

Optimum Walnut Canopies: Spacing and Managing Orchards for Both Early and Mature Production

Production

Bruce Lampinen



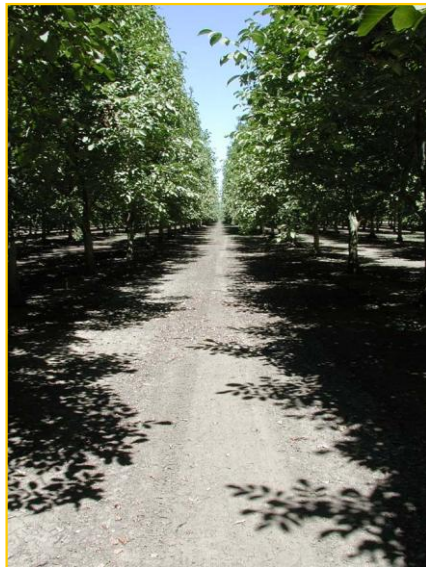
~10% midday light interception



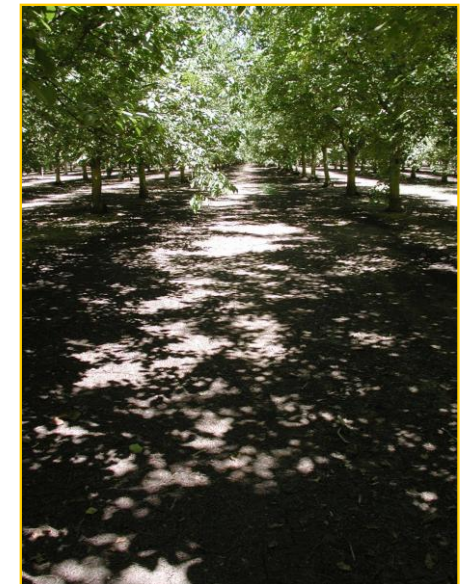
~45% midday light interception



~30% midday light interception

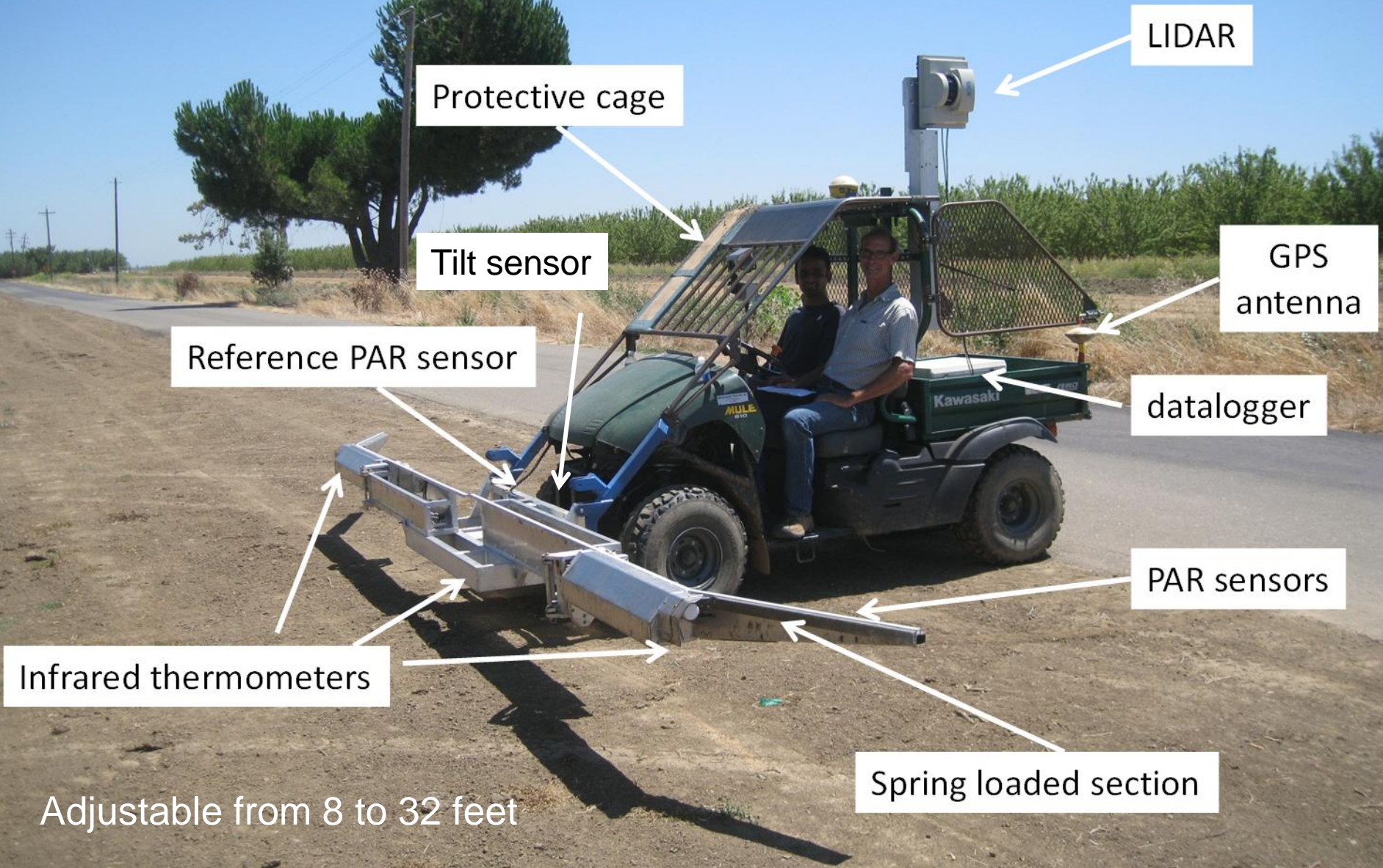


~70% midday light interception



~90% midday light interception

2nd Generation mule light bar



LIDAR

Protective cage

Tilt sensor

GPS antenna

Reference PAR sensor

datalogger

PAR sensors

Infrared thermometers

Spring loaded section

Adjustable from 8 to 32 feet

- Improvements with second generation Mule

- Continuously adjustable from 10-32 feet (versus 18-26 feet for first generation)
- Soil surface temperature at much higher resolution (2 degree angle of view versus 45 degree angle of view and faster acquisition)
- HD video camera that runs when Mule is moving
- New GPS that works much better in dense canopies





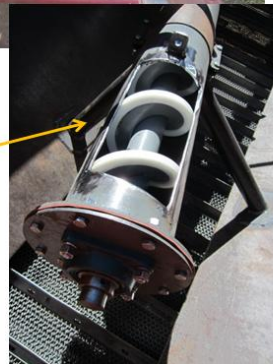
Mid-summer, drive down rows with Mule light bar



