Water Management and Crop Quality

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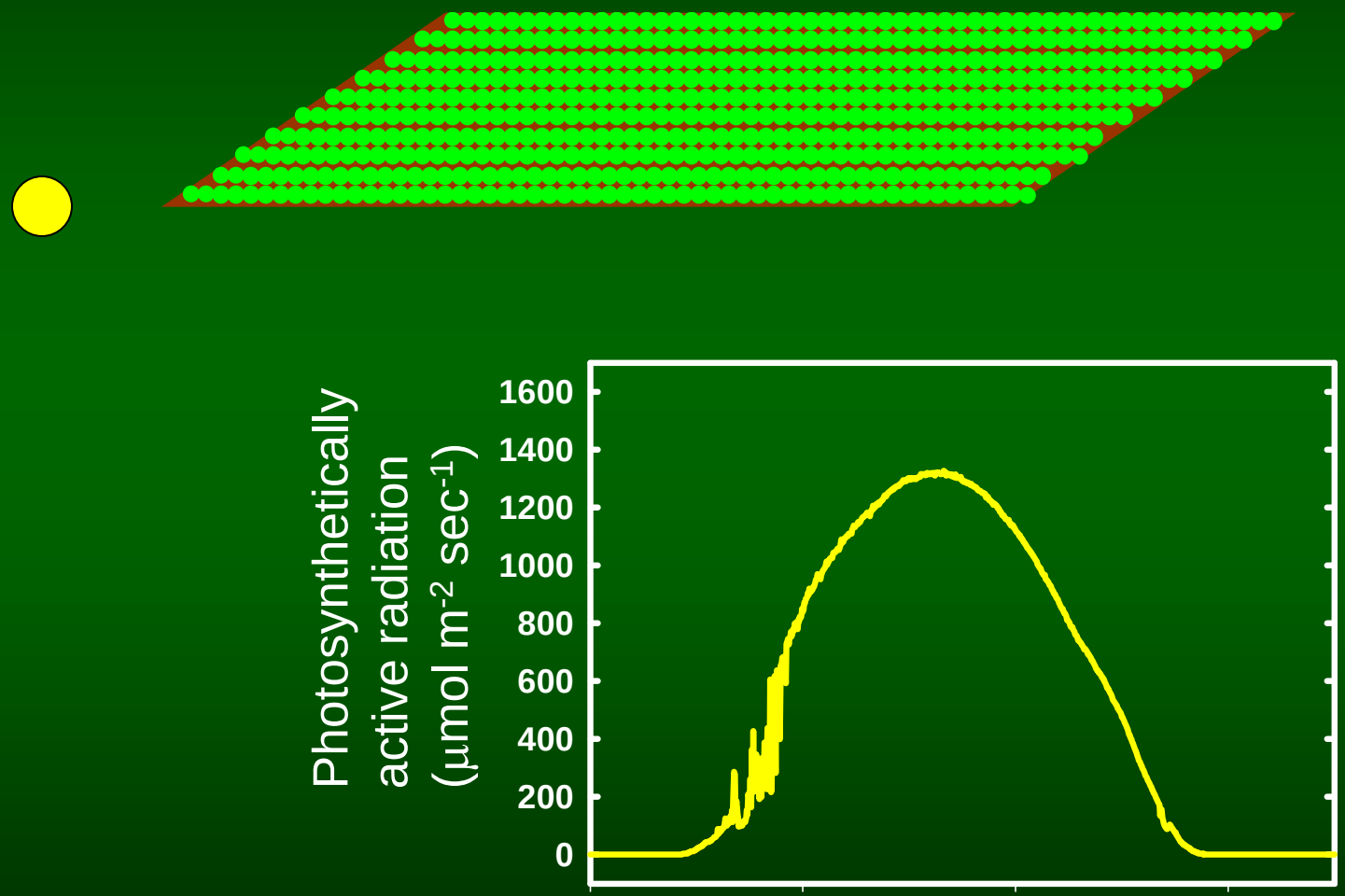
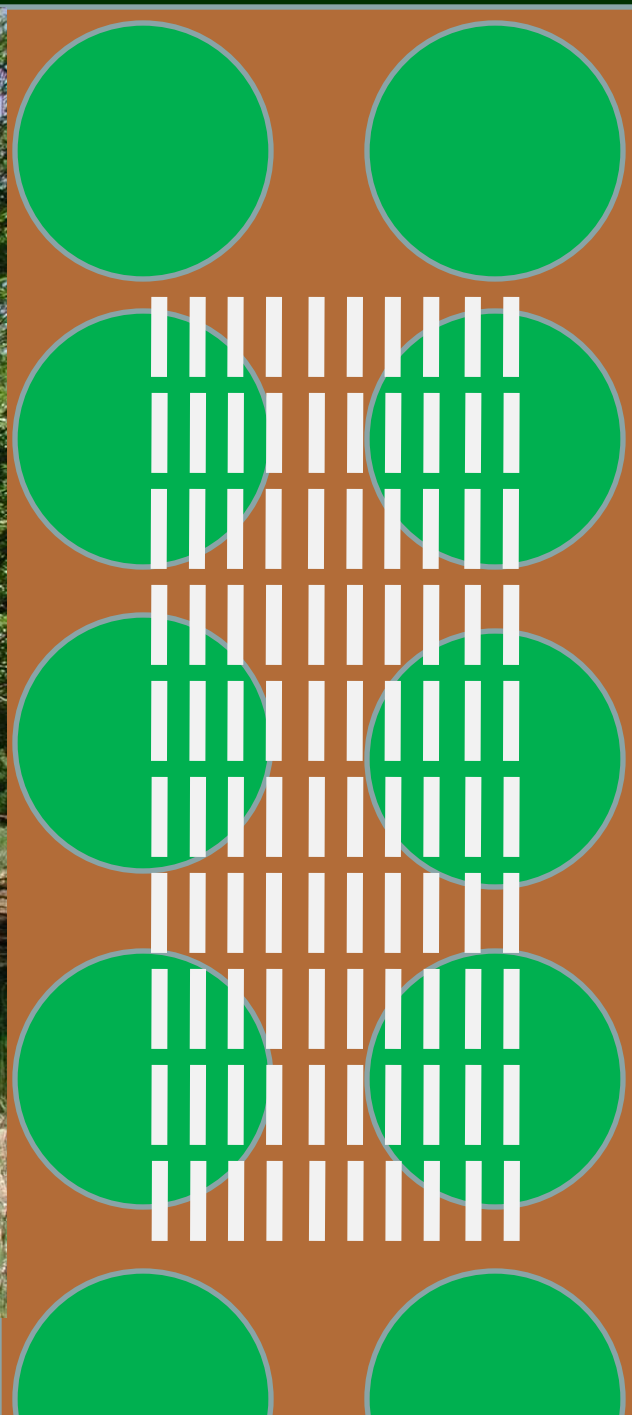
UC Davis

Factors influencing yield potential in a developing orchard

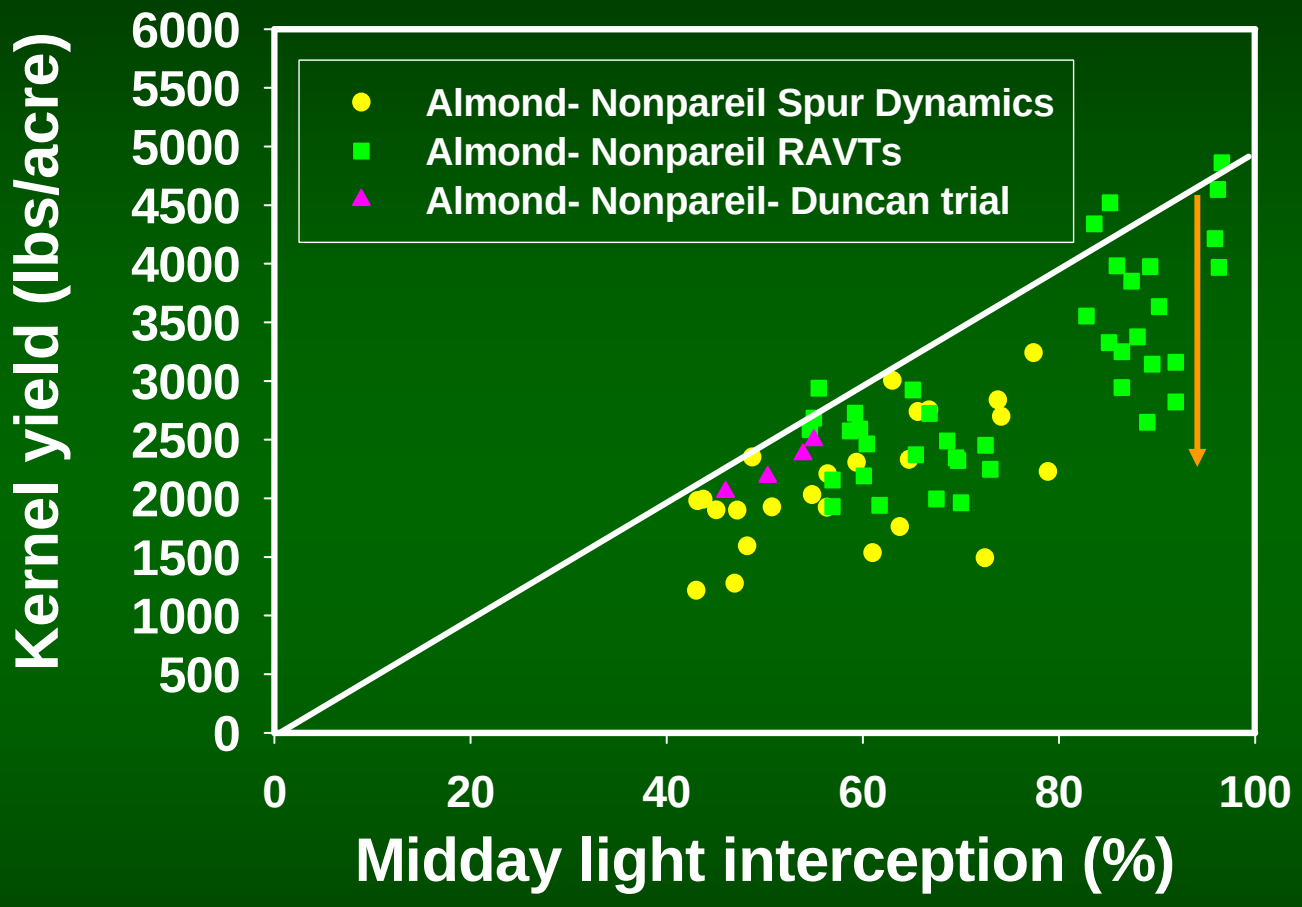
- Canopy size as influenced by
  - Variety
  - Rootstock
  - Tree spacing
  - Irrigation management
  - Nutrition management
  - Pruning


Photosynthetically active radiation (µmol m-2 sec-1)
1600
1400
1200
1000
800
600
400
200
0

