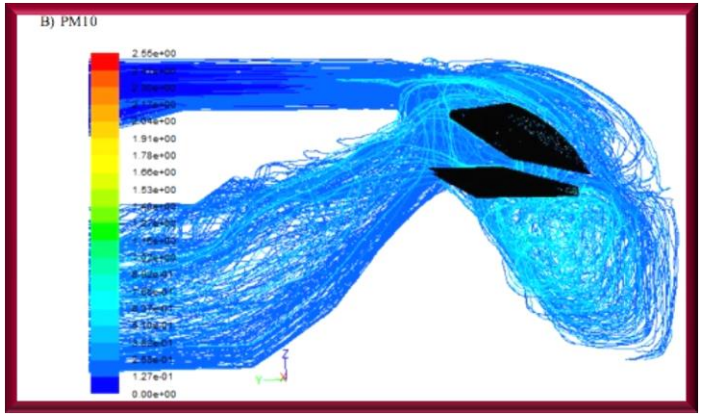
- A 15% reduction in fan speed results in …
  - 40% reduction in visible dust
  - 40% reduction in time dust resides within rows
  - 70% less TSP and PM10 measured within the canopy

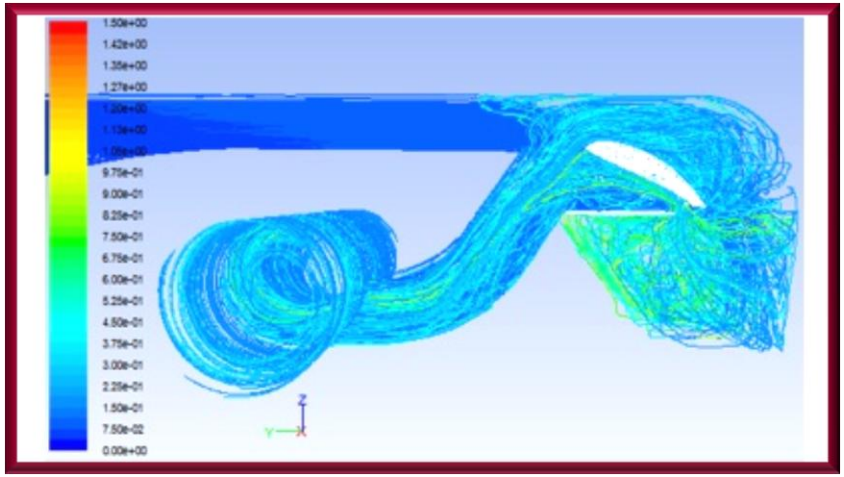
Product Quality

- Similar for the standard and 15% reduction

Design Tools

Computer assisted design and evaluation





Conclusions

Visible dust reductions

- Sweeper setting
- Sweeper type - fuel efficiency vs. time in field
- Orchard and equipment management
  - Ground speed
  - Natural benefits of orchard canopy
  - Separation fan speed and product quality
- Designs tools for assisting and evaluating equipment

Wrap-Up, Discussion and Q&A

Preview Poster Session

Refreshment Sponsor

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VALENT®

Sessions at 3:30 pm:

Insect + Mite Management Updates in Grand Ballroom

Economics of Growing Almonds in Arbor Theater

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