At harvest, pick up and weigh all nuts from same area driven down with light bar

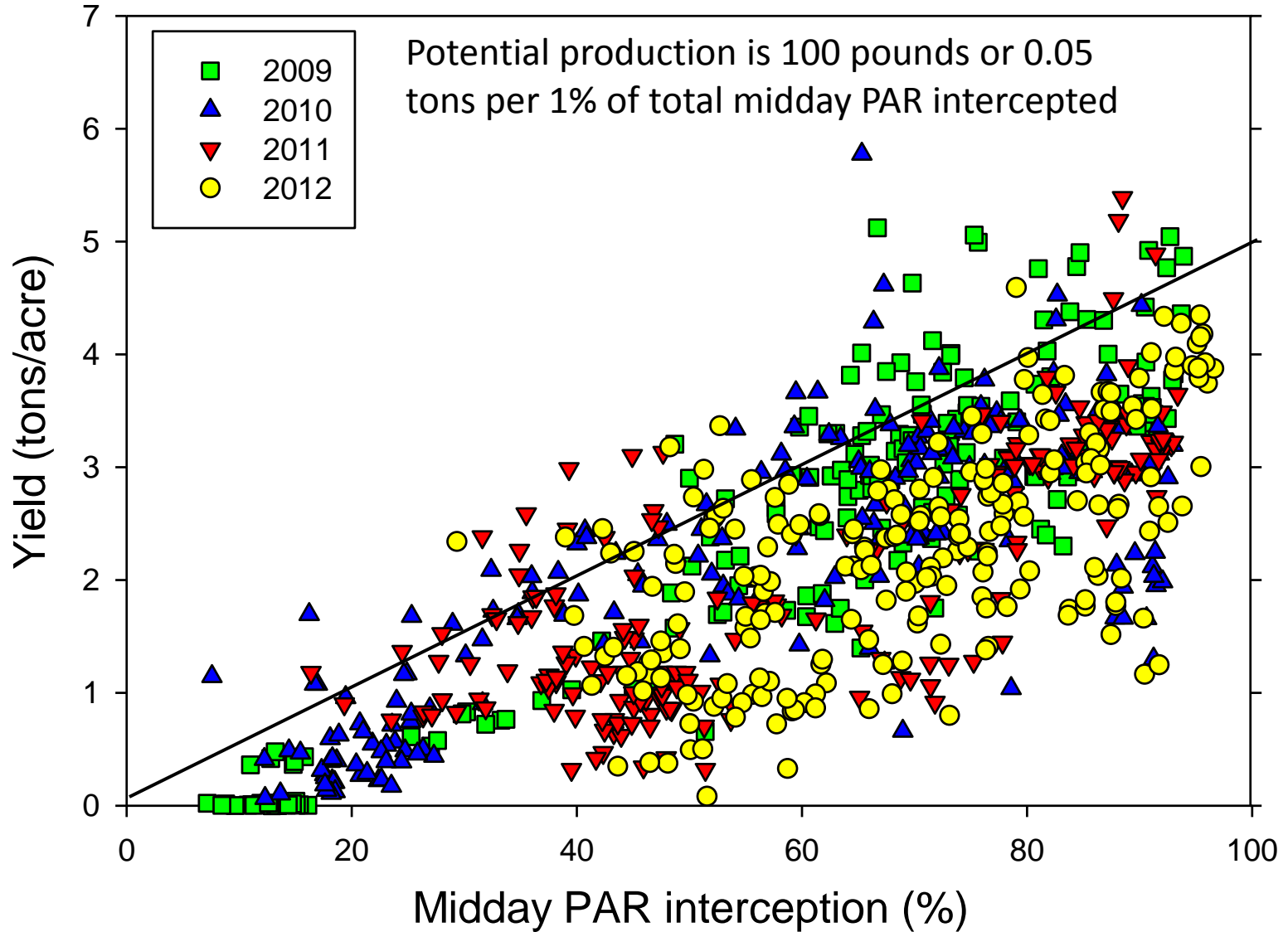


Hydraulically driven auger to deliver samples to rear

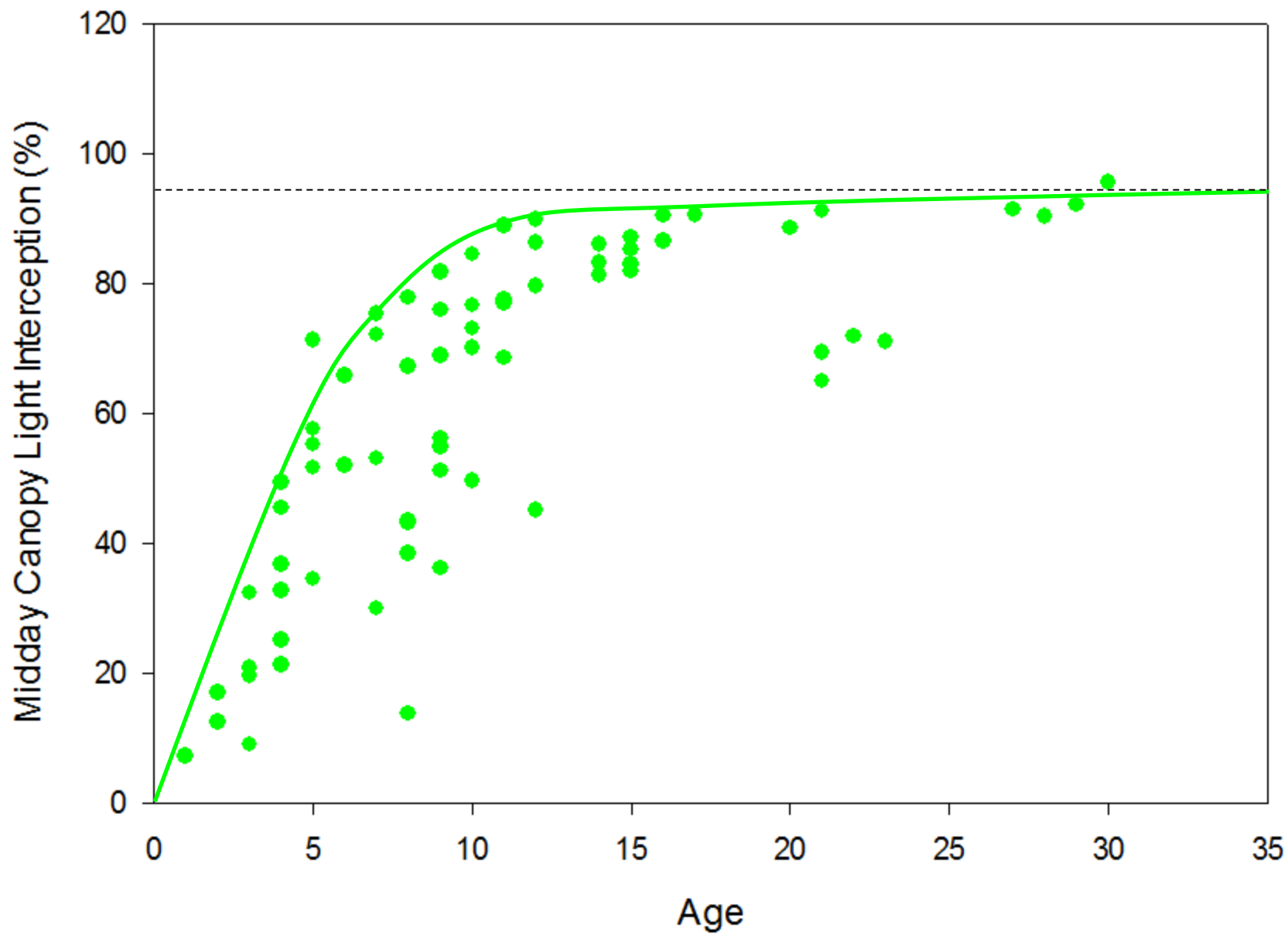


Samples are delivered to 5 gallon bucket at rear (much safer than old method of getting samples by hand)

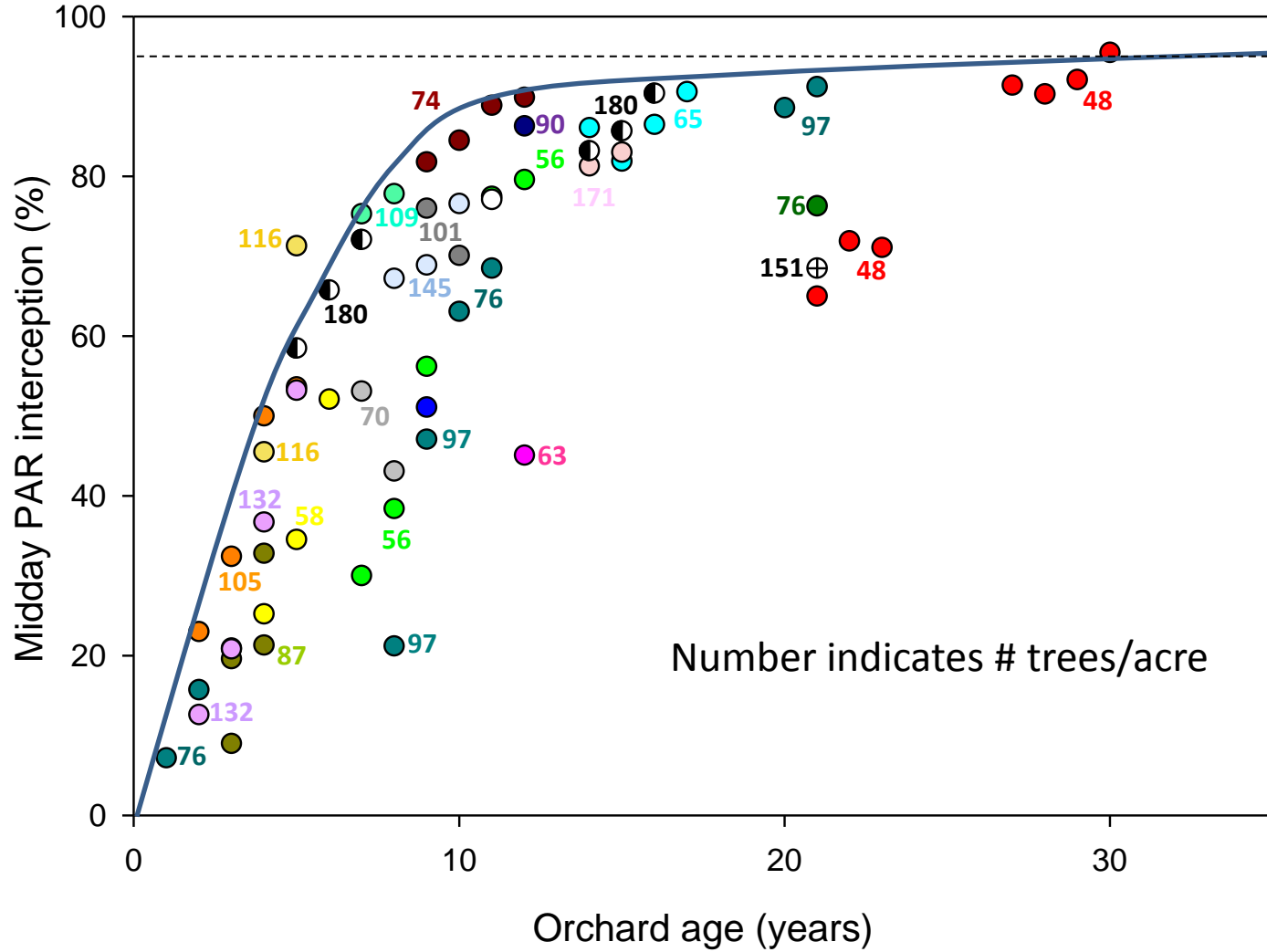
All walnut data 2009-2012



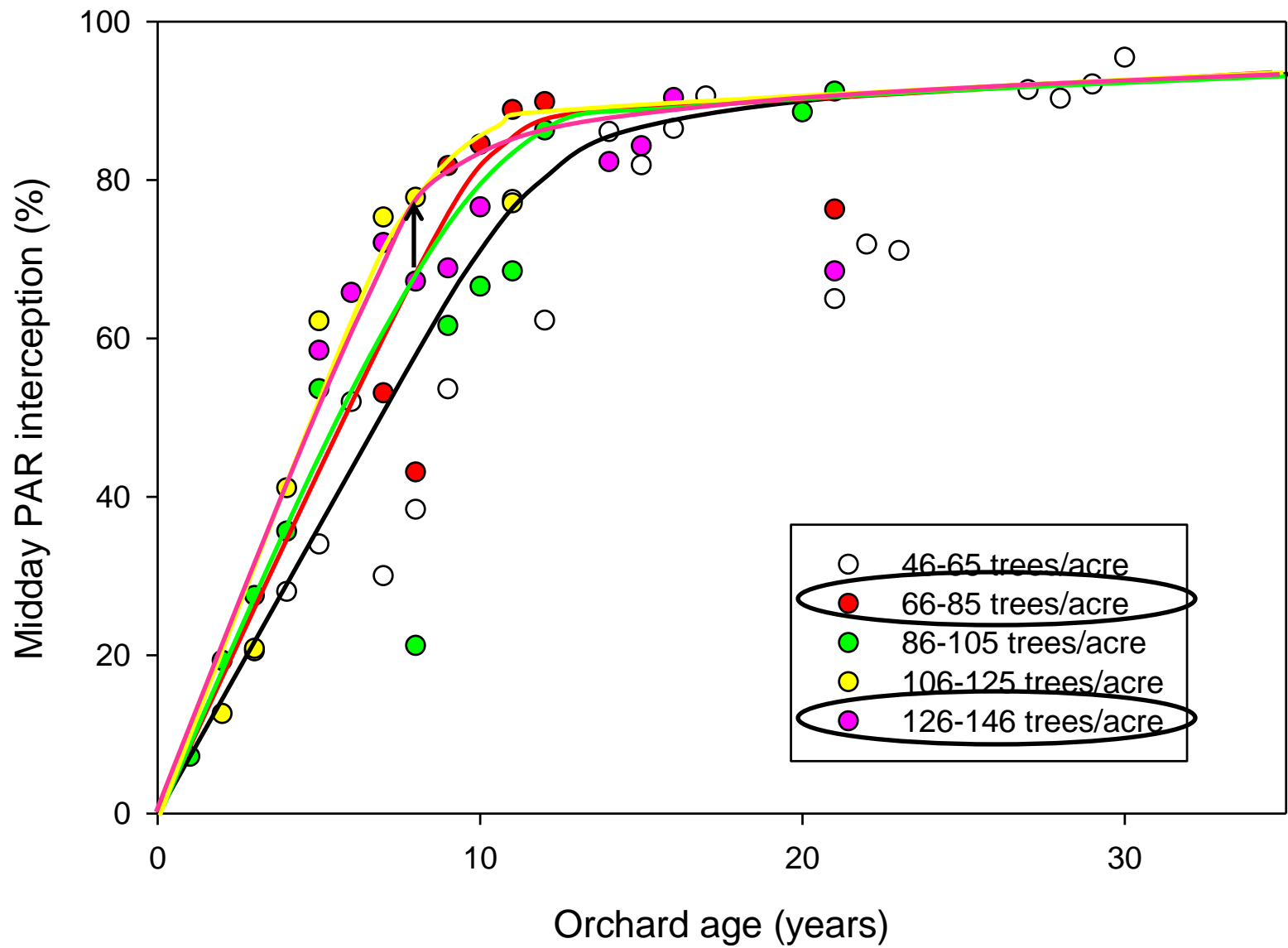
(PAR = photosynthetically active radiation)