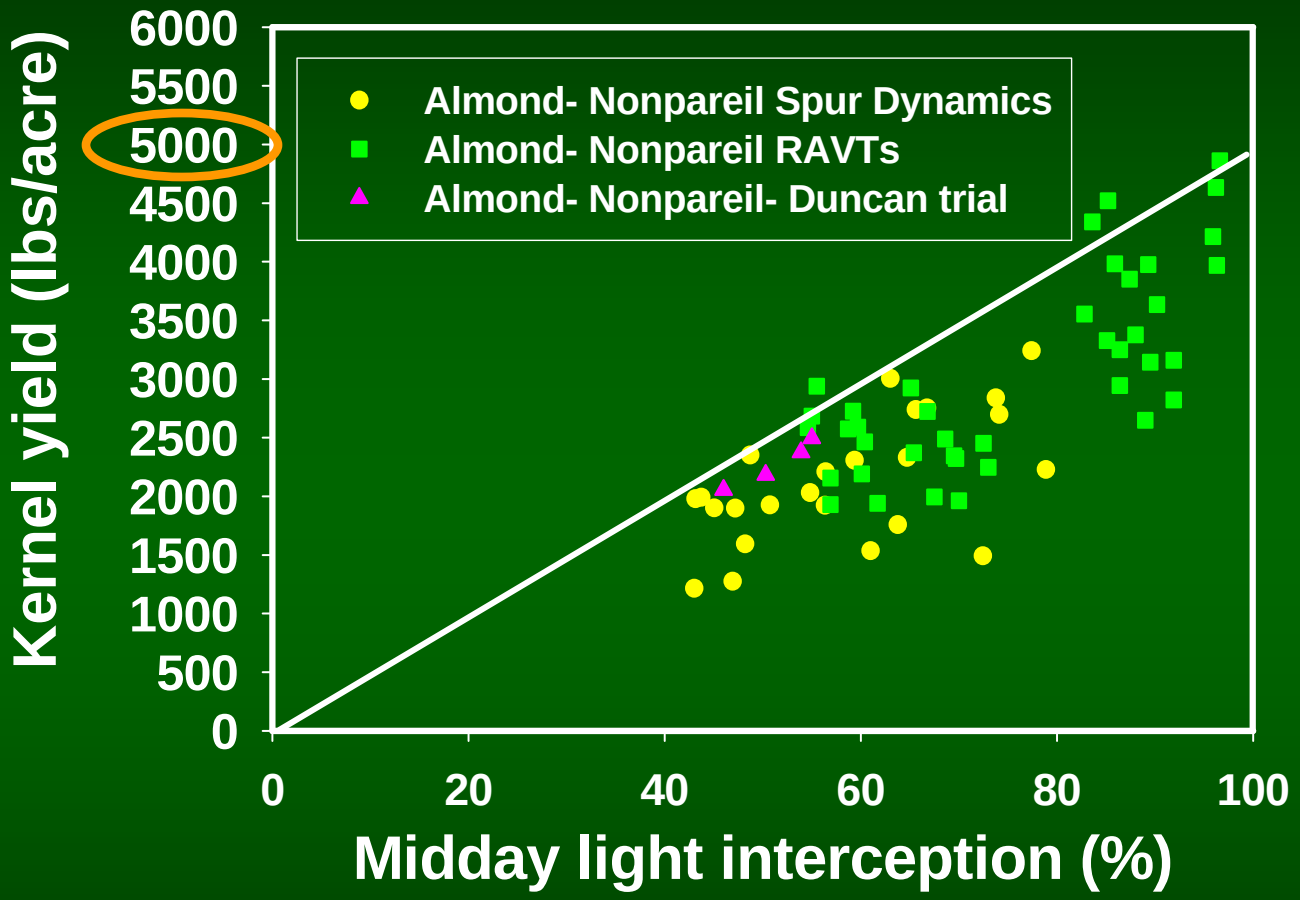


Full sun reference


Kawasaki
MULE
610

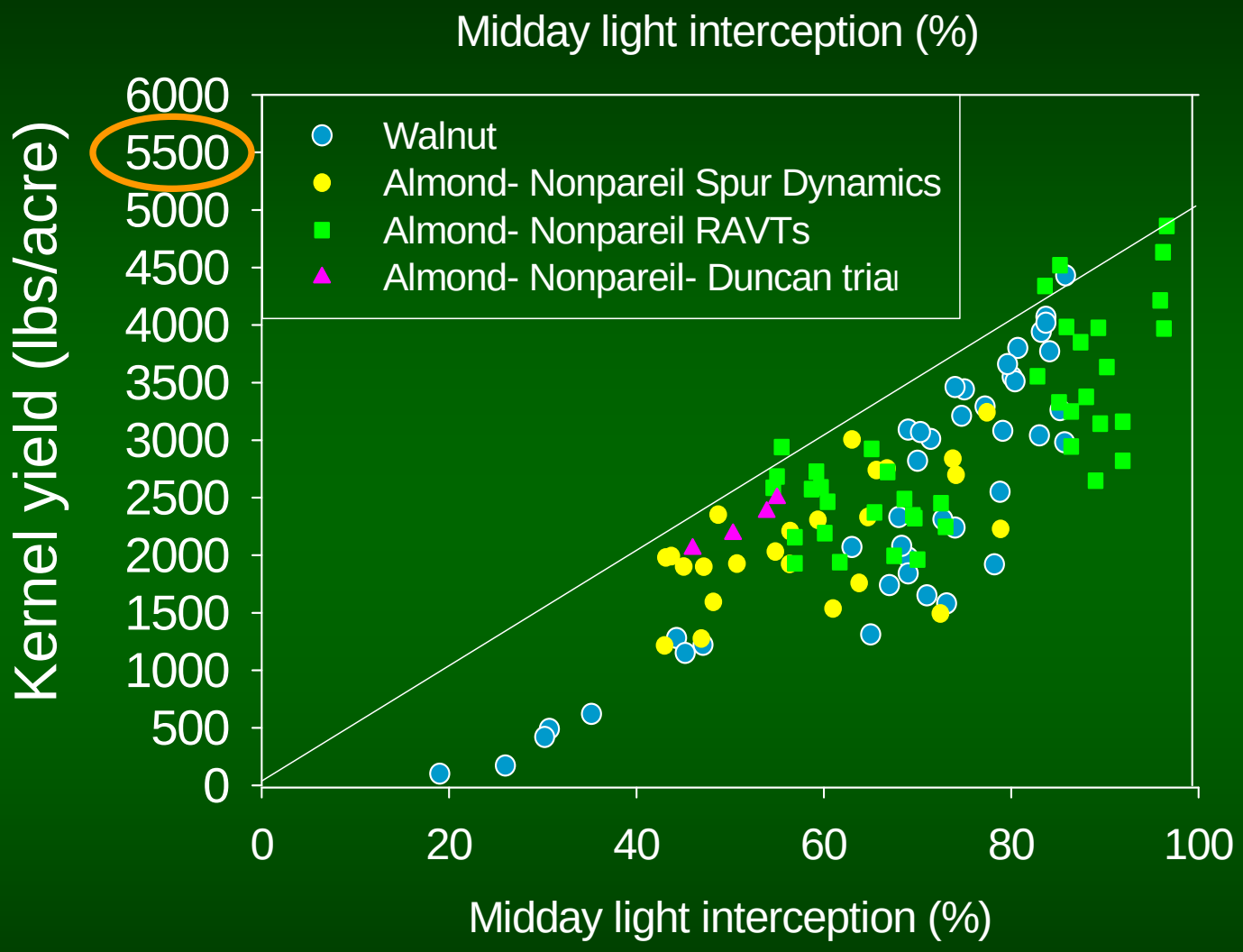


The white line is the maximum potential yield. Any number of factors can make your orchard yields lower including water stress (excess or deficit), disease pressure, poor bloom overlap with pollenizers, poor nutrient management etc.



Potential for 5000 kernel pounds per acre at 100% light interception

Realistically, not easy to get above about 80% of potential light interception since you need to have access down the rows and you need light reaching orchard floor to dry nuts.



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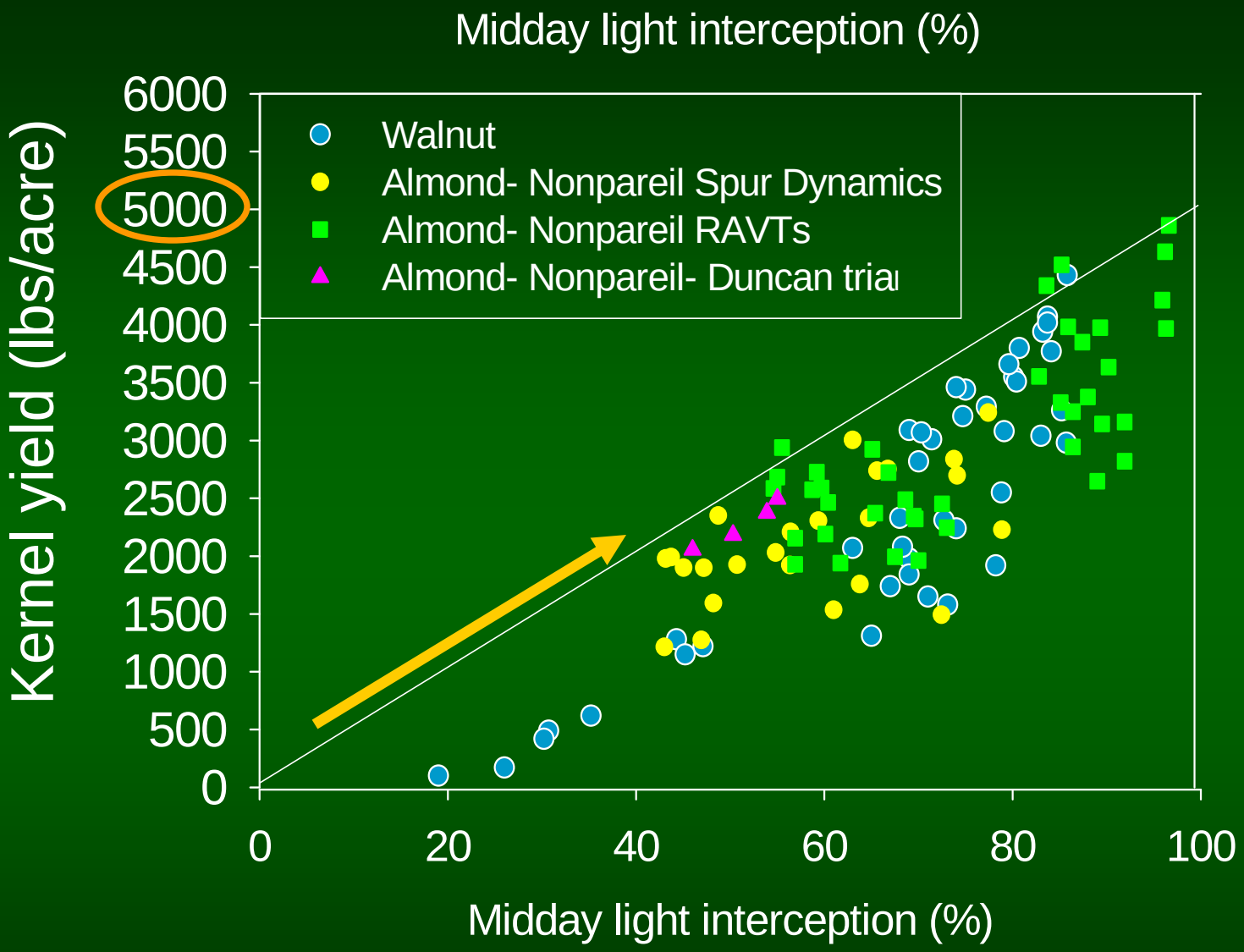
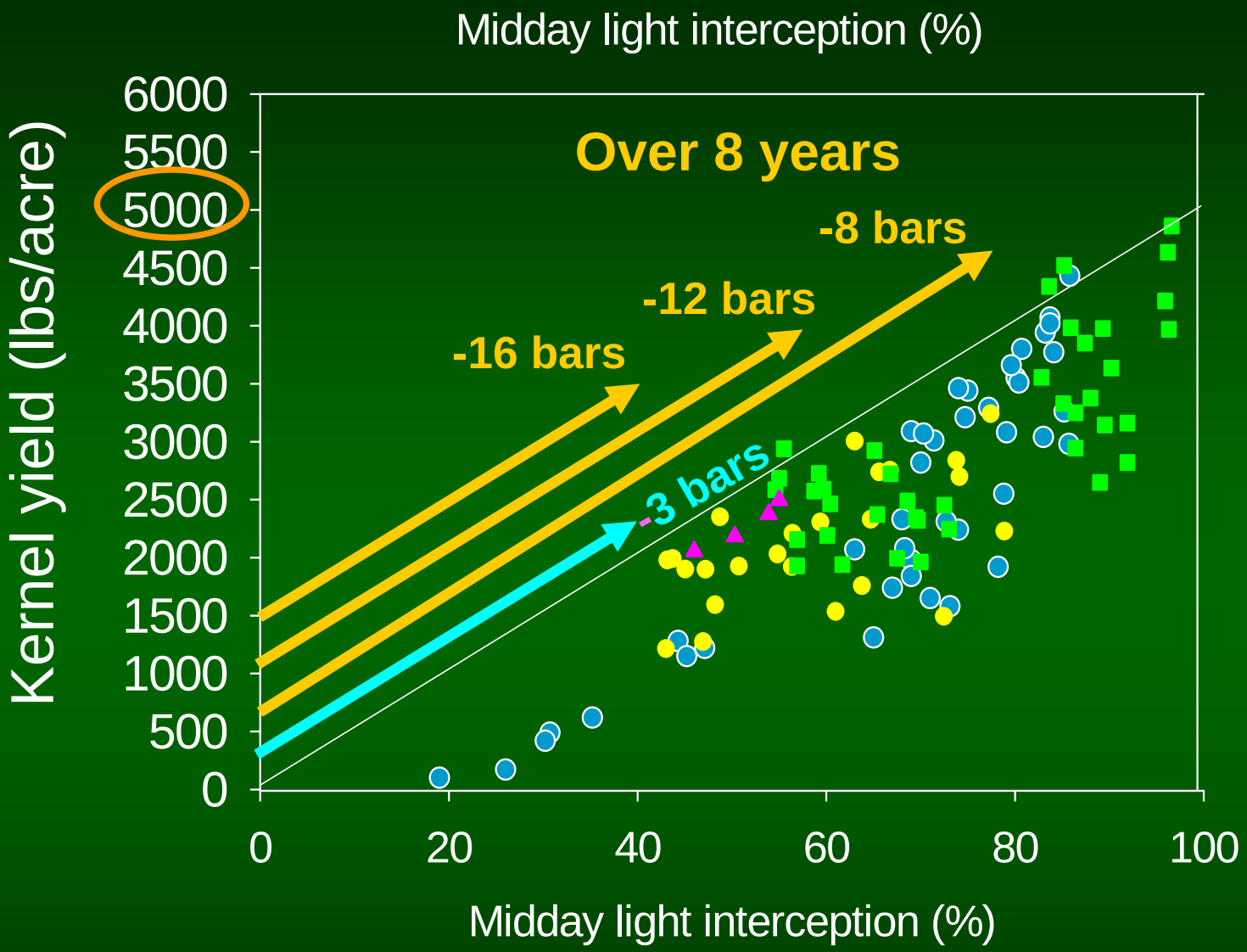


Rate of canopy development determines yield potential



Approximately 5% loss in rate of canopy development per bar of seasonal average midday stem water potential deficit- but also dramatic decrease in growth under excessively wet conditions

Per acre loss is about $250 per bar of deficit per year. This is equal to a potential loss of $160,000 over eight years for every bar of seasonal average midday stem water potential stress the trees experience.

-$8,000 per acre

-$14,000 per acre

However, once the canopy has reached the desired level of development, there is no advantage to keeping the trees near the fully watered baseline. Relatively small levels of stress (as measured by falling off the fully watered baseline by 2 to 3 bars) are probably beneficial from a long term tree survival perspective and should not effect productivity.

Hull rot covered by Ken Shackel earlier

Almond Lower Limb Dieback

- Bruce Lampinen
- Jim Adaskaveg
- Greg Browne
- Joe Connell
- Roger Duncan
- Brent Holtz
- Themis Michailides
- Sam Metcalf

Usually beginning in late April to early May, leaves on lower limbs begin to yellow and then turn brown

Eventually, the whole limb collapses

Stanislaus LLDB Fungicide Trial #1

- Captan or Pristine, with and without a bark penetrating surfactant, was applied to lower canopy in Orchard #1 in early May prior to expected onset of limb dieback
- Overall incidence of limb dieback was low
- No difference among treatments.