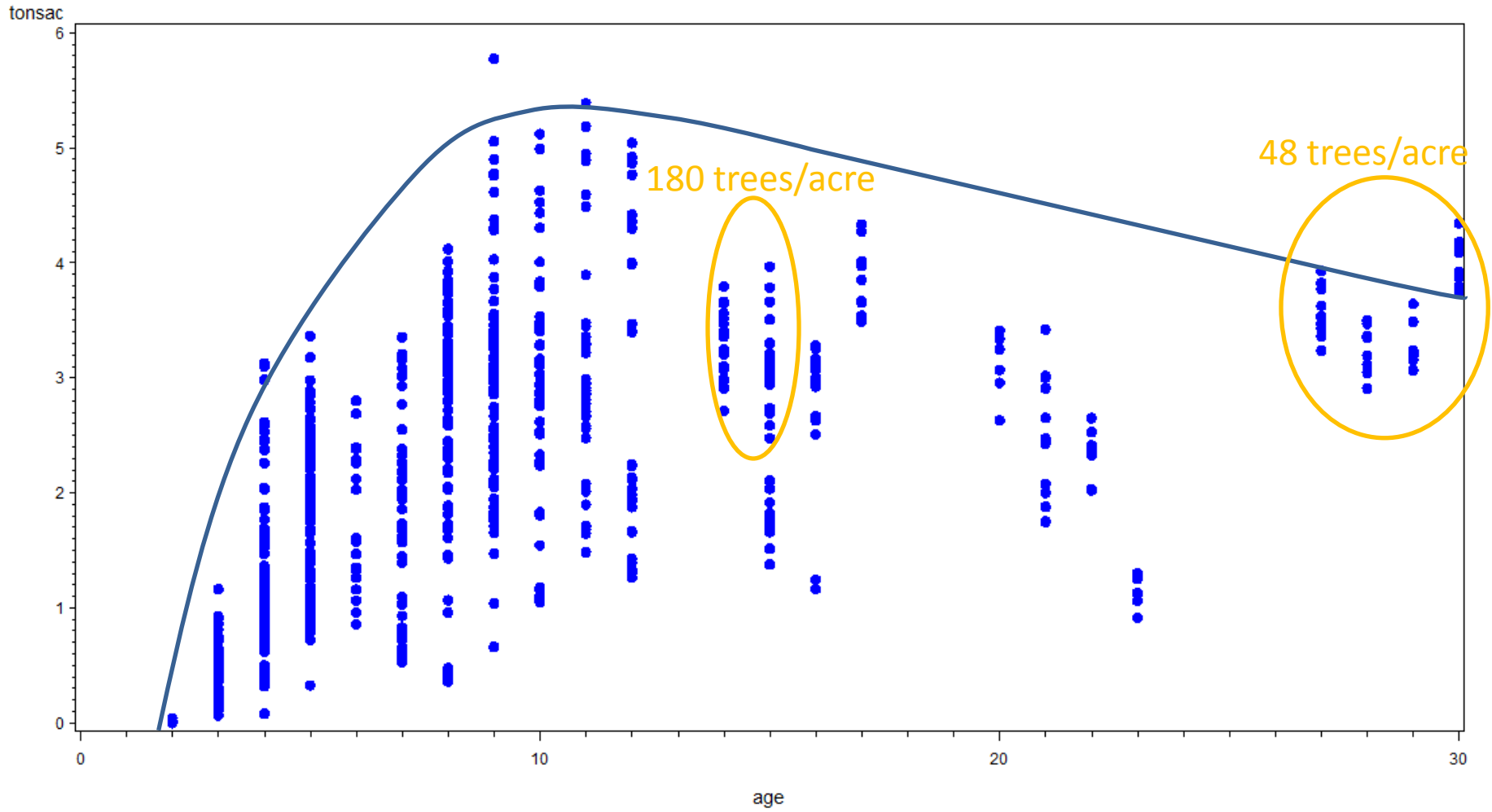


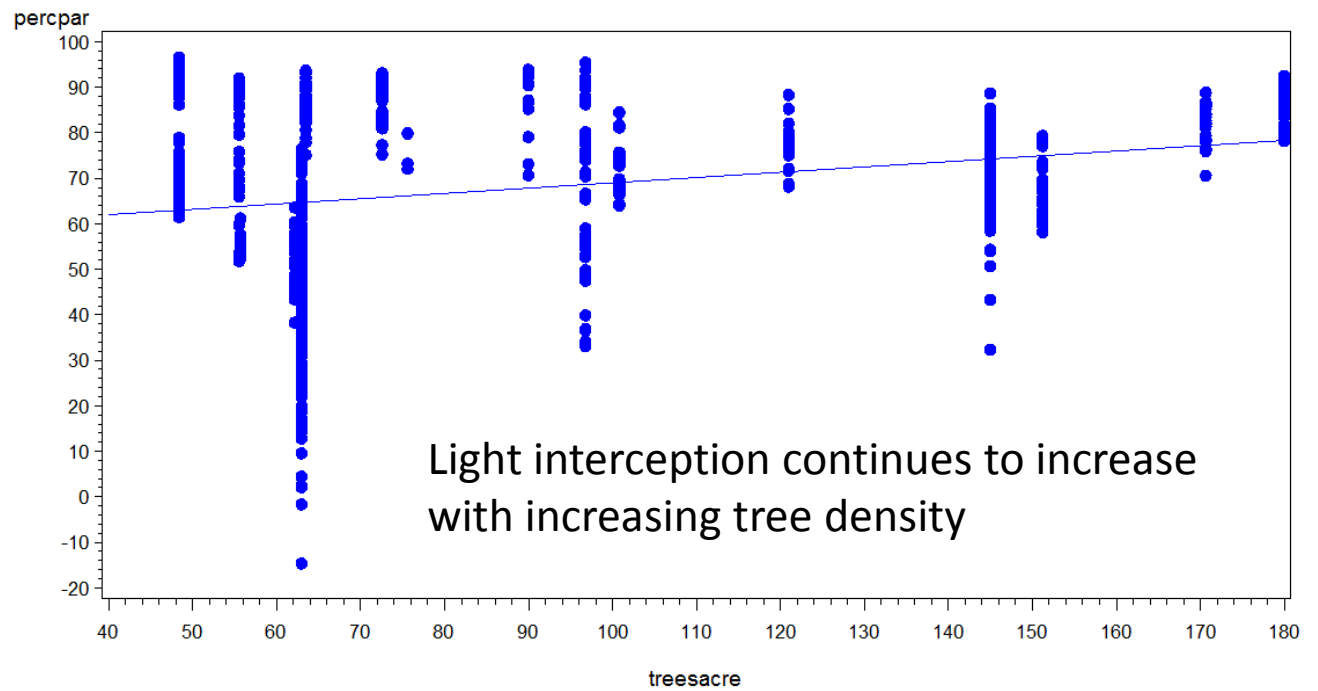
All walnut sites 2009 to 2012



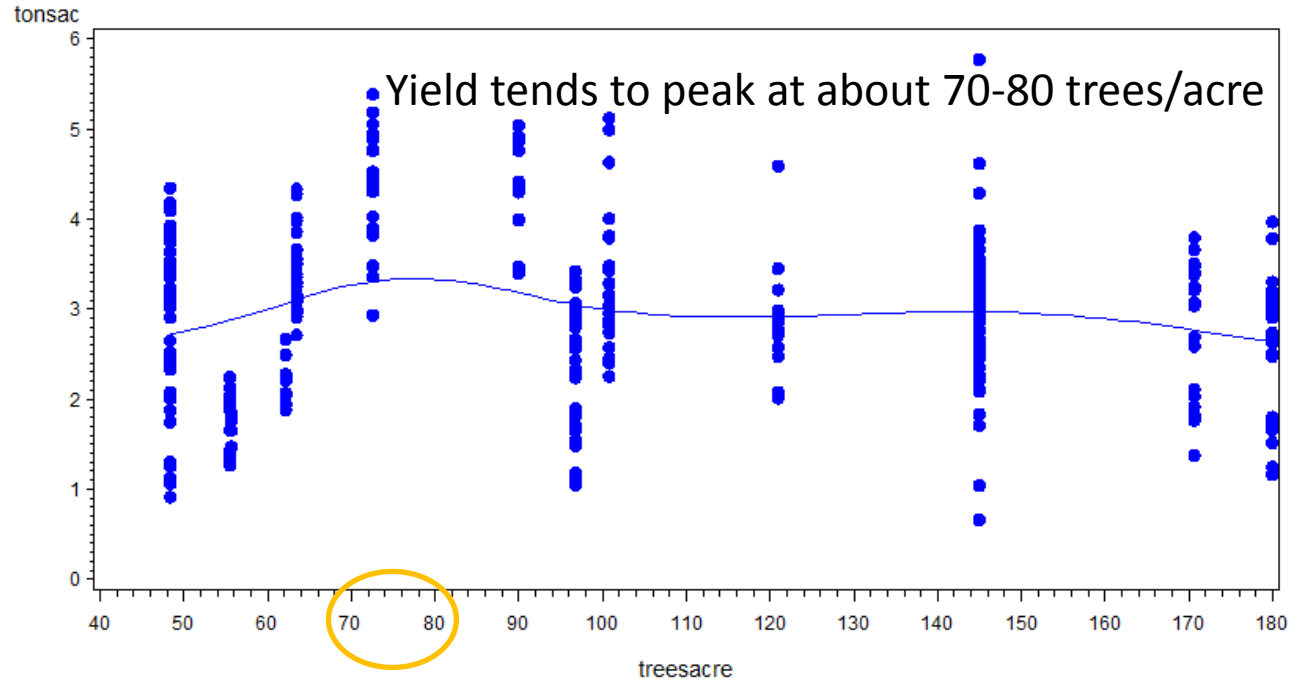
- 45
- 48
- 56
- 58
- 62
- 63
- 65
- 70
- 74
- 76
- 87
- 90
- 97
- 101
- 105
- 109
- 116
- 121
- 132
- 145
- 151
- 171
- 180



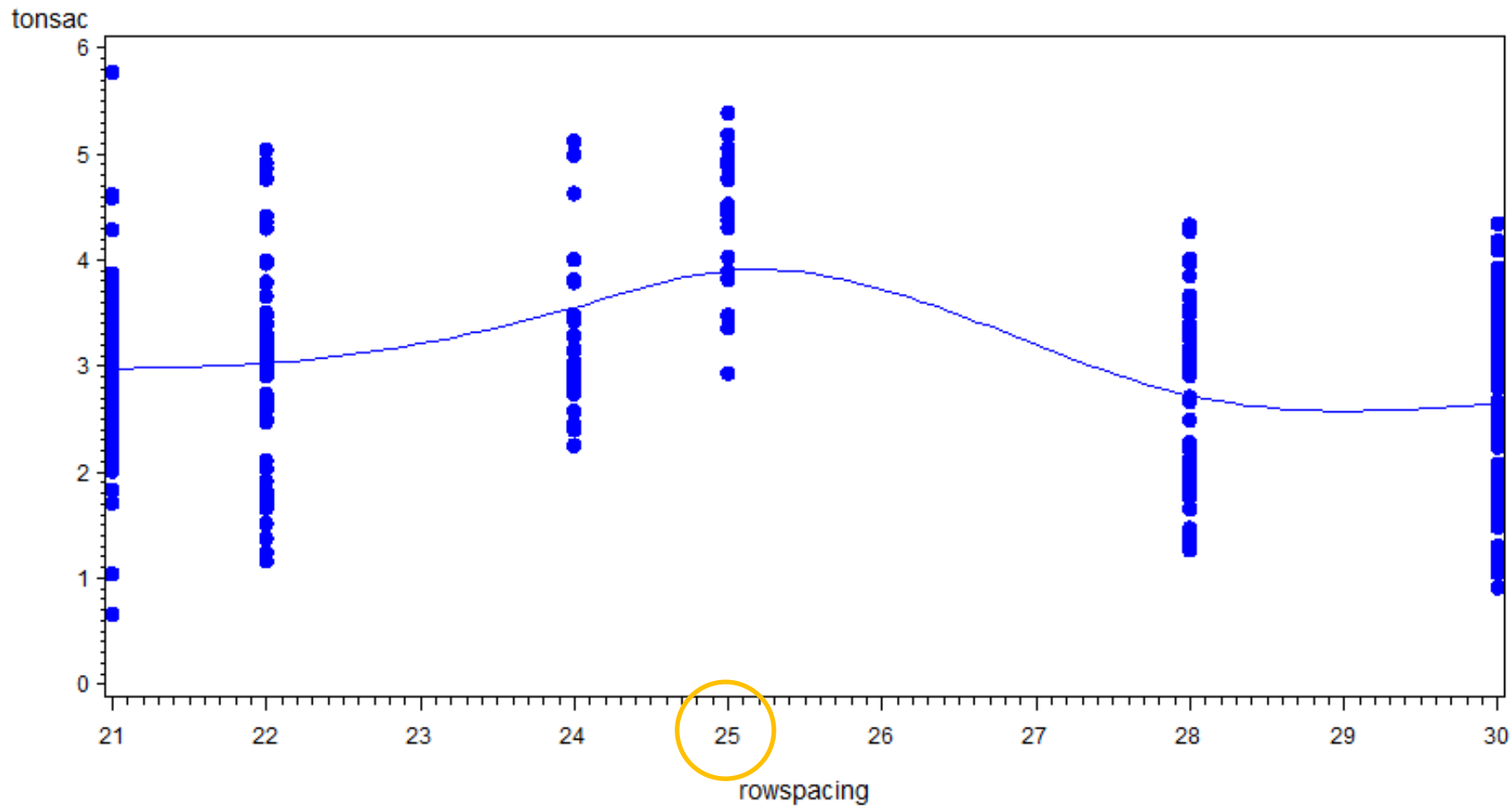




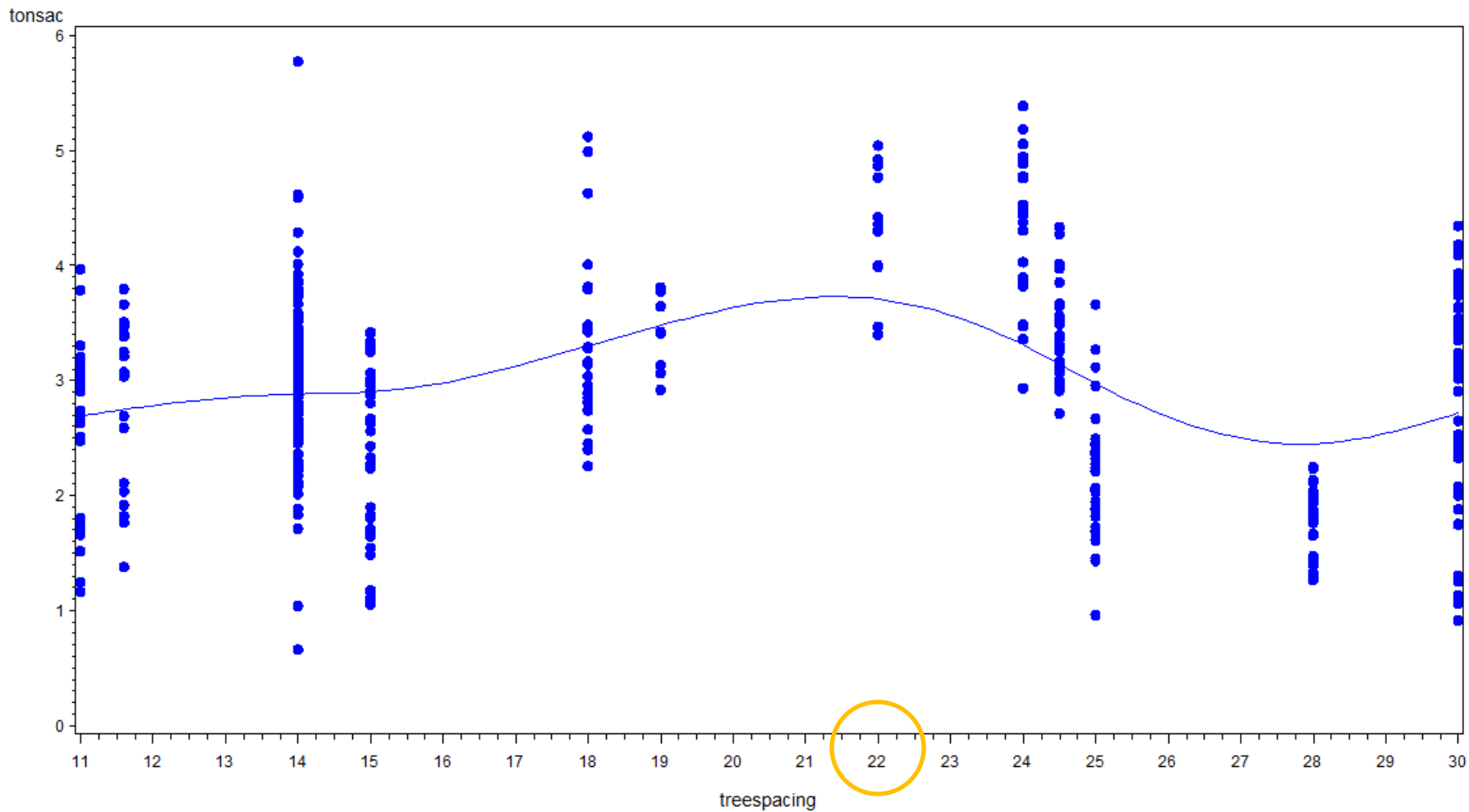
Orchard age > 8 years



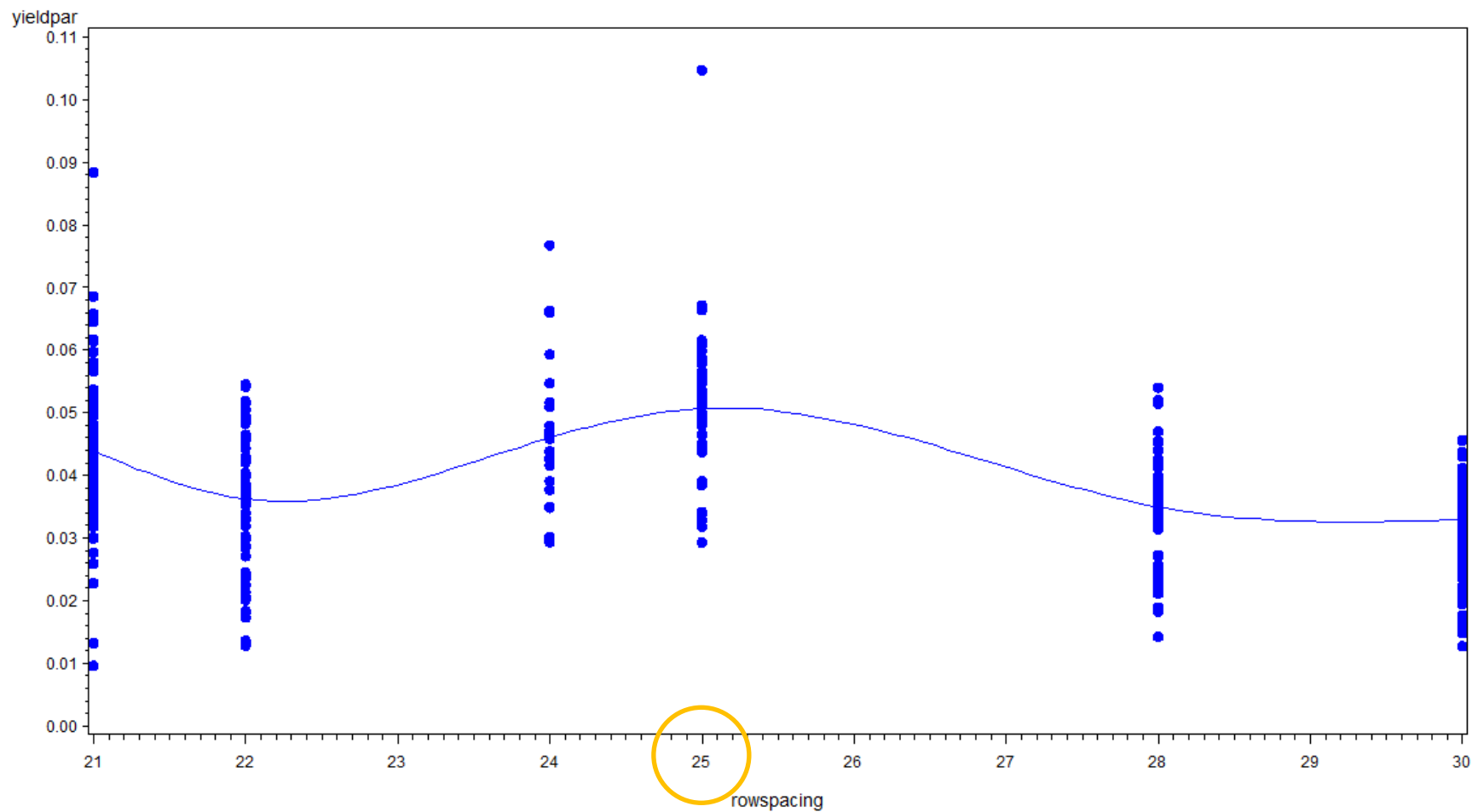
Orchard age > 8 years

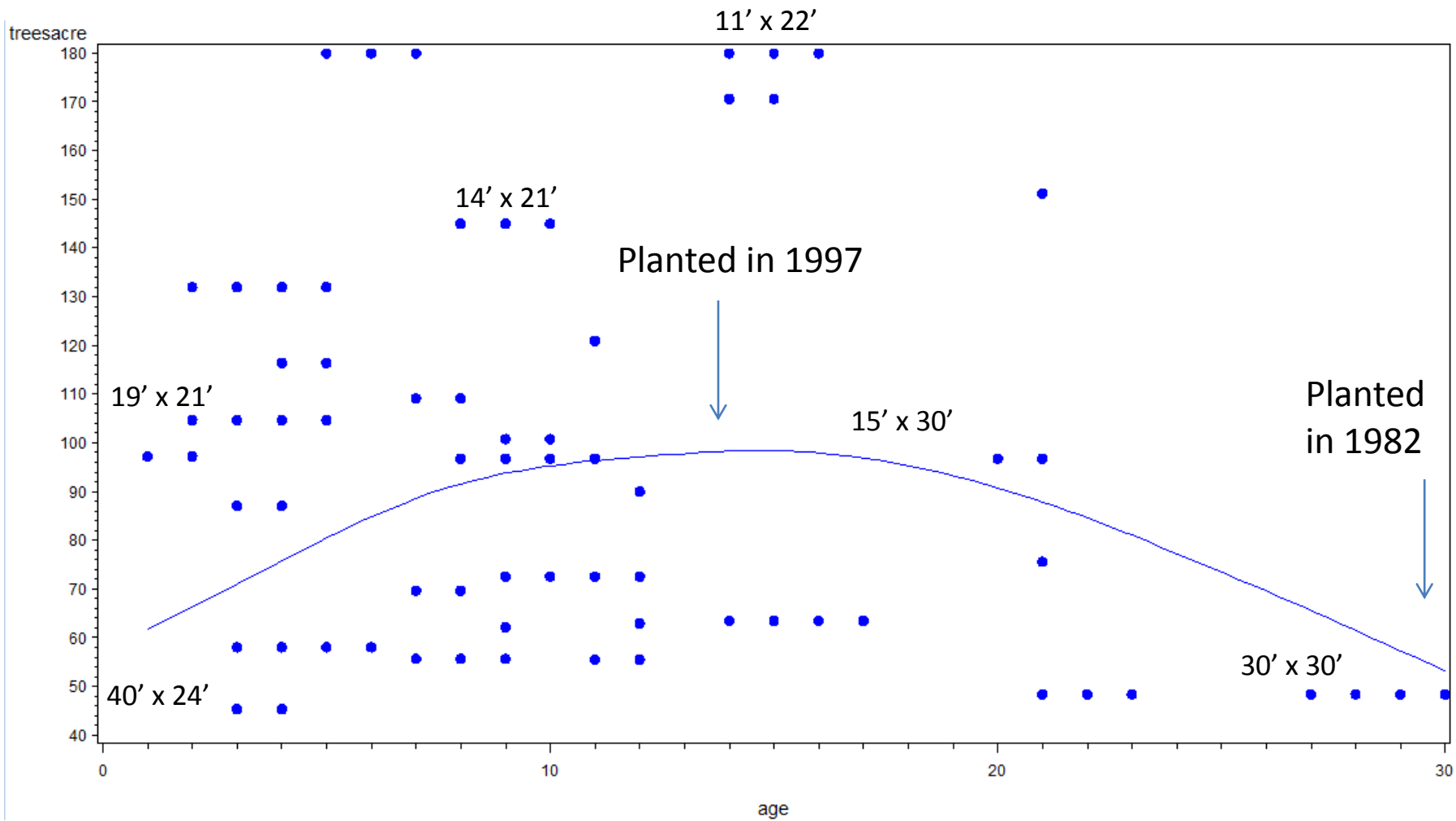


Orchard age > 8 years



Orchard age > 8 years



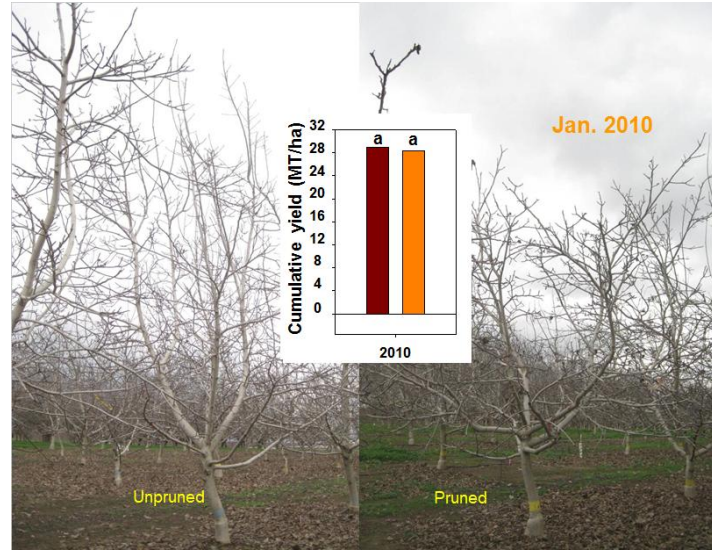


Optimum appears to be at about 24'-26' traditional spacing and about 65-75 trees per acre. The highest yielding orchard in trial was 24' row spacing by 25' tree spacing

Row spacing	Tree spacing	#trees/acre
20	20	109
21	21	99
22	22	90
23	23	82
24	24	76
25	25	70
26	26	64
27	27	60
28	28	56
29	29	52
30	30	48

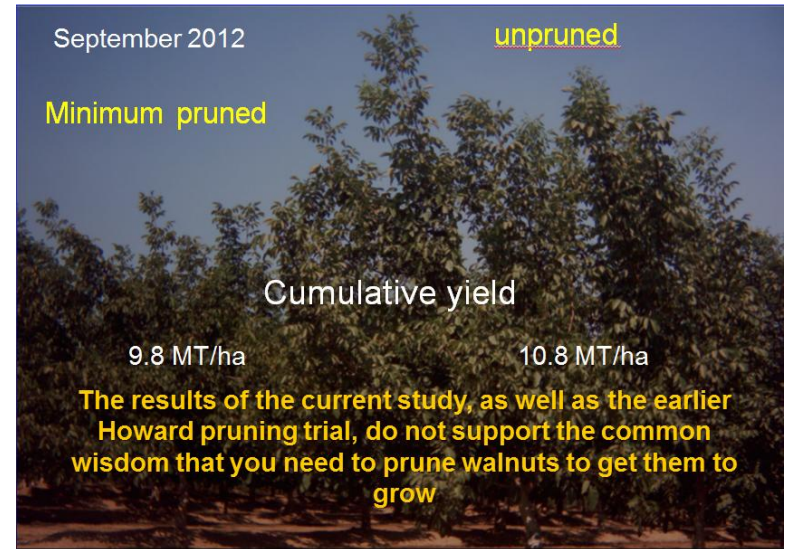
- **Howard pruning trial- After 7 years of treatment imposition**

- Pruned versus unpruned- no sign. dif. in:
 - Tree size
 - Midday canopy light interception
 - Cumulative yield
 - Percent sunburn
 - Nut quality- except more large nuts in unpruned in 2008
- This study does not support the common wisdom that you need to prune walnuts to get them to grow



- **Chandler pruning trial- After 5 years of treatment imposition, there were no benefits to pruning and cumulative yields were similar among all treatments**

- Pruned versus unpruned- no sign. dif. in:
 - Heavy pruning resulted in smaller trees and less yield in early years
 - No benefits of either minimal or heavy pruning
- This study does not support the common wisdom that you need to prune walnuts to get them to grow



March 2007

elongation
(neoformed
growth)



March 2008

lateral
branching
(preformed
growth
only)



Feb 2009

elongation
(neoformed
growth)