Stanislaus LLDB Fungicide Trial #2

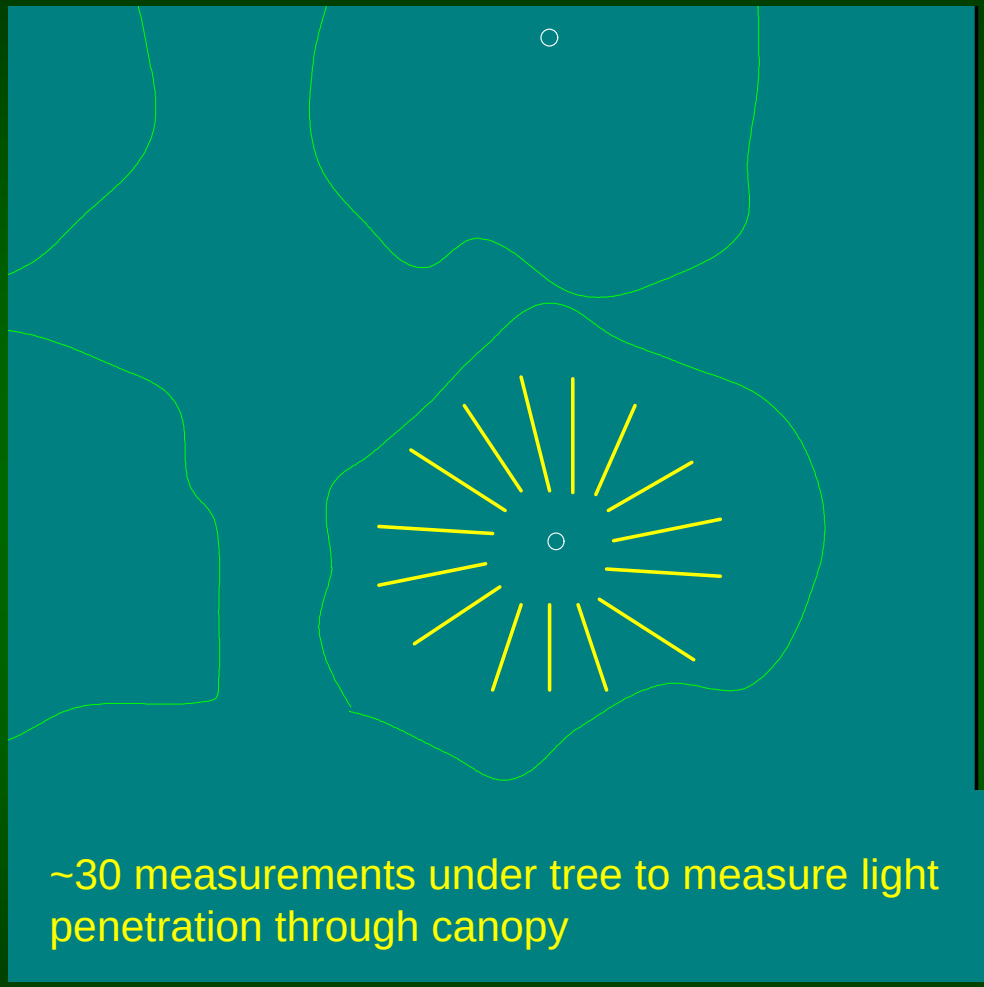
Materials applied to trunks and scaffolds on June 22, 2007

Symptoms rated August 17, 2007

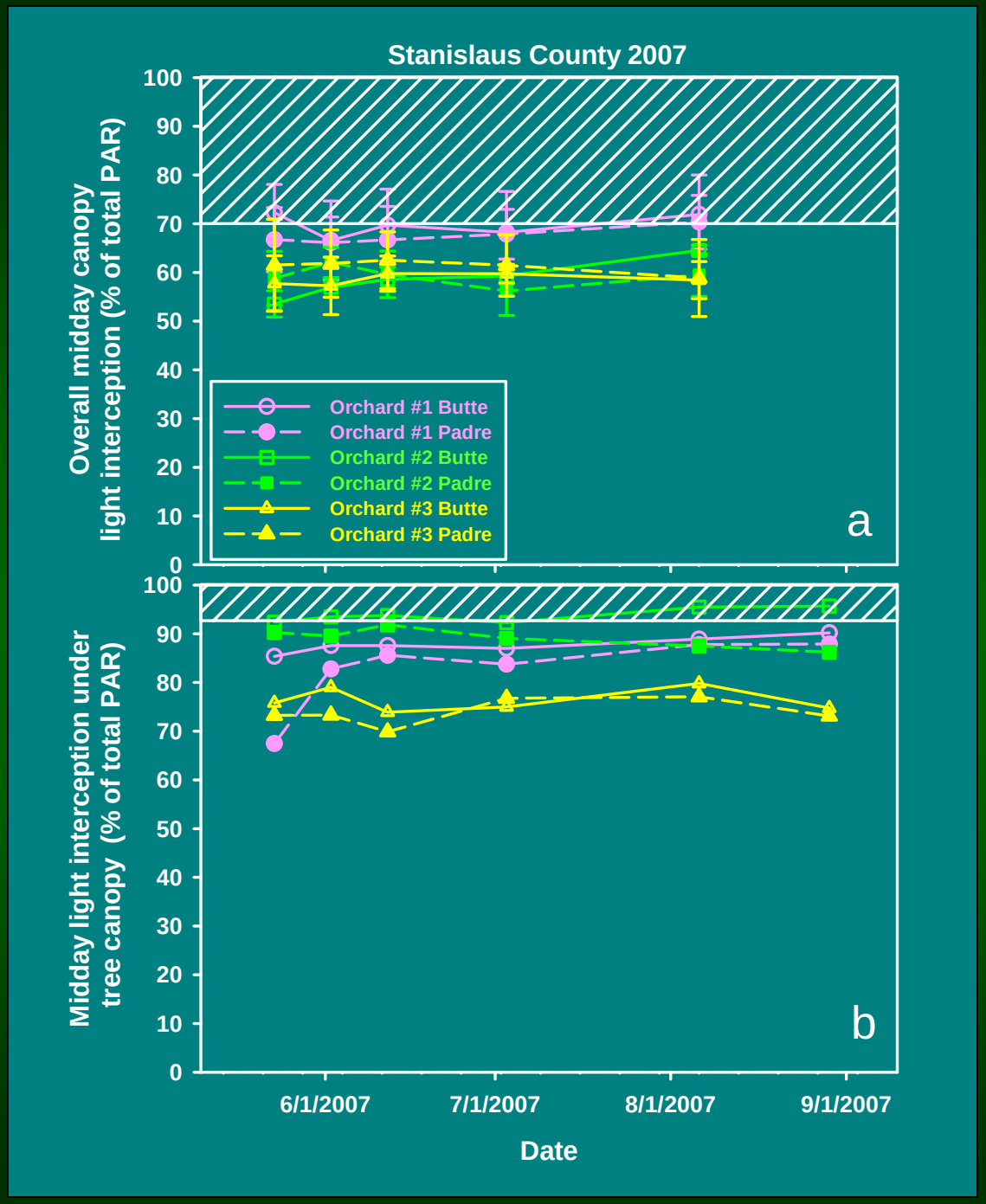
Treatment	LLDB Symptoms (Rating 0-4)
Agri-fos @ 1.5 qt. / gal. solution + 3 oz penetrant	3.6 a
Captan 80 WDG @ 5.66 lb + 3 oz penetrant	2.3 b
Untreated	2.0 b
Pristine @ 14.5 oz + 3 oz penetrant	1.6 b

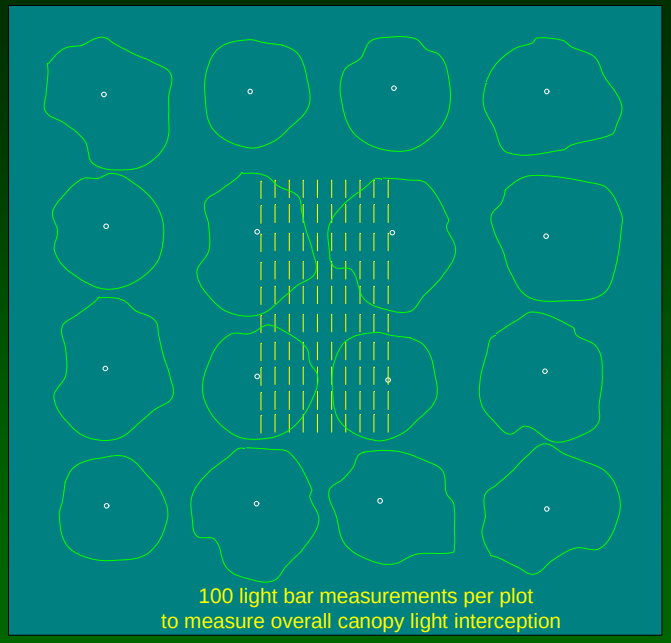
The pattern of LLDB related dieback is different from the normal pattern of shading related dieback- more commonly individual spurs yellow and following year will be dead

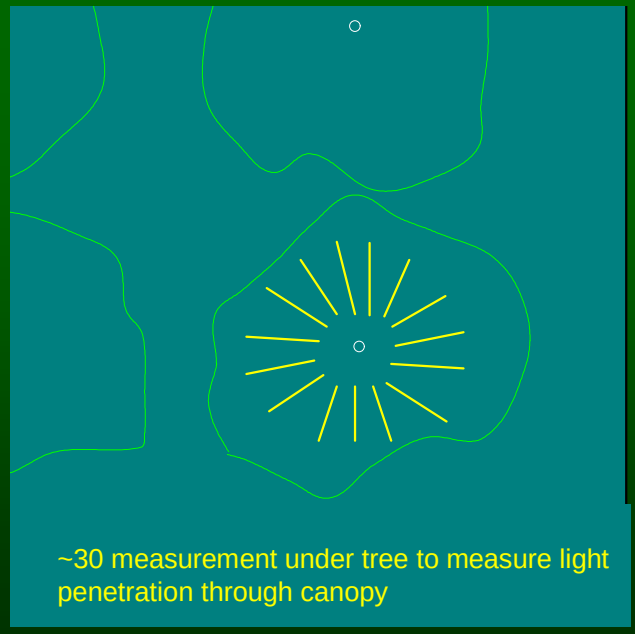
100 light bar measurements per plot
to measure overall canopy light interception



~30 measurements under tree to measure light penetration through canopy

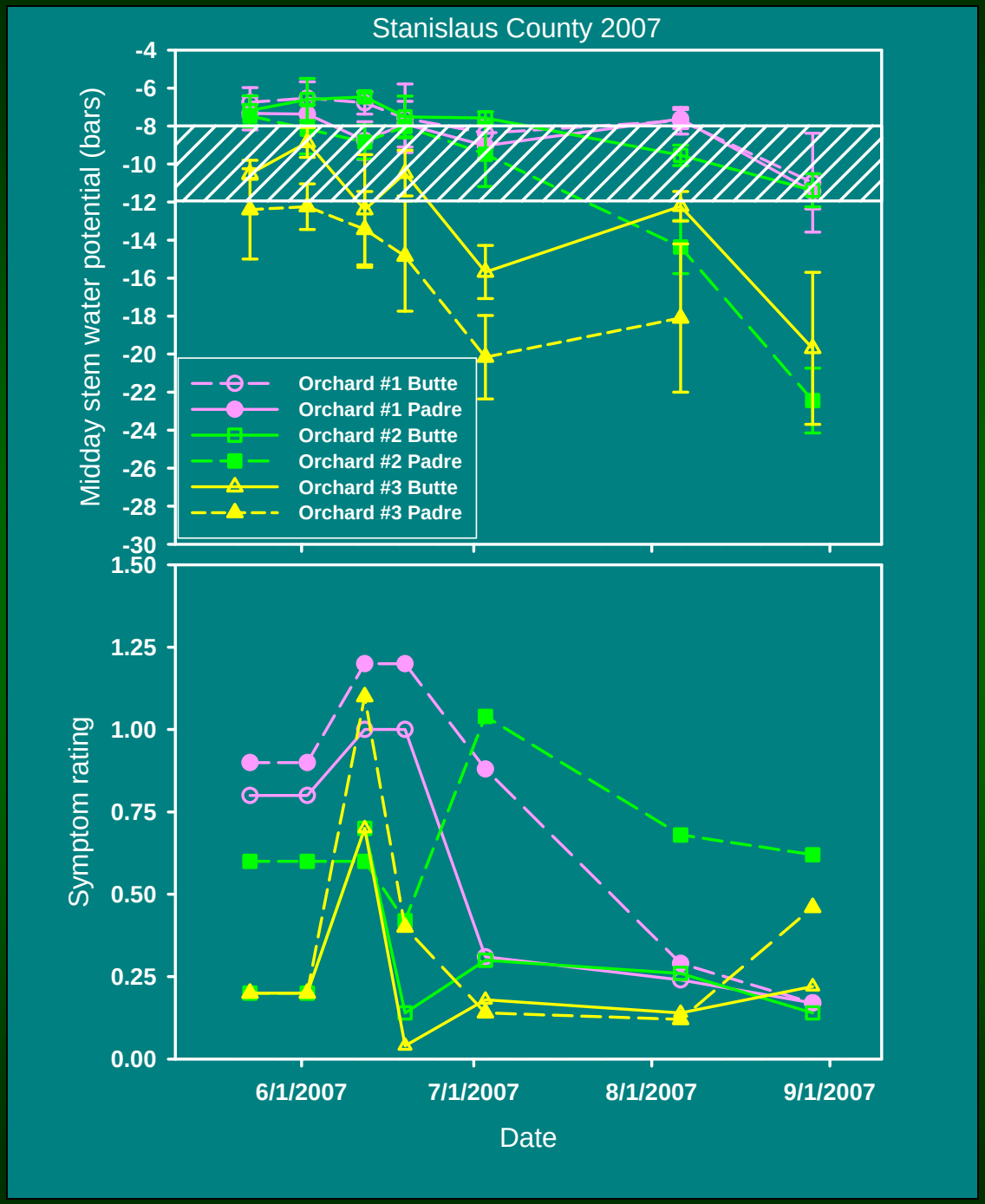

Stanislaus County 2007
Overall midday canopy light interception (% of total PAR)
Midday light interception under tree canopy (% of total PAR)
Orchard #1 Butte
Orchard #1 Padre
Orchard #2 Butte
Orchard #2 Padre
Orchard #3 Butte
Orchard #3 Padre
a
b
6/1/2007
7/1/2007
8/1/2007
9/1/2007
Date