Unpruned

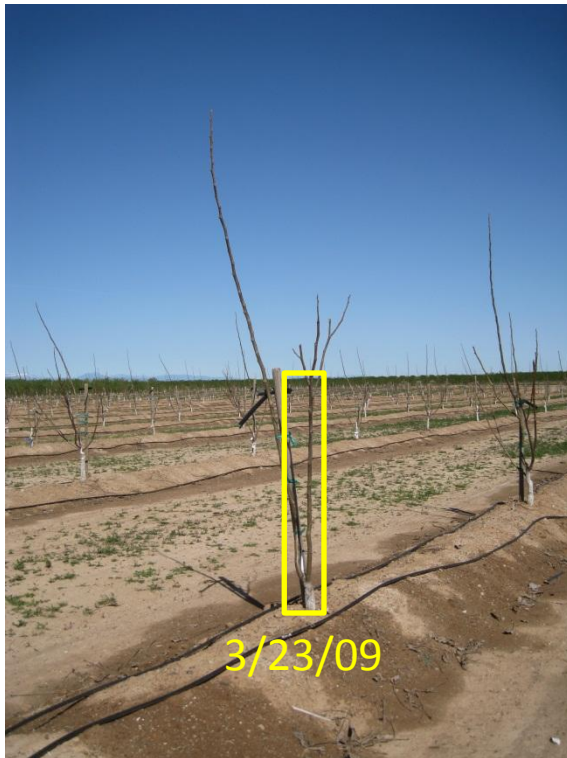
Unpruned

Unpruned

Unpruned

Heavily pruned

Before pruning



Unpruned

Heavily pruned

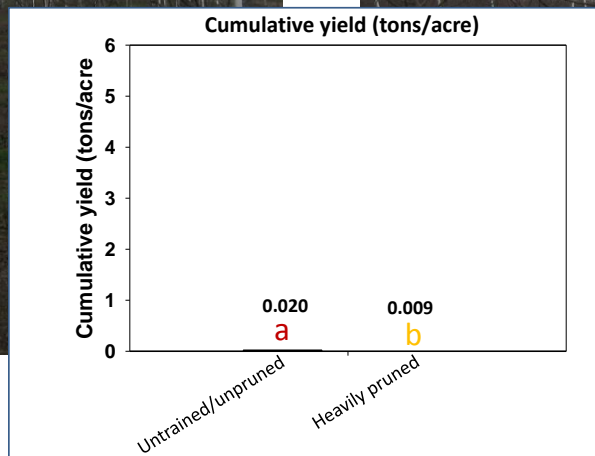
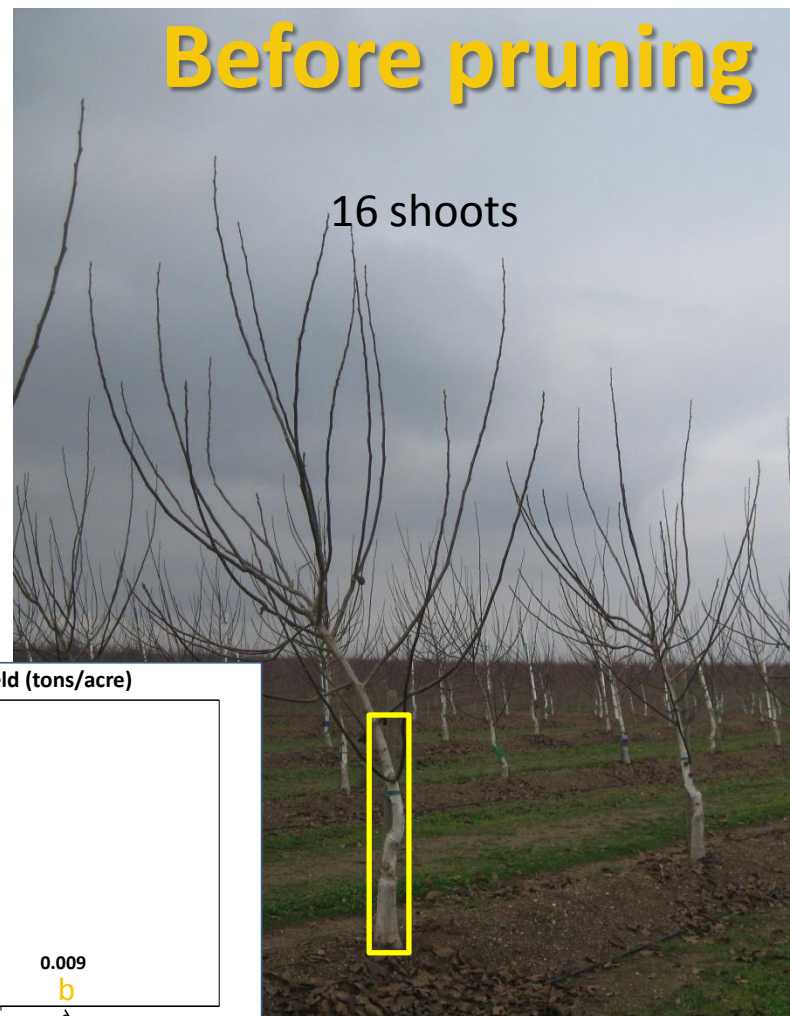
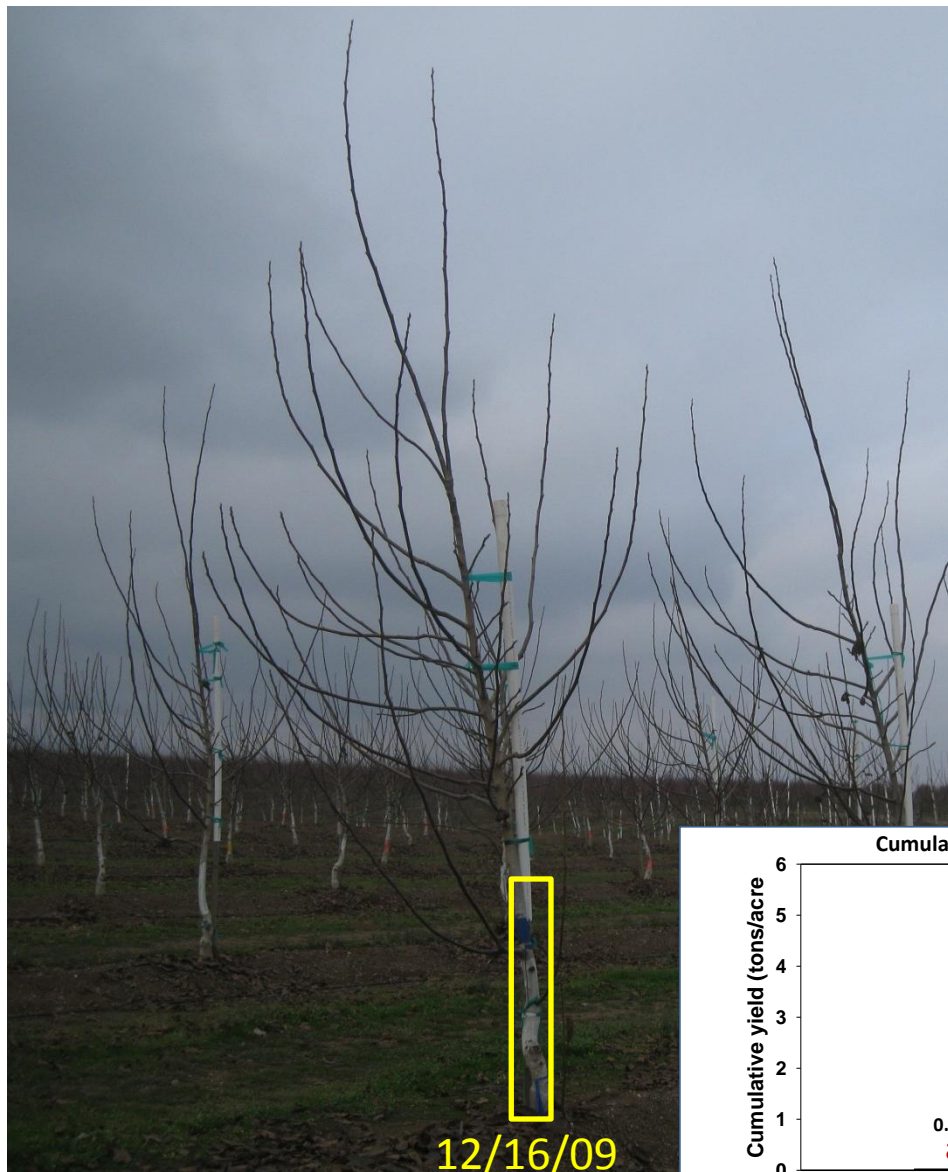


After pruning



Unpruned

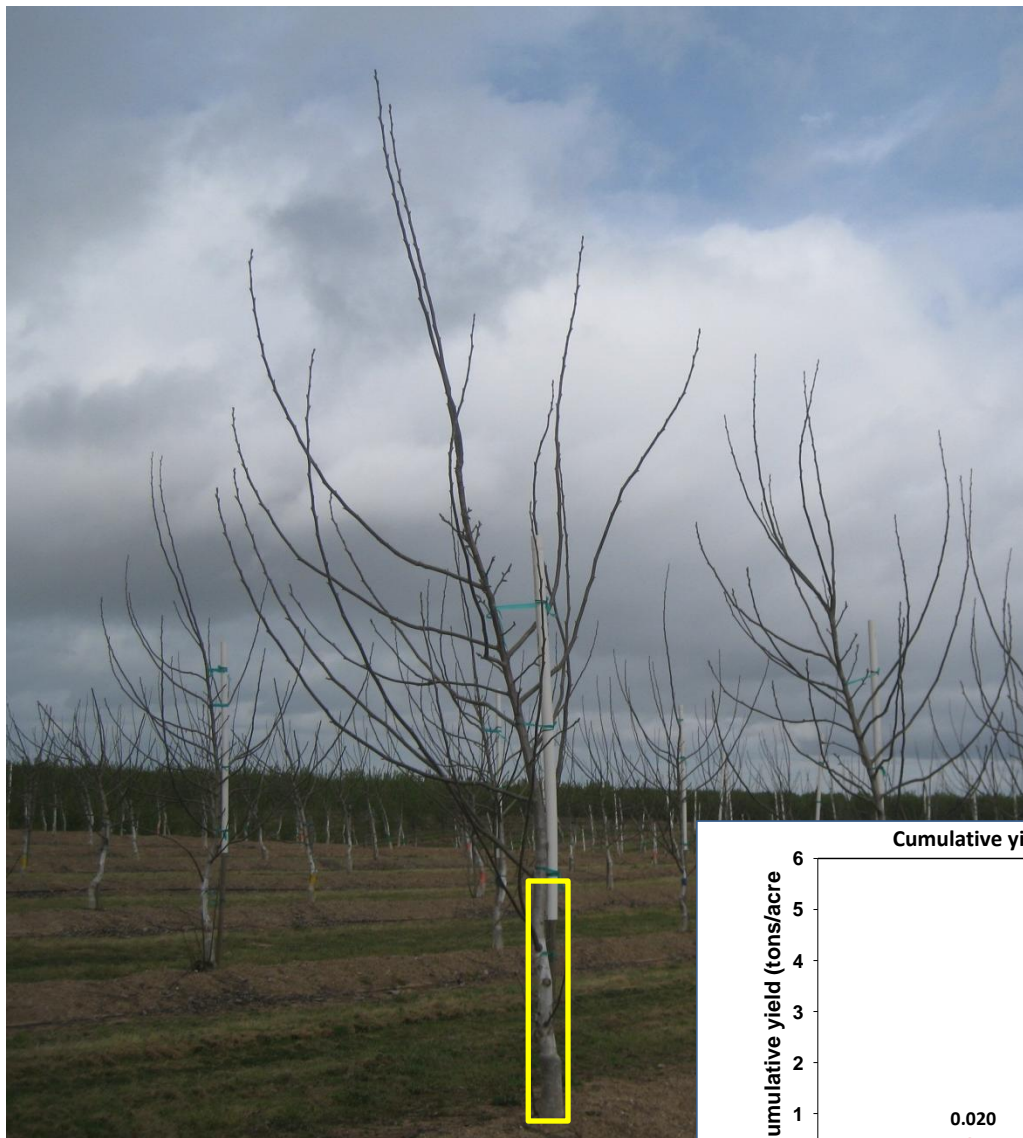
Heavily pruned



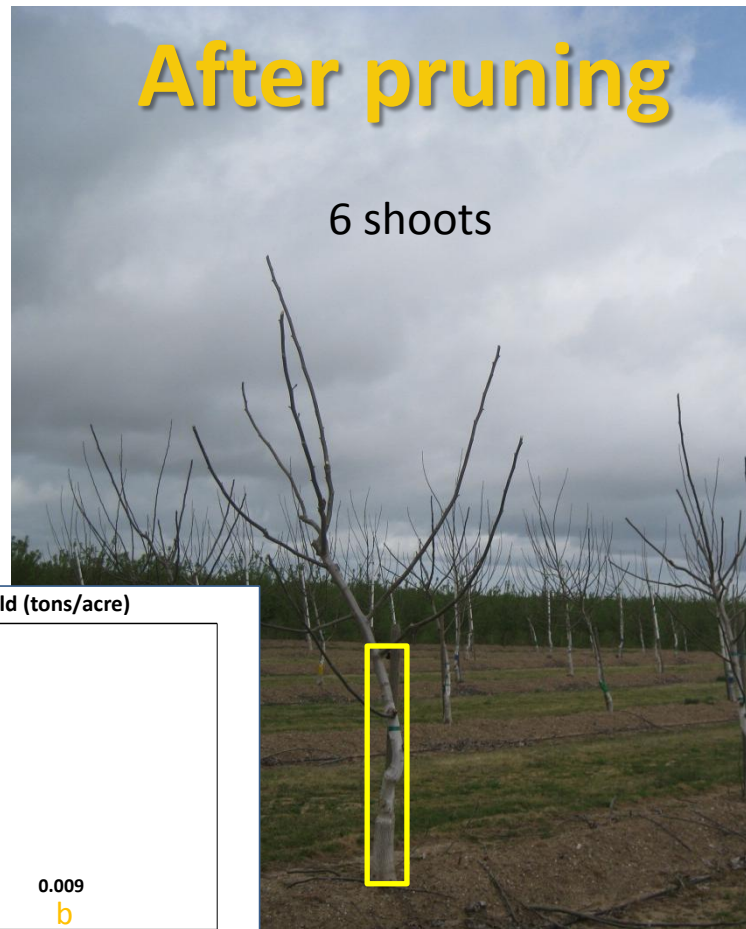
12/16/09

Unpruned

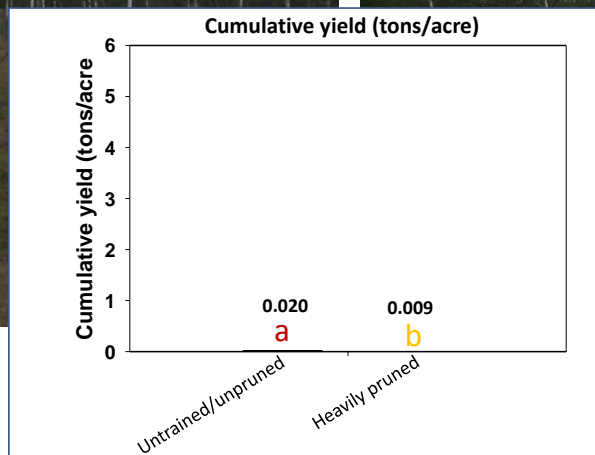
Heavily pruned



3/29/10

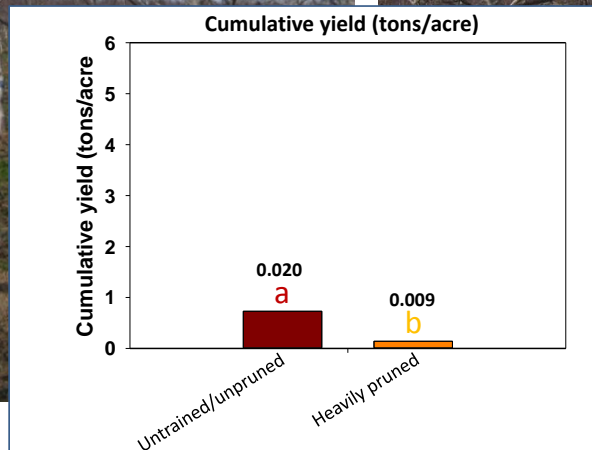
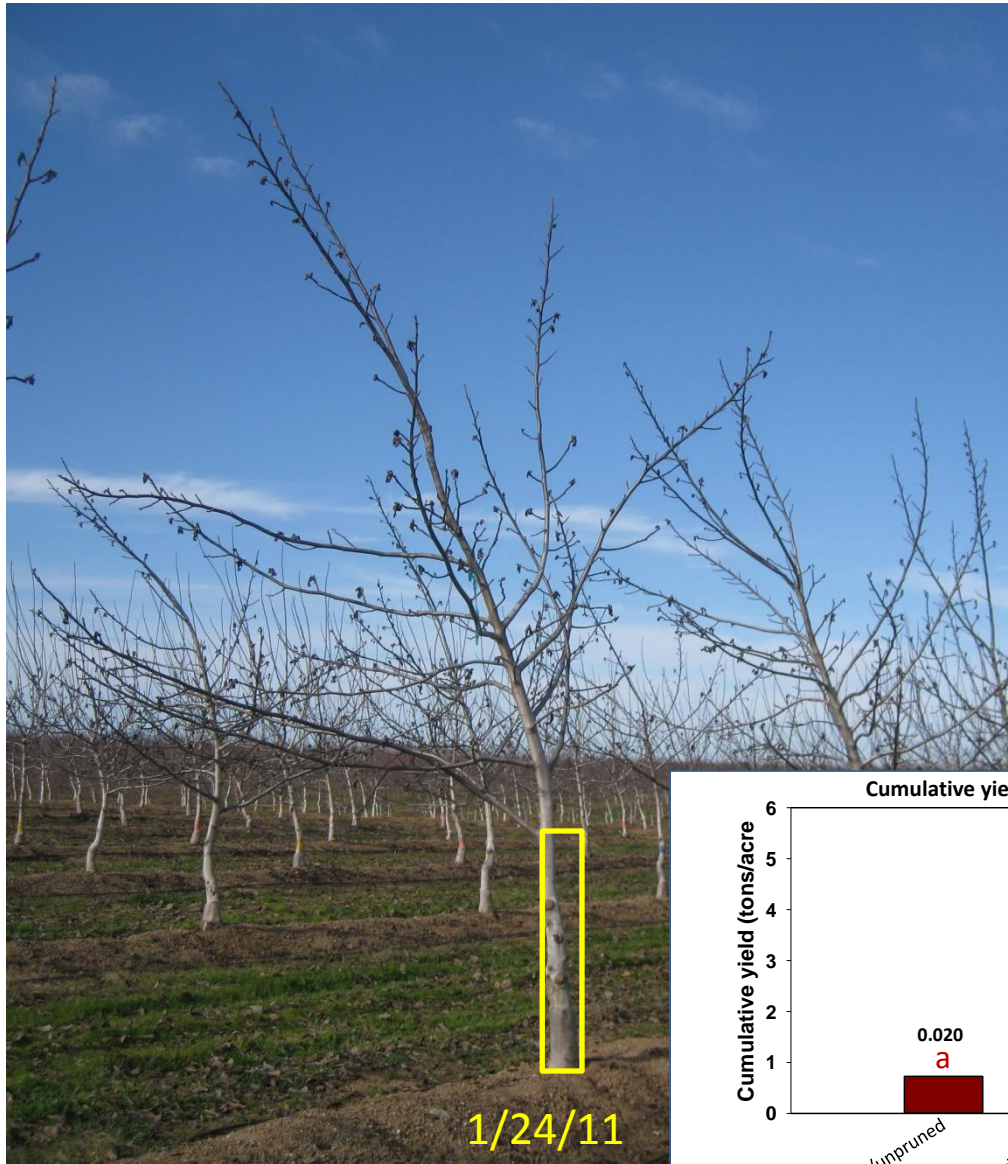