100 light bar measurements per plot
to measure overall canopy light interception

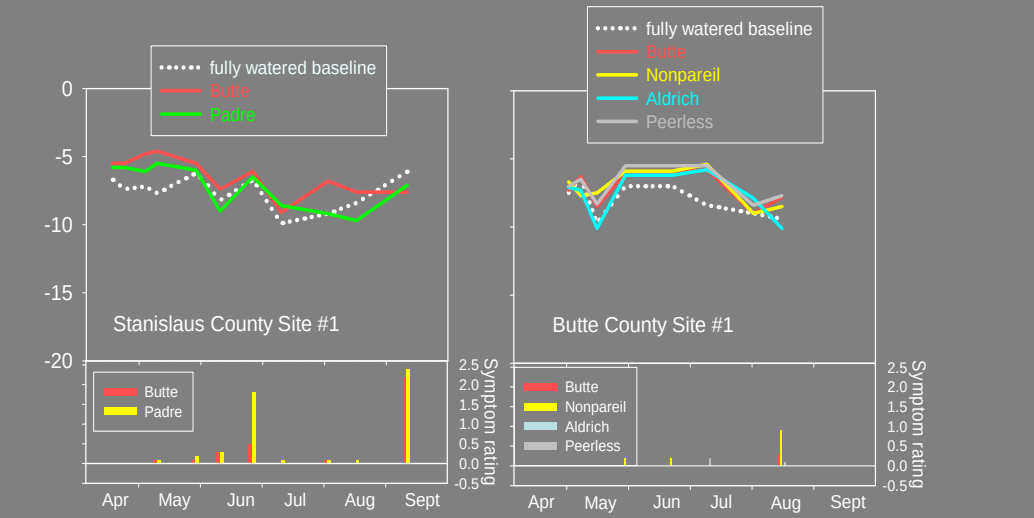

~30 measurement under tree to measure light penetration through canopy

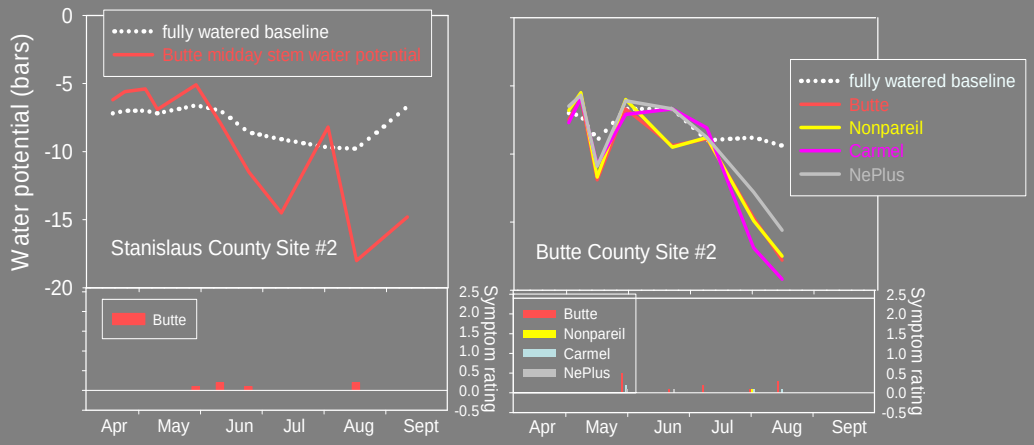
Midday stem water potential was measured periodically through the season on lower canopy healthy leaves

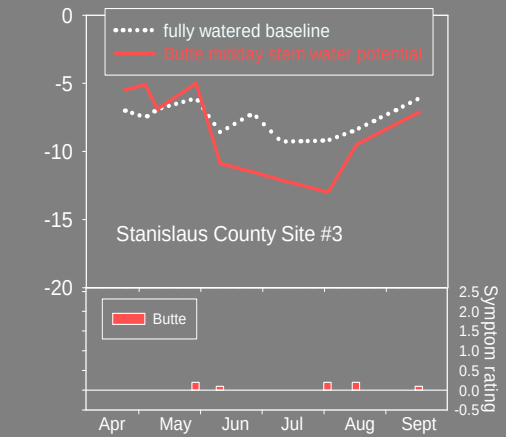
When measuring midday stem water potential, it is important to avoid bagging any leaves on branches showing symptoms of LLDB since even green leaves on these branches were found to have much lower MSWP


Stanislaus County 2007
Midday stem water potential (bars)
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
Orchard #1 Butte
Orchard #1 Padre
Orchard #2 Butte
Orchard #2 Padre
Orchard #3 Butte
Orchard #3 Padre
Symptom rating
1.50
1.25
1.00
0.75
0.50
0.25
0.00
6/1/2007
7/1/2007
8/1/2007
9/1/2007
Date

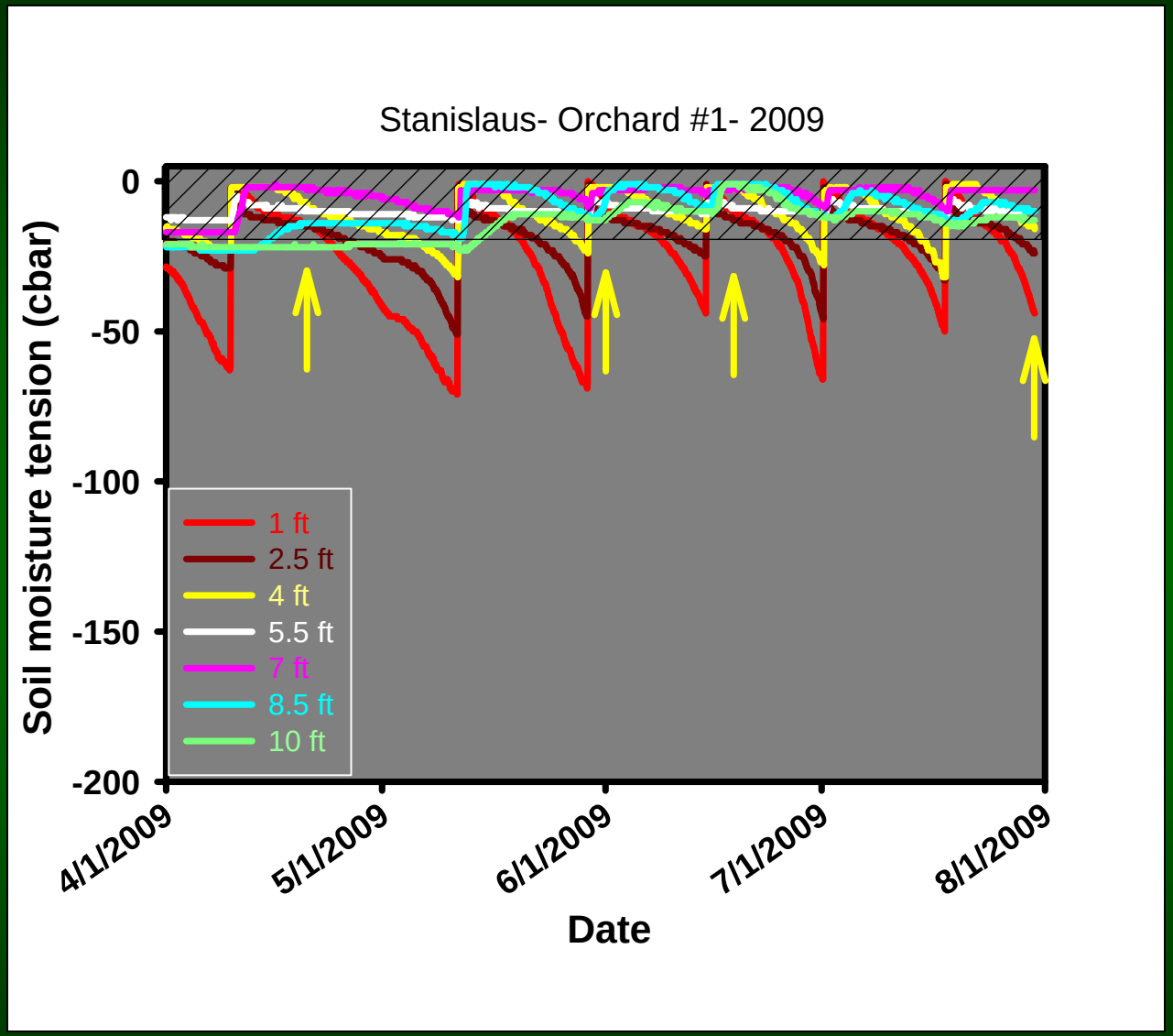
In 2008, symptoms occurred when trees were wetter than the fully watered baseline and subsided when trees got drier as the season progressed.







In 2009, symptoms again occurred when trees were wetter than the fully watered baseline. Water potentials showed trees were excessively wet on sampling dates indicated by yellow arrows but quite stressed at end of irrigation cycle suggesting shallow rooting.

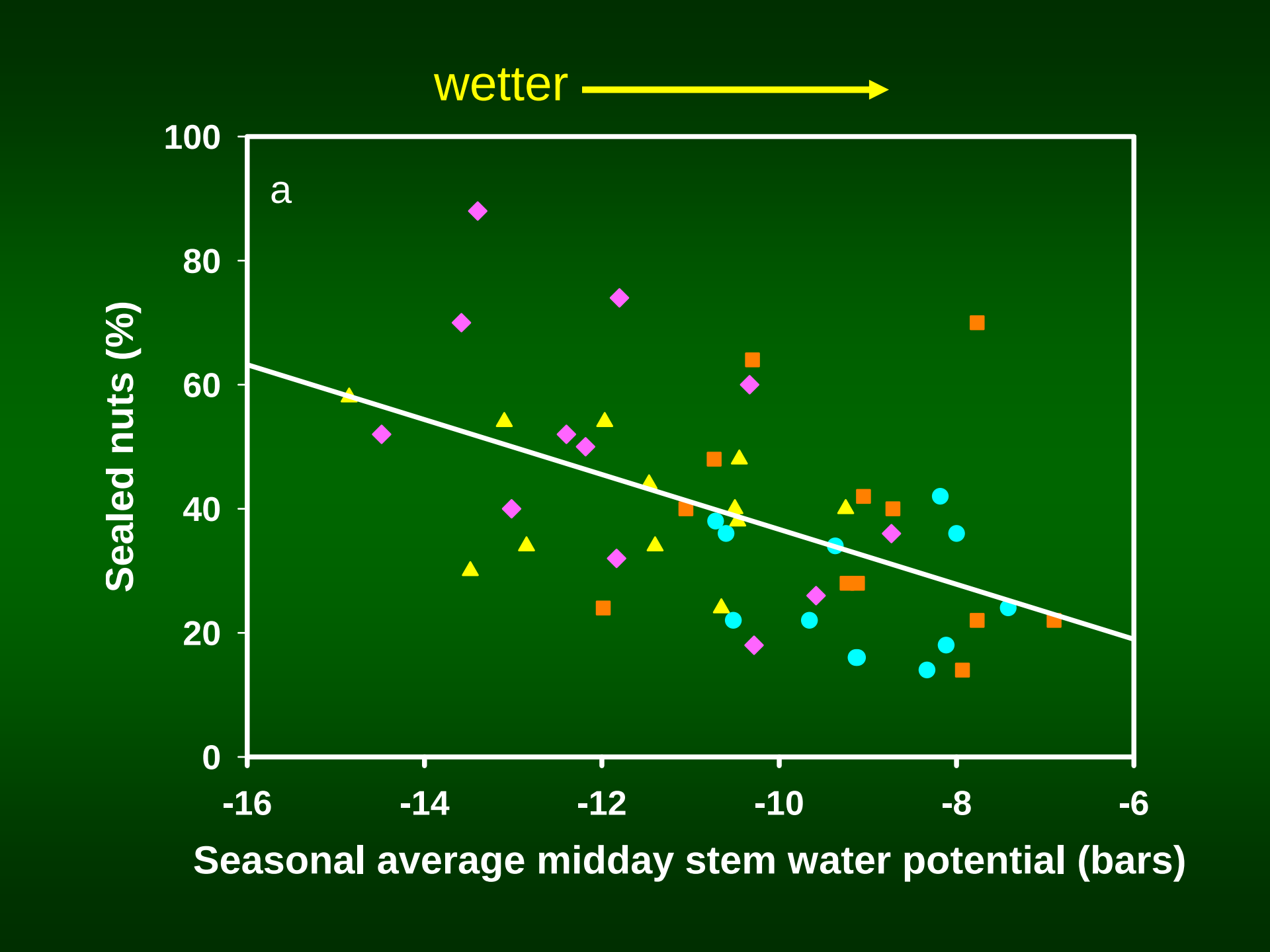


Preliminary Conclusions

- Light levels were near level where shading related dieback would occur in some, but not all of LLDB orchards

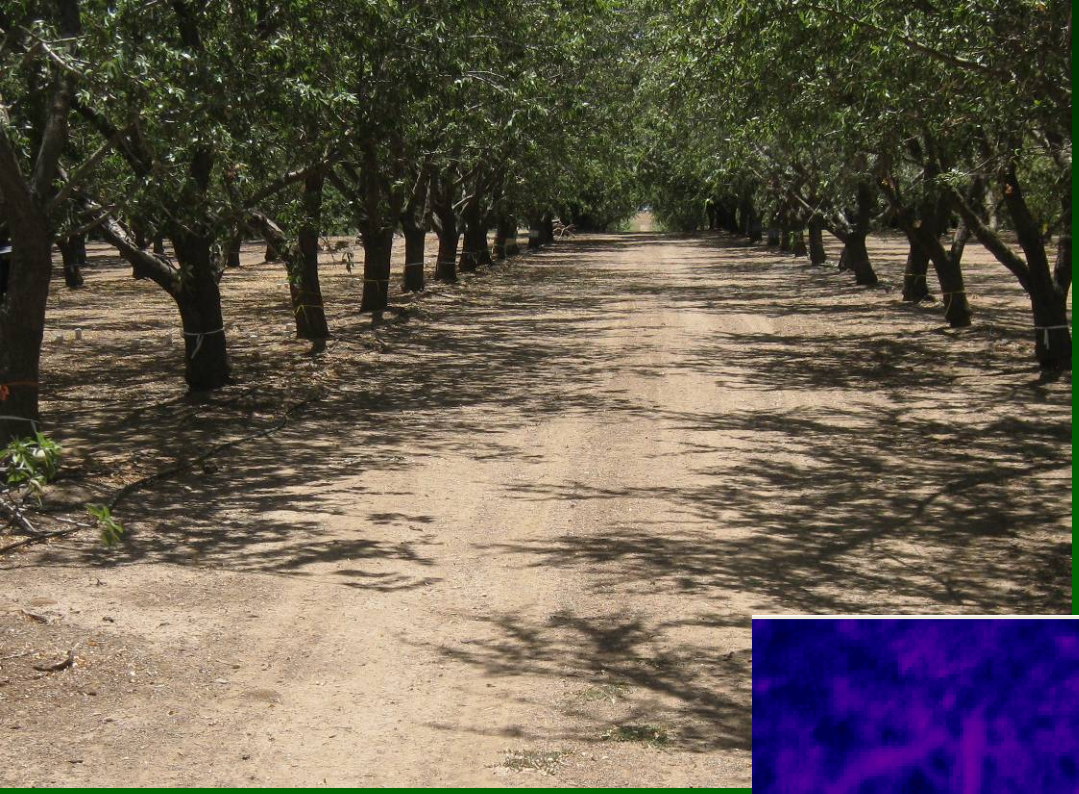
- Likely a role of excessively wet soil conditions early in the year
  - For a given level of soil moisture, symptoms were worse in flood irrigated orchards compared to sprinkler/drip irrigated orchards suggesting soil oxygen deprivation may play a role

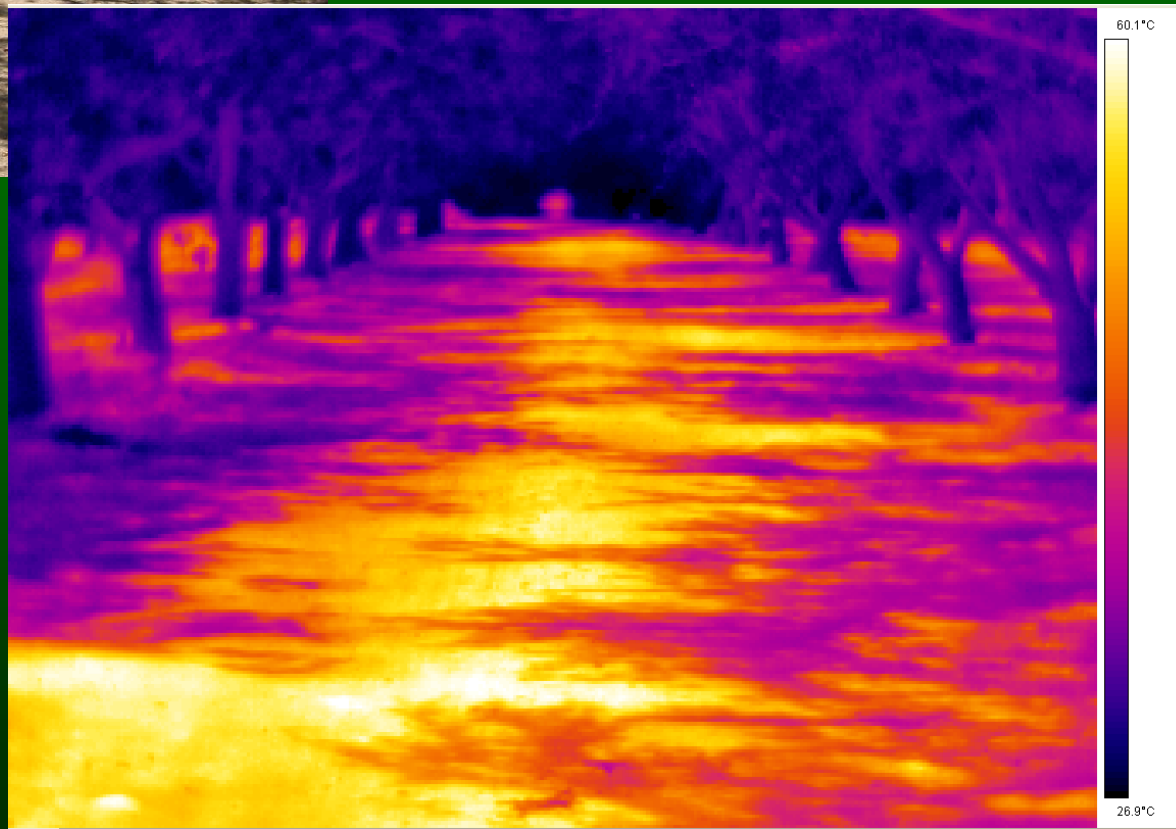
Once an orchard has filled in it’s allotted space, there is probably no advantage to keeping it near fully watered baseline water potential.

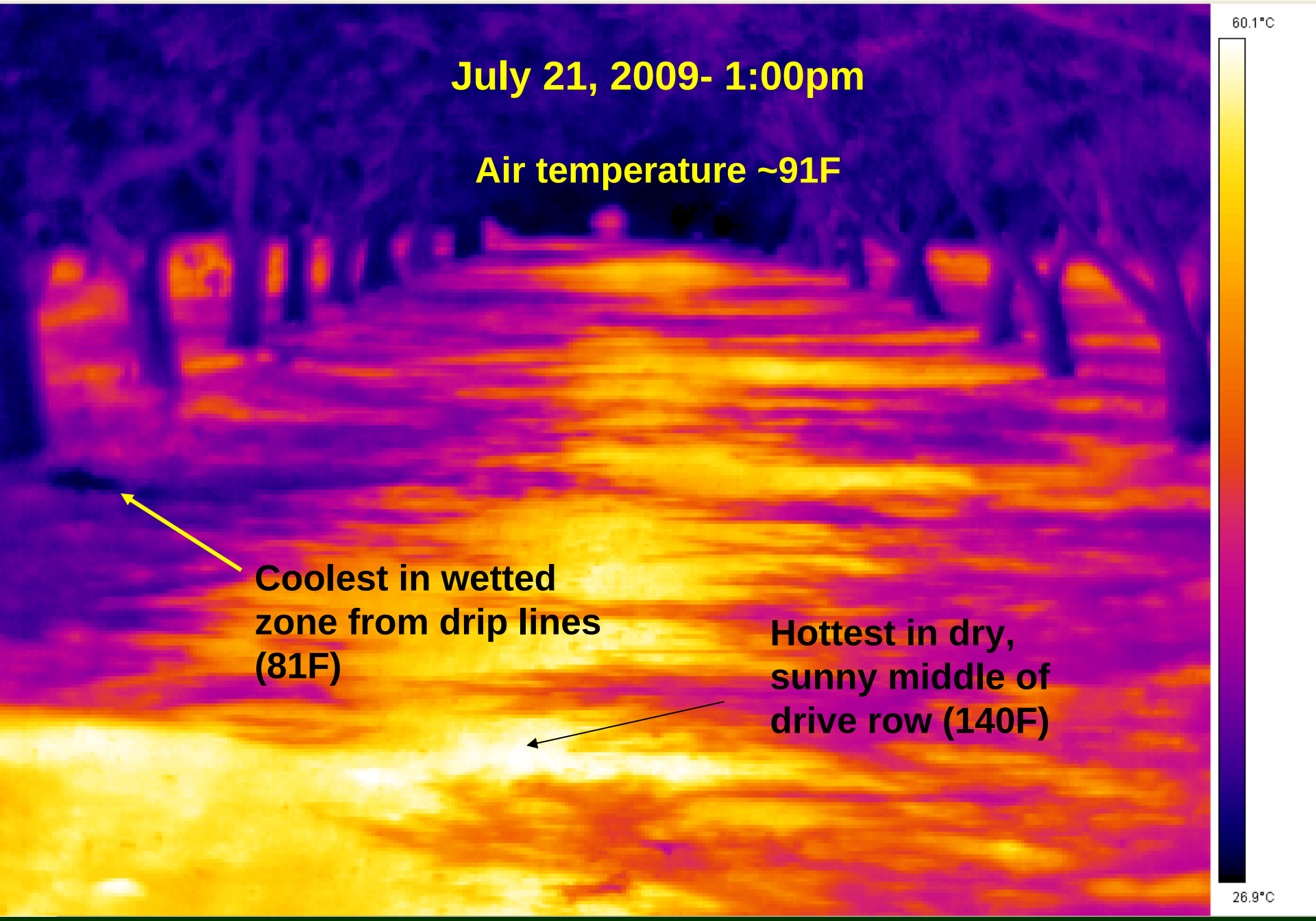

wetter
a
100
80
60
40
20
0
Sealed nuts (%)
-16
-14
-12
-10
-8
-6
Seasonal average midday stem water potential (bars)


Open shells increase food safety risks when nuts are shaken/fall to ground

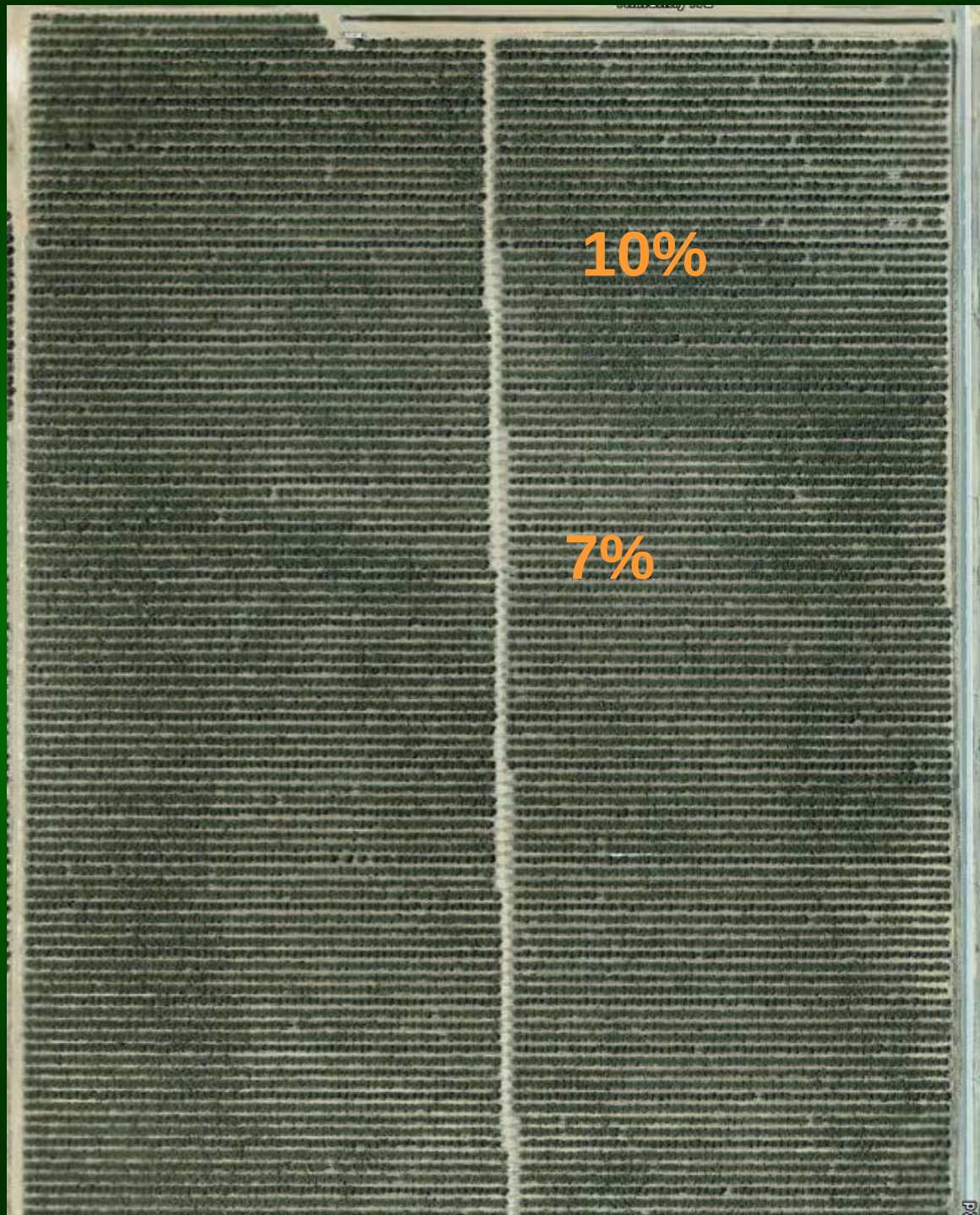
Wet soils near harvest can lead to increased food safety risk




60.1°C
26.9°C


July 21, 2009- 1:00pm
Air temperature ~91F
Coolest in wetted zone from drip lines (81F)
Hottest in dry, sunny middle of drive row (140F)
60.1°C
26.9°C

After drying on orchard floor, moisture content of nuts will vary based on canopy development as well as differences in water status



Running orchard excessively wet increases risks of stockpiling wet nuts


Walnut

Irrigation trial at Linden (Vina), 2002

3 irrigation treatments (H, M, L), 4 replicate plots/treatment

Each plots has 20 trees (3 x 7), only central 4 trees monitored

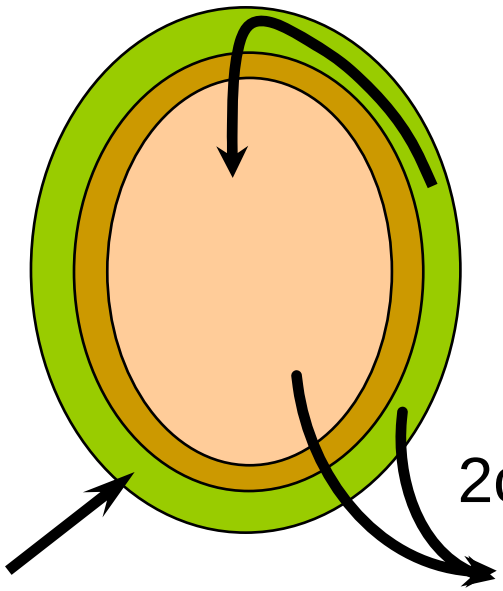
5 nuts sampled from each monitoring tree, August 12

Midday stem water potential monitored every 2 weeks,
by Prichard, Grant, Lampinen

Each nut assayed, individually, with
10 neonate CM larvae
by Nick Mills

Walnut Susceptibility to Codling Moth Preference (1) or Performance (2)

1. Adult oviposition preference for walnut cultivars



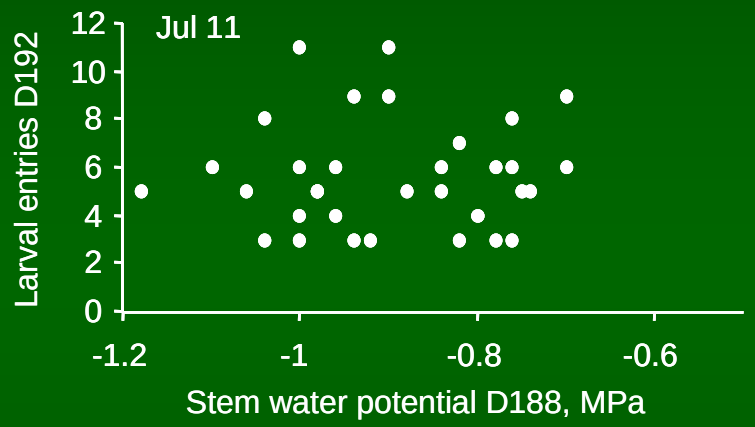
2b. Success of penetration of hardened shell

2a. Success of neonate establishment in the husk

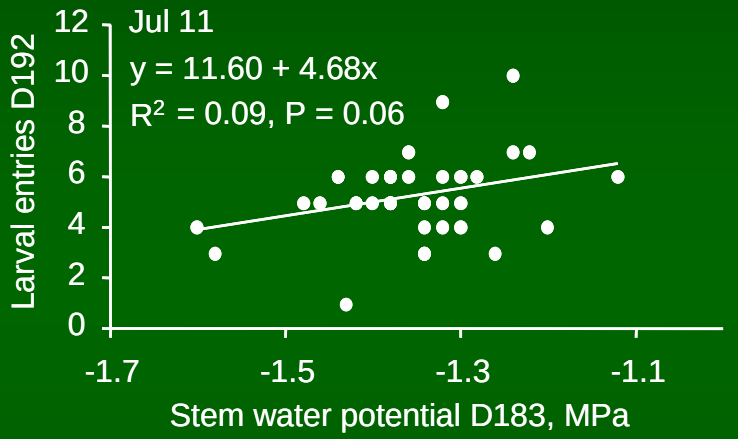
2c. Consequence of food source for larval growth and adult fecundity

Relationship between stem water potential in walnuts and susceptibility of nuts to CM larval entry into the hull

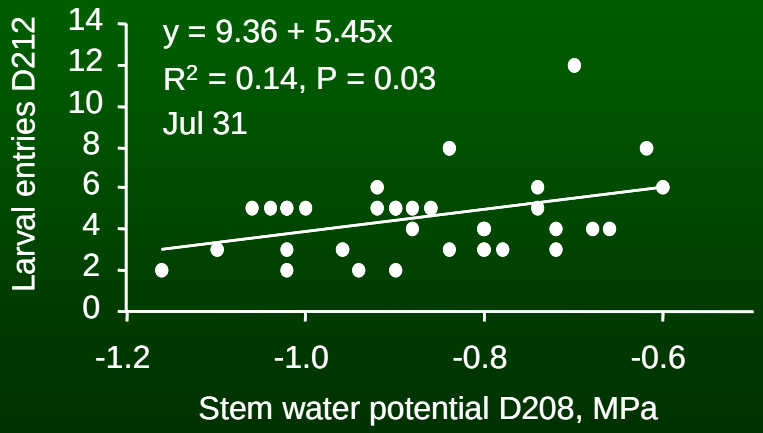
Lockeford, July 2001

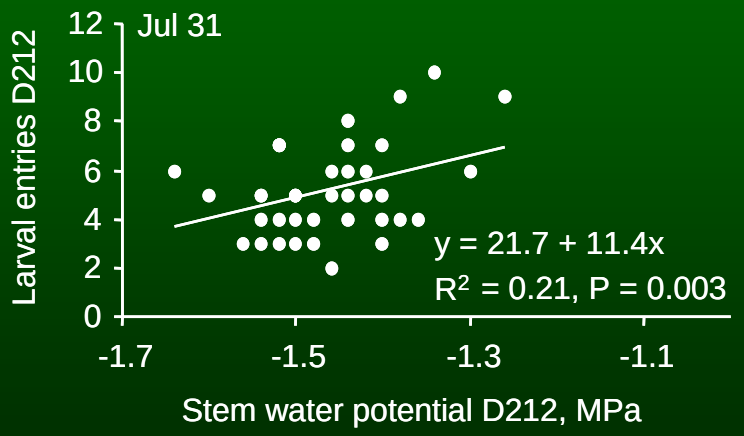


Farmington, July 2001

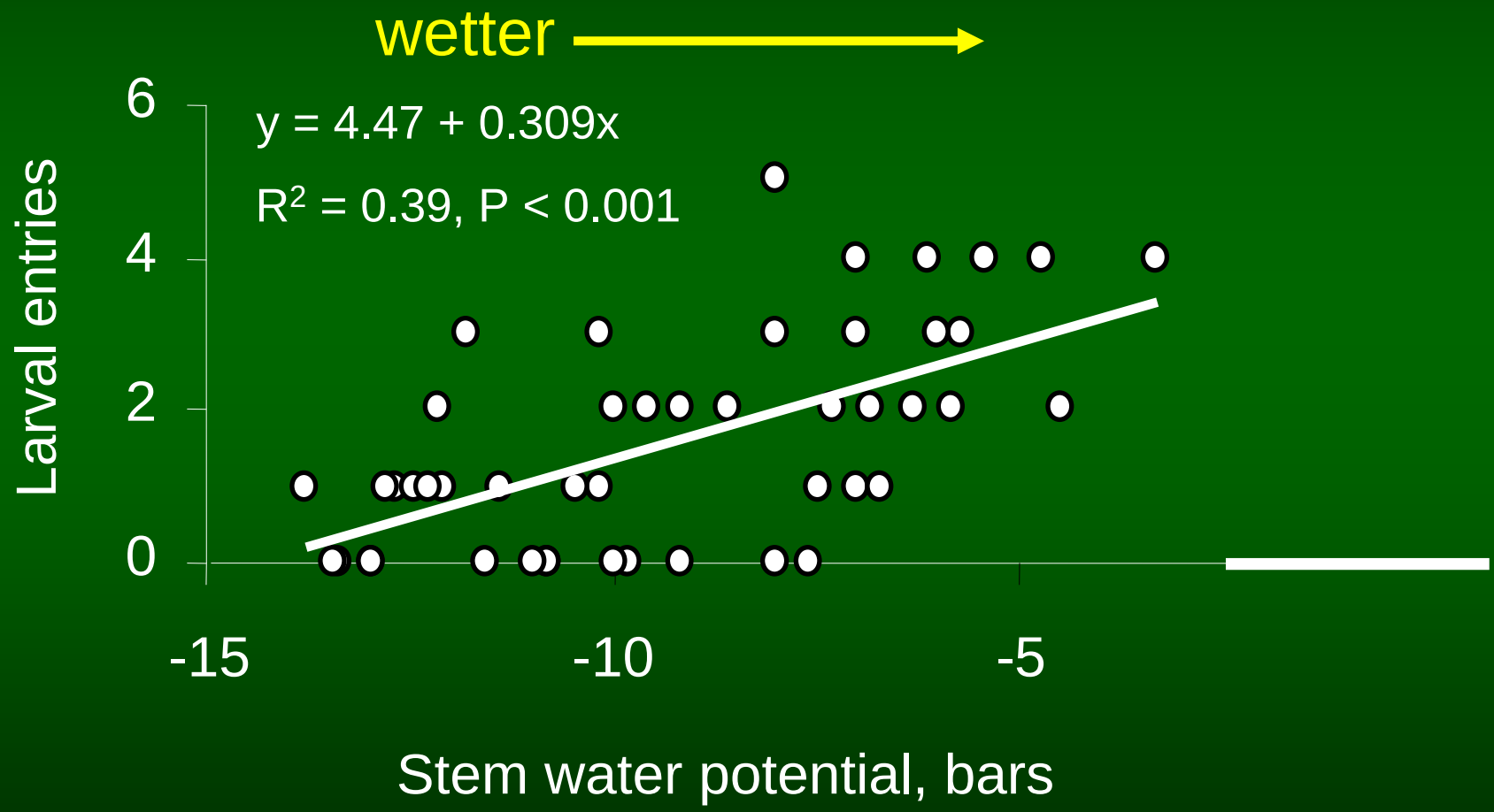


wetter →





Nuts sampled and assayed Aug 12



Orchard dieback- 6 year old Chandler block, Yuba County





Late summer 2001- a few trees looked bad

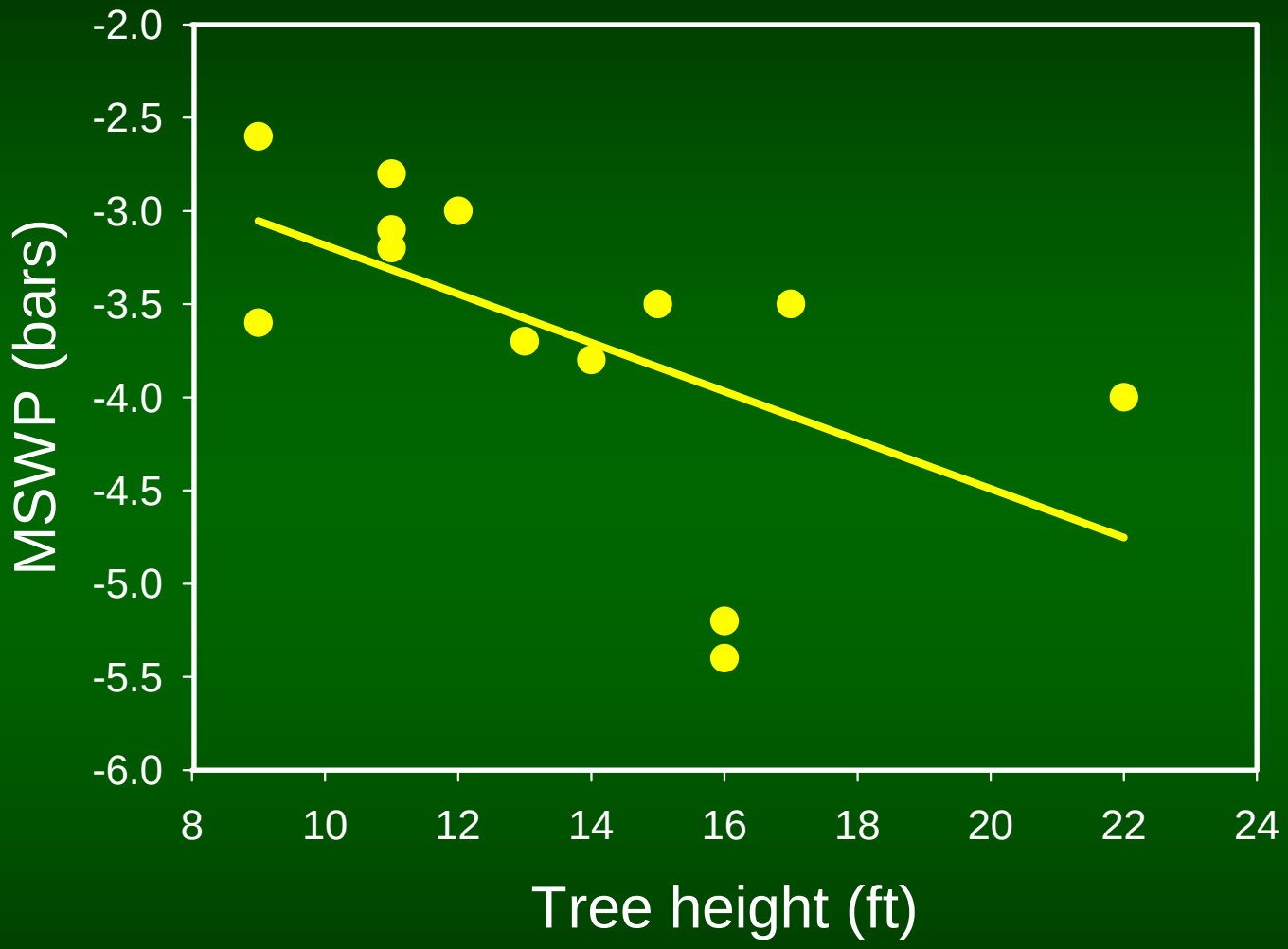
By late summer 2002- many trees looked bad

16’

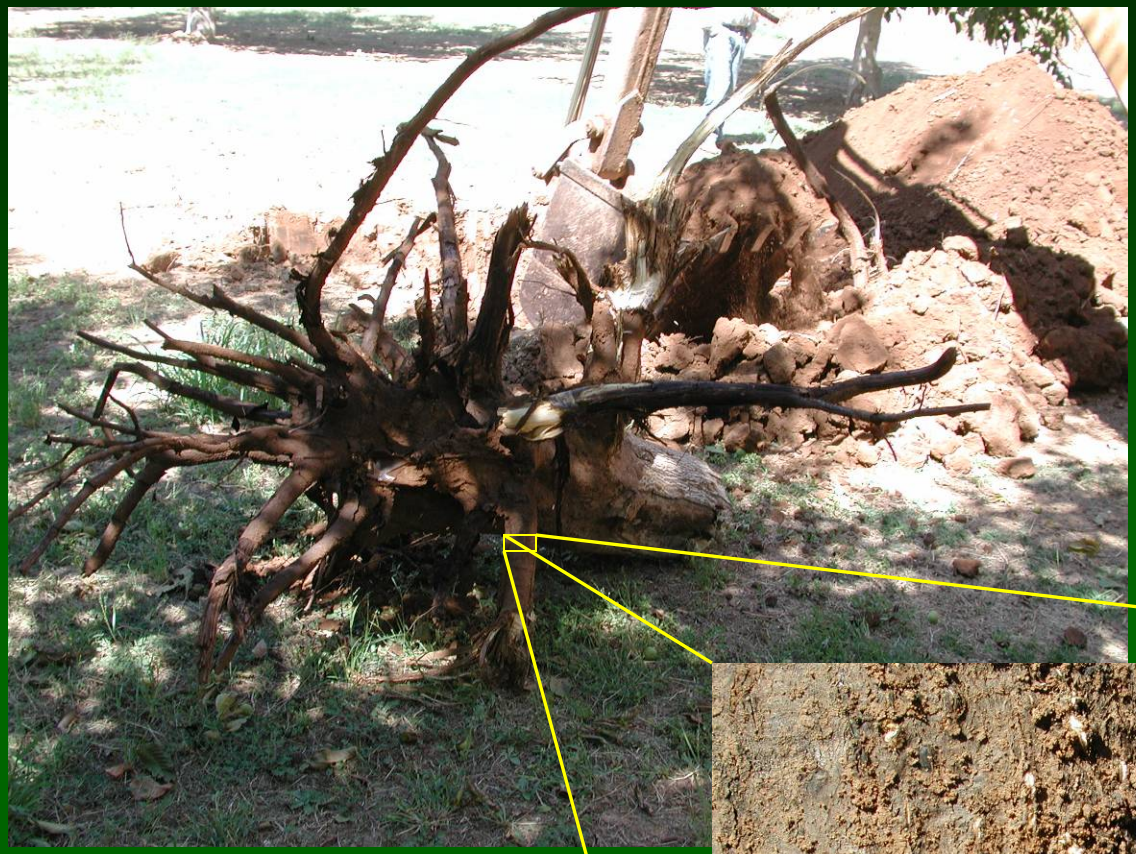
-5.2 bars

11’

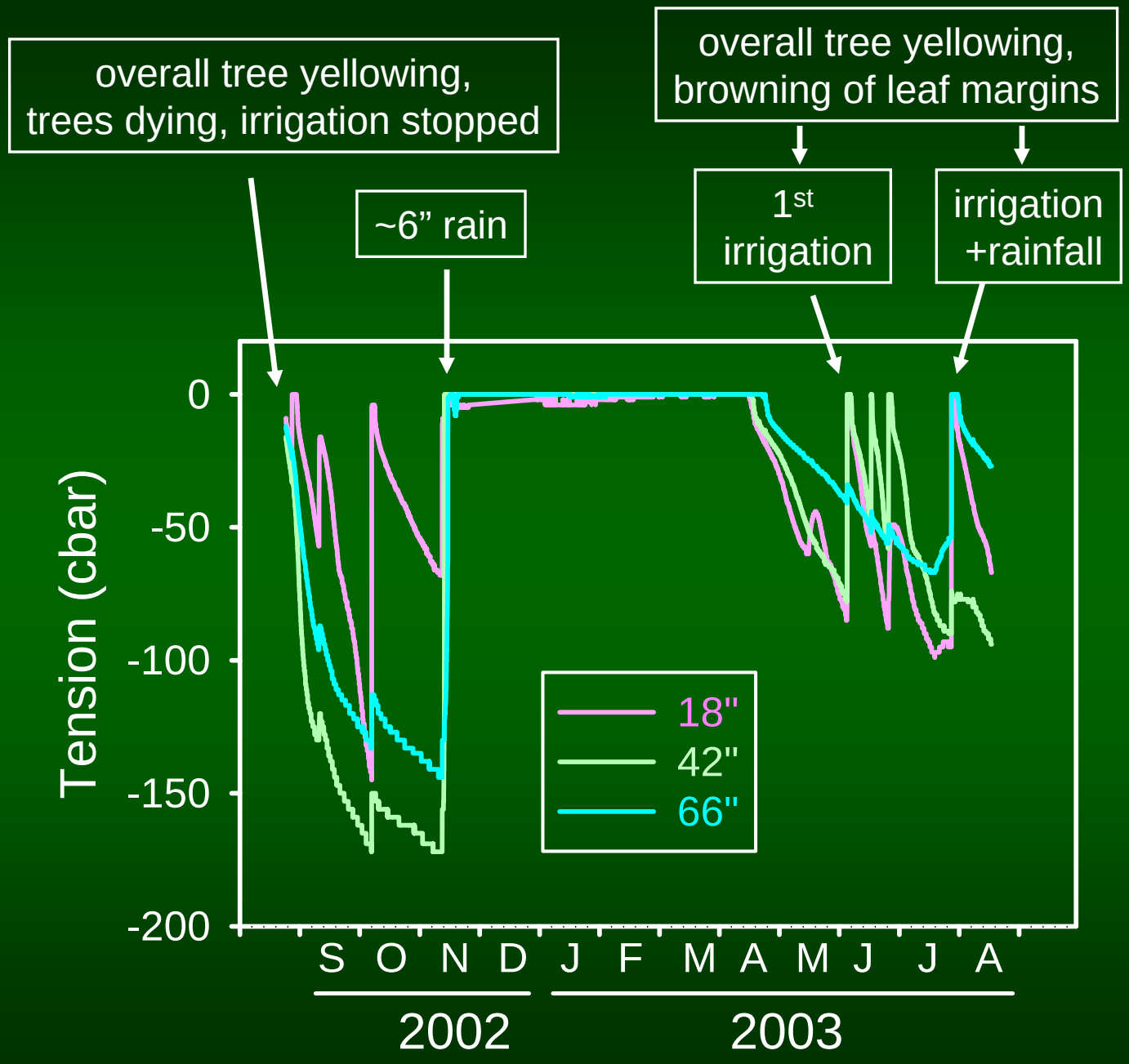
-2.8 bars

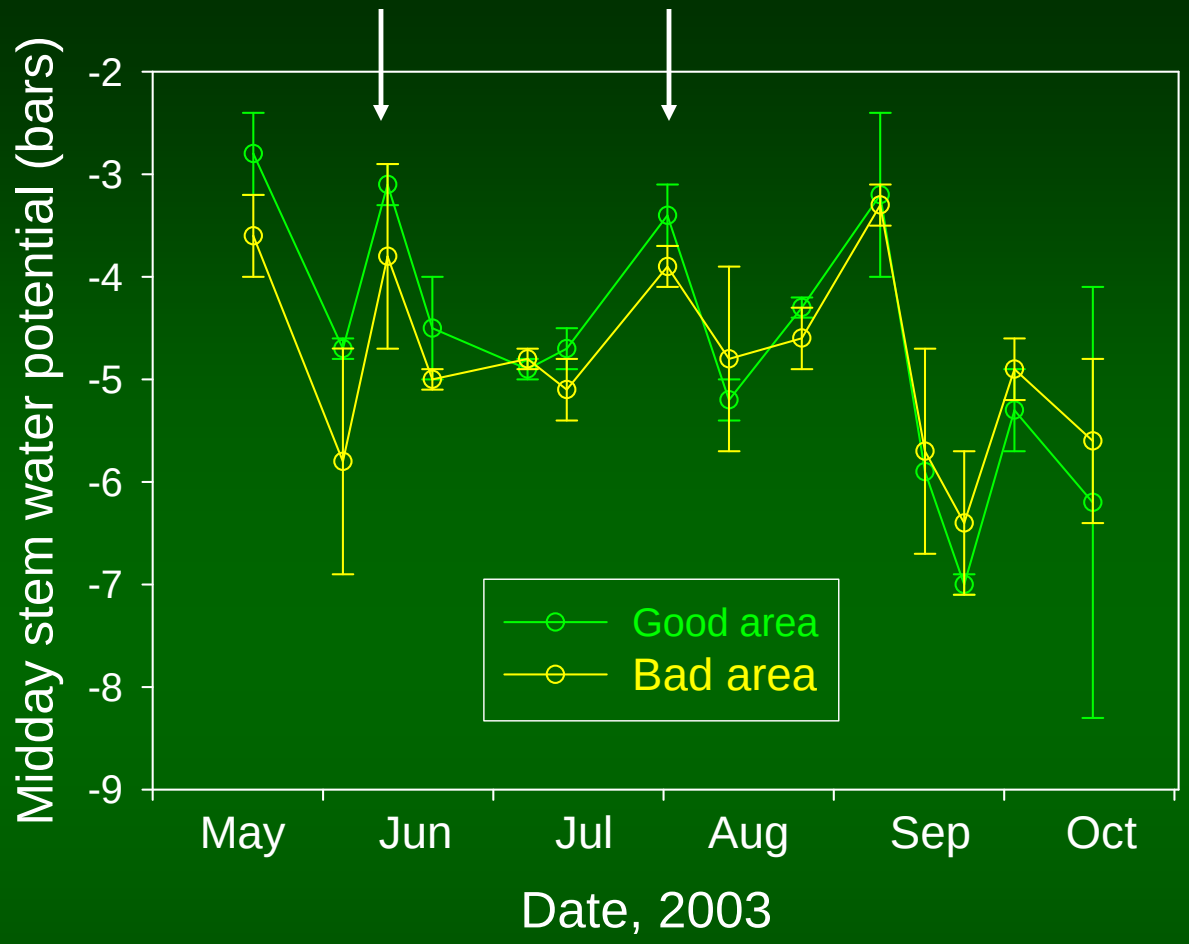

-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
-5.0
-5.5
-6.0
MSWP (bars)
8
10
12
14
16
18
20
22
24
Tree height (ft)


FORD



All living roots in top one foot or so and swollen lenticels indicating waterlogging found on roots


overall tree yellowing, trees dying, irrigation stopped
~6” rain
overall tree yellowing, browning of leaf margins
1st irrigation
irrigation +rainfall
Tension (cbar)
0
-50
-100
-150
-200
18"
42"
66"
S O N D J F M A M J J A
2002
2003

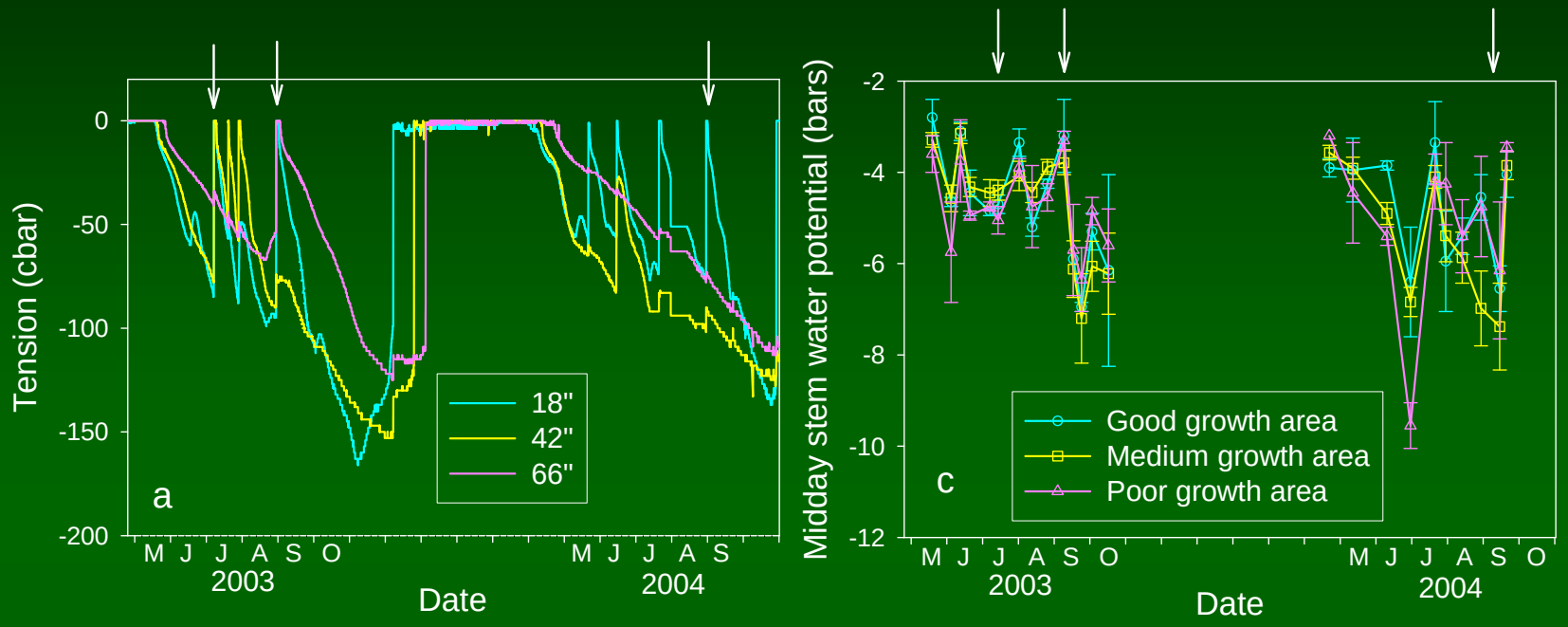


Estimated applied water

2002 = ~80”

2003 = ~15”

Arrows indicate symptom appearance/increase



Estimated applied water

2002 = ~80”

2003 = ~15”

2004 = ~12”

ET based scheduling would have been difficult due to difficulty in estimating stored soil moisture available to trees


Aug. 22, 2005

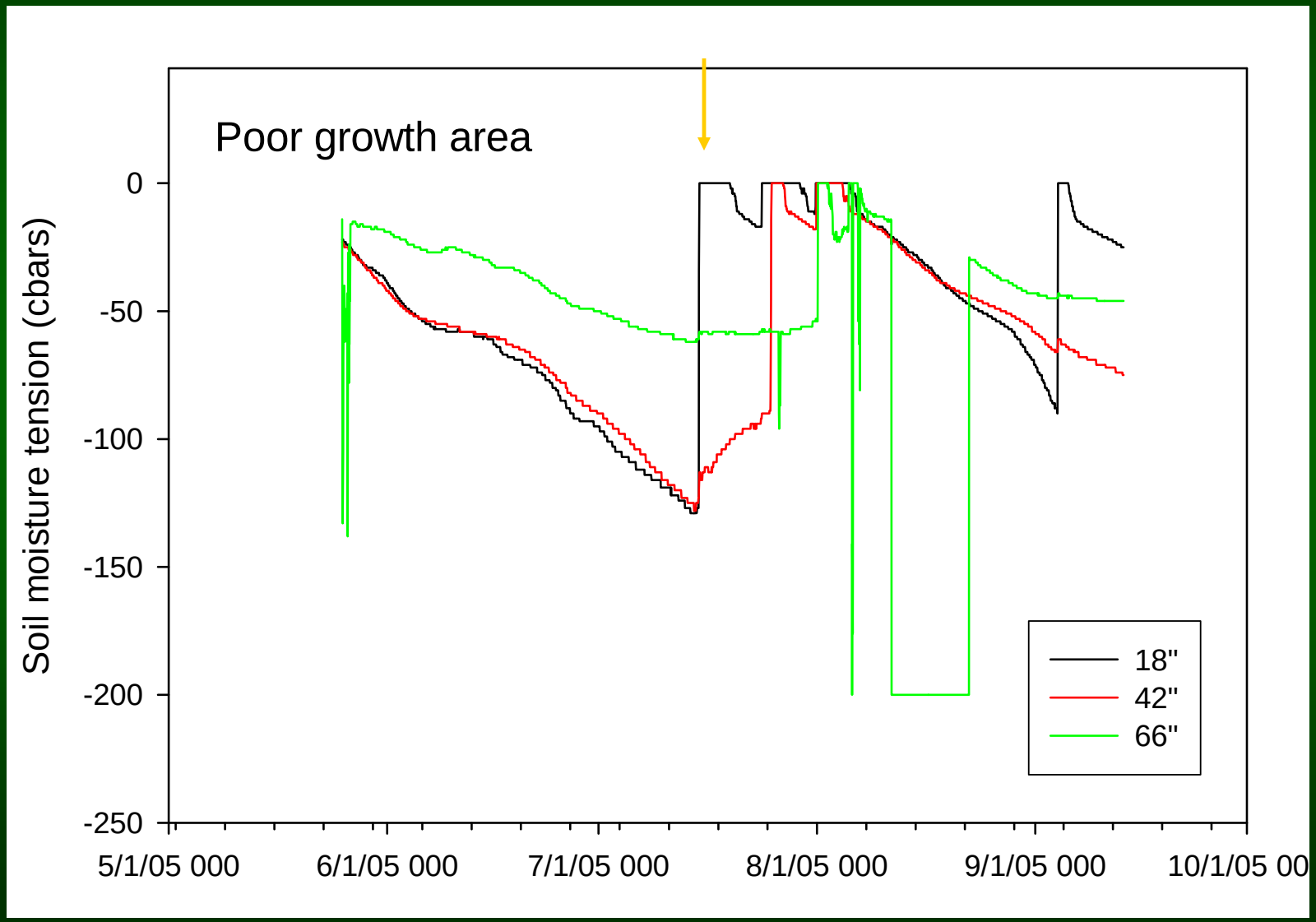

July 7, 2005

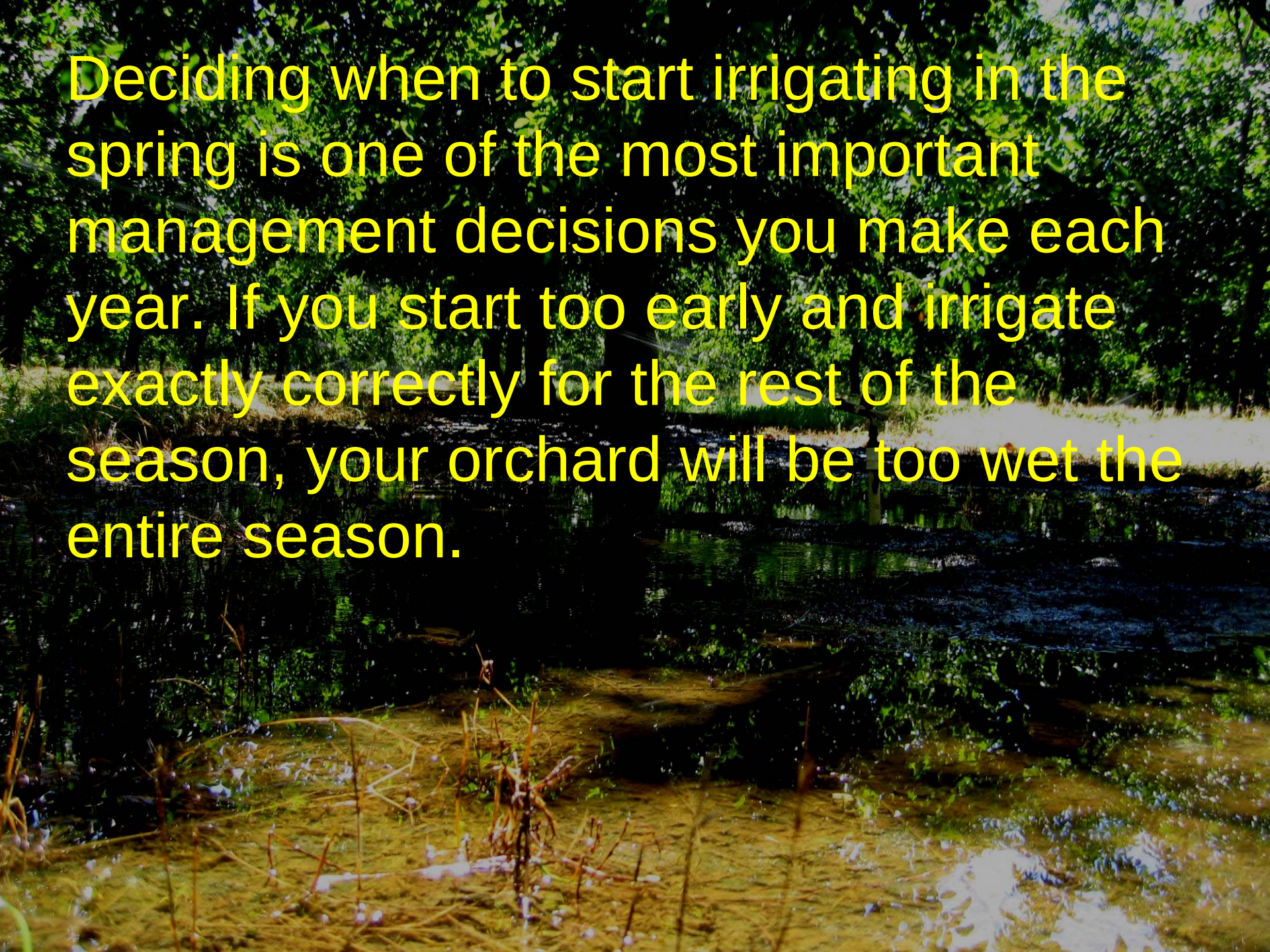

Aug. 5 2005


July 25, 2005

trees look good

trees look bad




Deciding when to start irrigating in the spring is one of the most important management decisions you make each year. If you start too early and irrigate exactly correctly for the rest of the season, your orchard will be too wet the entire season.

Important note:

You do not need *Phytophthora* present to kill trees with excessive water. Trees will die from anoxia related conditions with or without *Phytophthora* present. They might die a little sooner if *Phytophthora* is present.

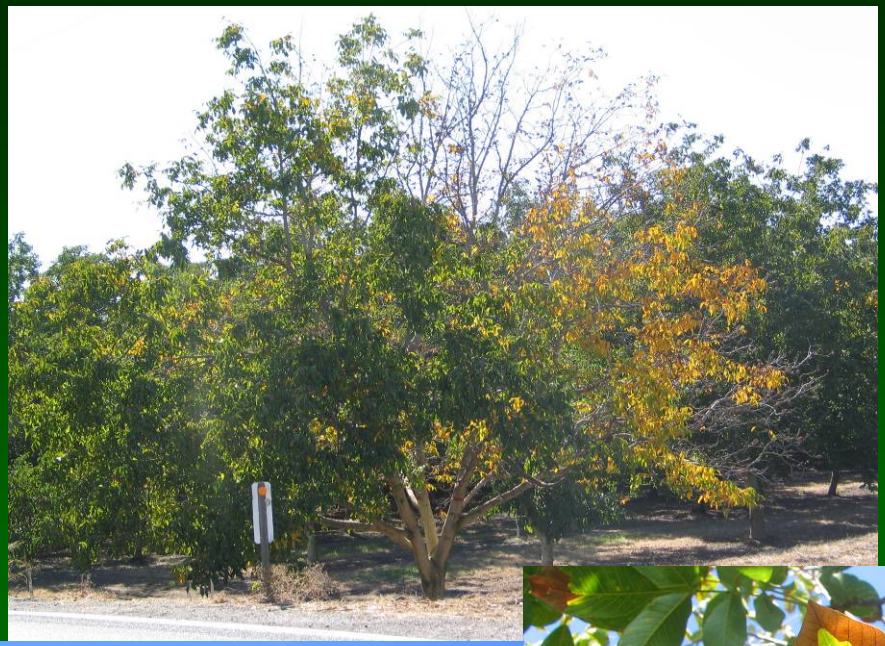
Leaf symptoms of over-irrigation in walnut- often on outer canopy leaves but can be anywhere


Dormant walnut bud
Germany


Female
flower
primordia
2
4
5
1
3
6
leaves
6
5
4
3
2
1
bud scales
Germany

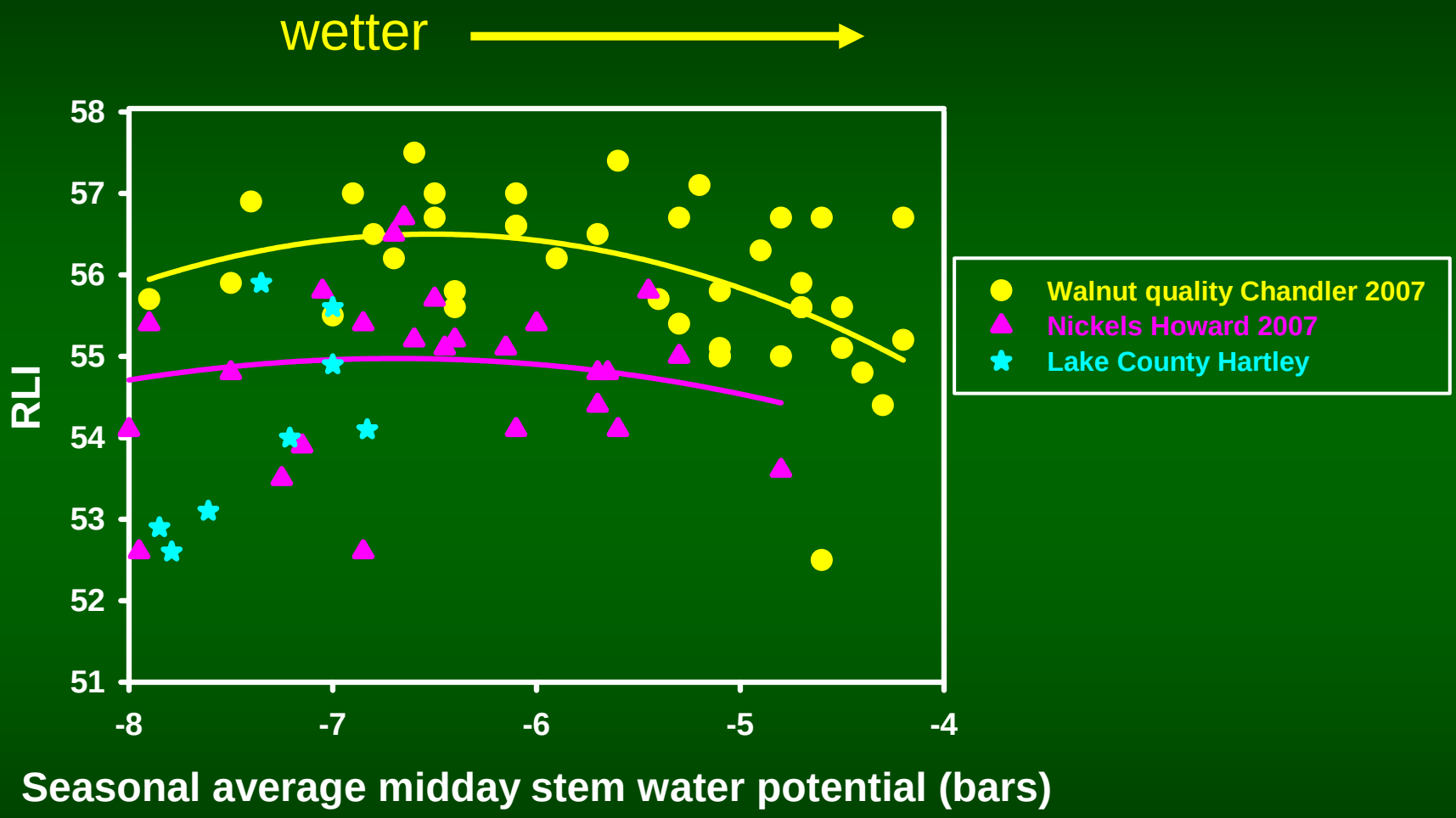
If secondary bud (near nut) does not start growing by mid-June it is usually because the tree is too wet

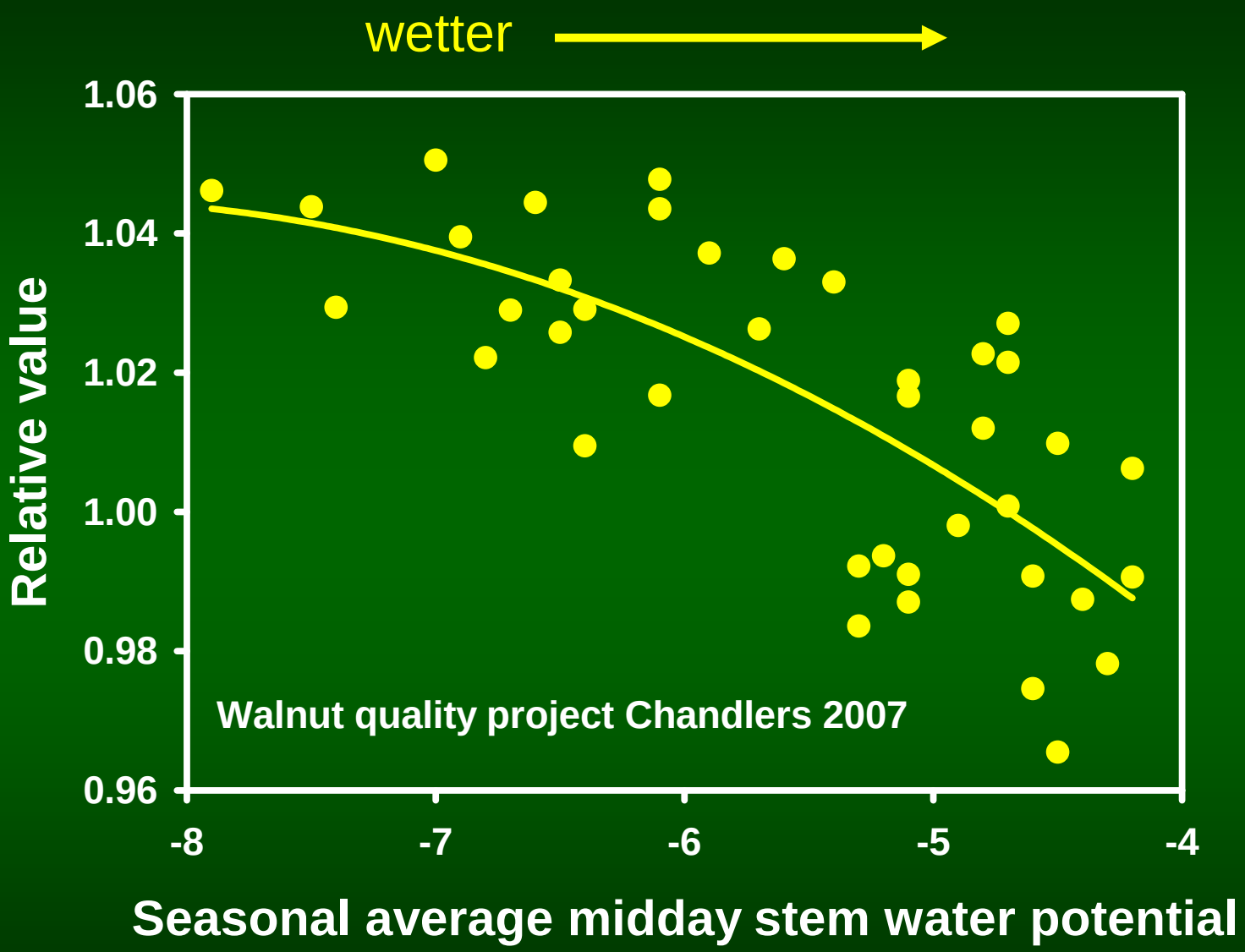
Typical appearance of a tree that was too wet in spring- may be water stressed later in summer due to compromised root system



All of the examples on this page were trees that we pressure bombed and were found to be overly wet.

Whenever you see any of these symptoms look at your water managment


wetter
RLI
58
57
56
55
54
53
52
51
-8
-7
-6
-5
-4
Walnut quality Chandler 2007
Nickels Howard 2007
Lake County Hartley
Seasonal average midday stem water potential (bars)


wetter
1.06
1.04
1.02
1.00
0.98
0.96
Relative value
Walnut quality project Chandlers 2007
-8
-7
-6
-5
-4
Seasonal average midday stem water potential

Conclusions

For either walnuts or almonds, it is essential to manage water effectively.

Deciding when to start irrigating in the springtime is one of the most important decisions- it should be based on the plant and/or soil moisture readings (ideally both) telling you that the tree needs water.

Over-irrigating is detrimental in many ways

- Decreased tree growth
- Increased insect and disease pressure
- Increased food safety risk

Questions?