03/29/10



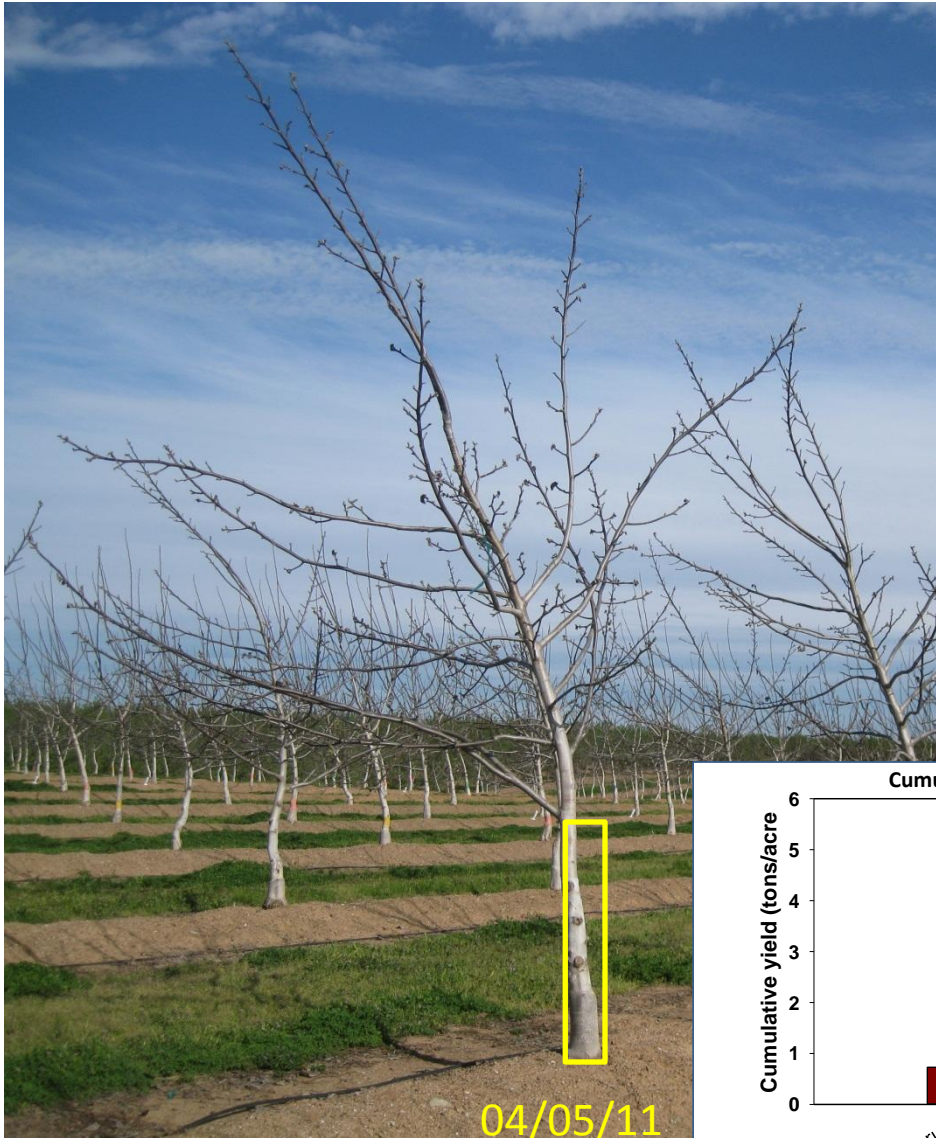
Unpruned

Heavily pruned

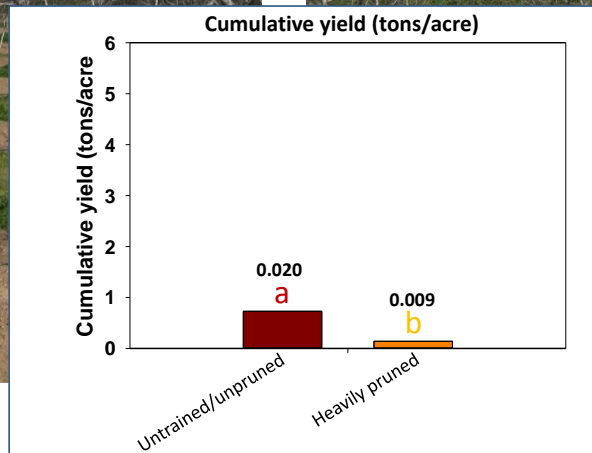


Unpruned

Heavily pruned



After pruning



Unpruned

Heavily pruned

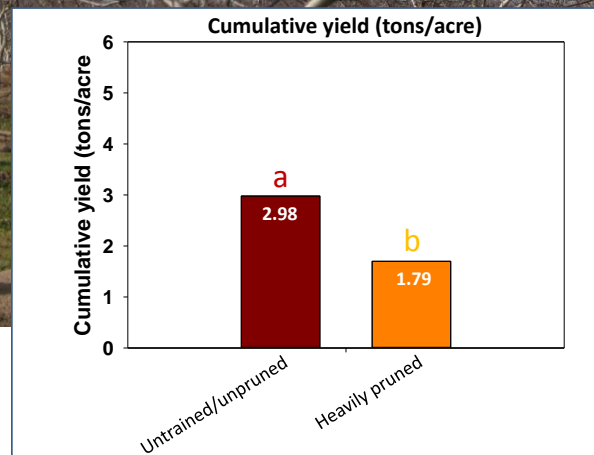
Before pruning



01/05/12



01/05/12



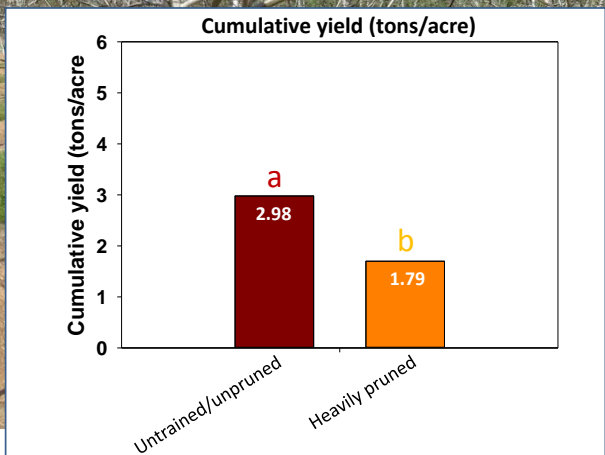
Unpruned

Heavily pruned

After pruning



04/15/12

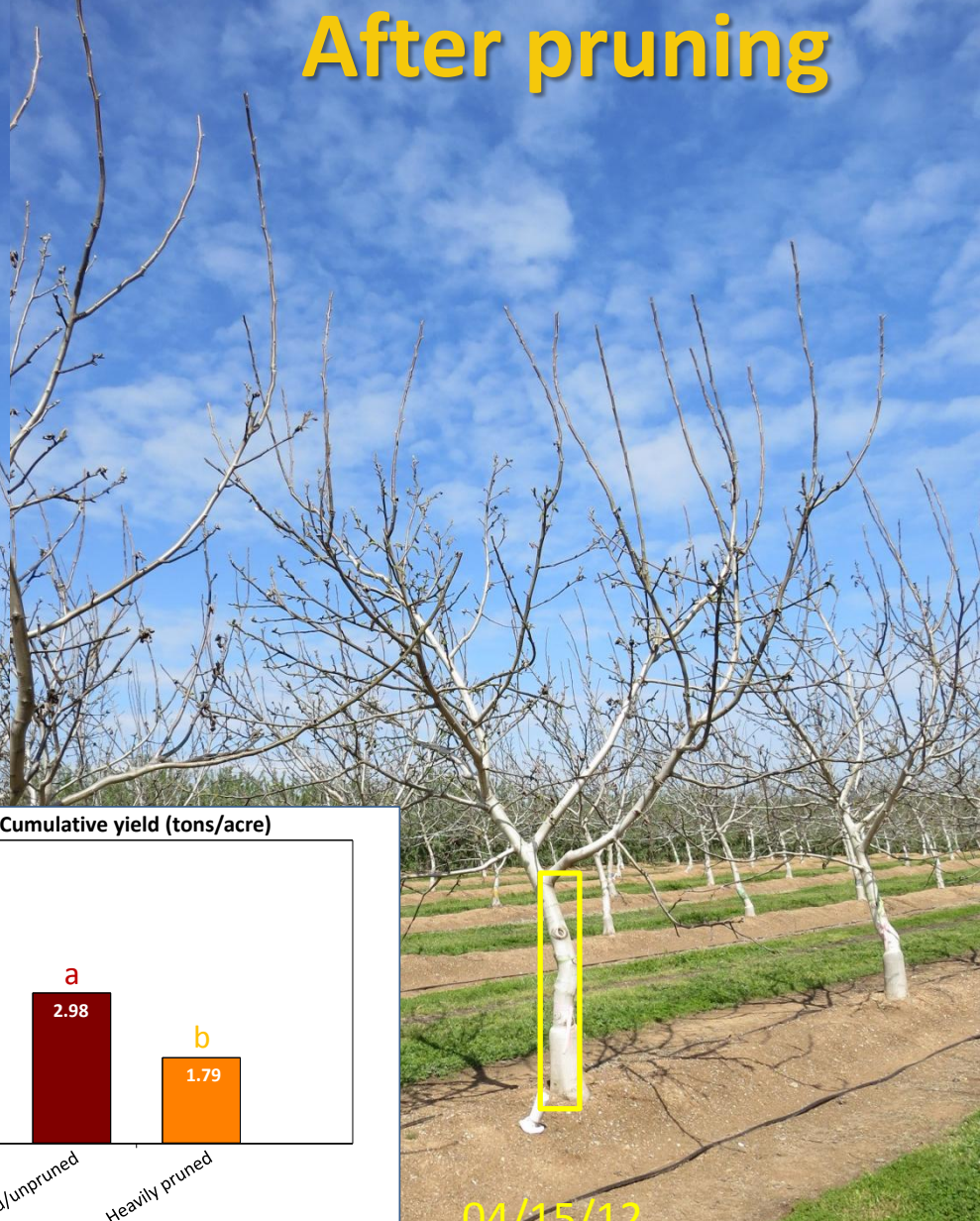


Cumulative yield (tons/acre)

Cumulative yield (tons/acre)

Untrained/unpruned

Heavily pruned



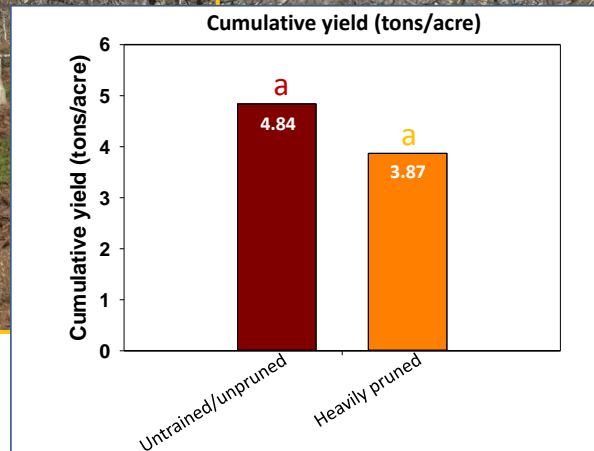
04/15/12

Unpruned

Heavily pruned Before pruning

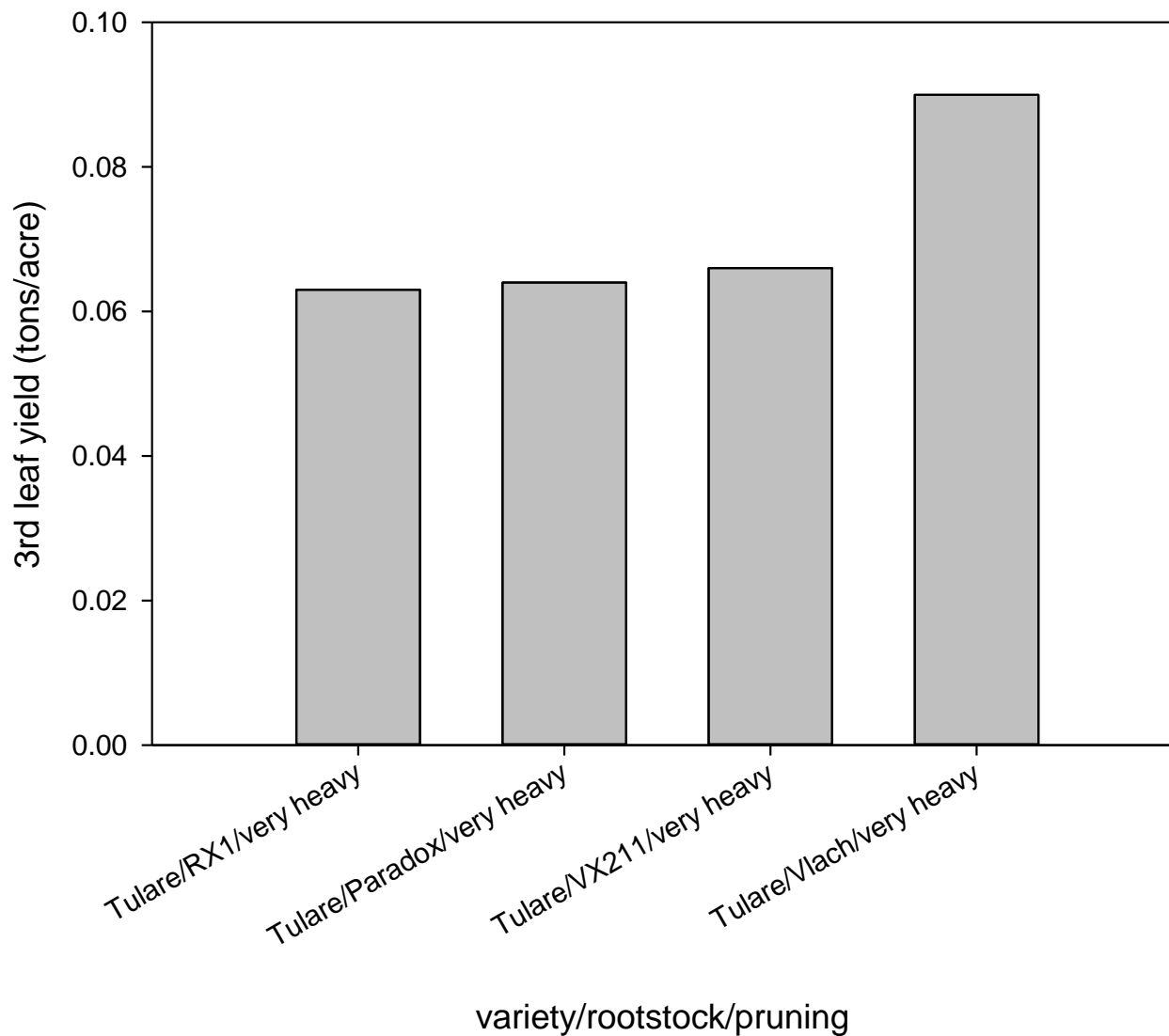


12/30/12



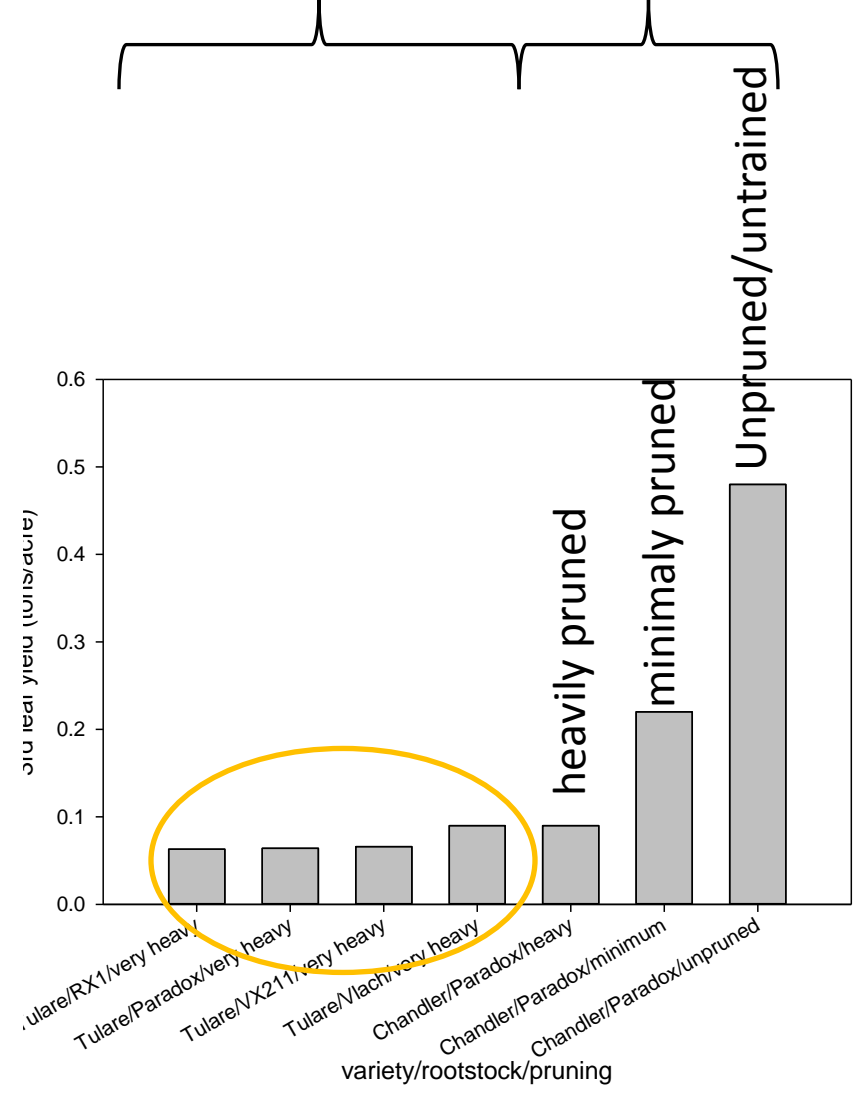
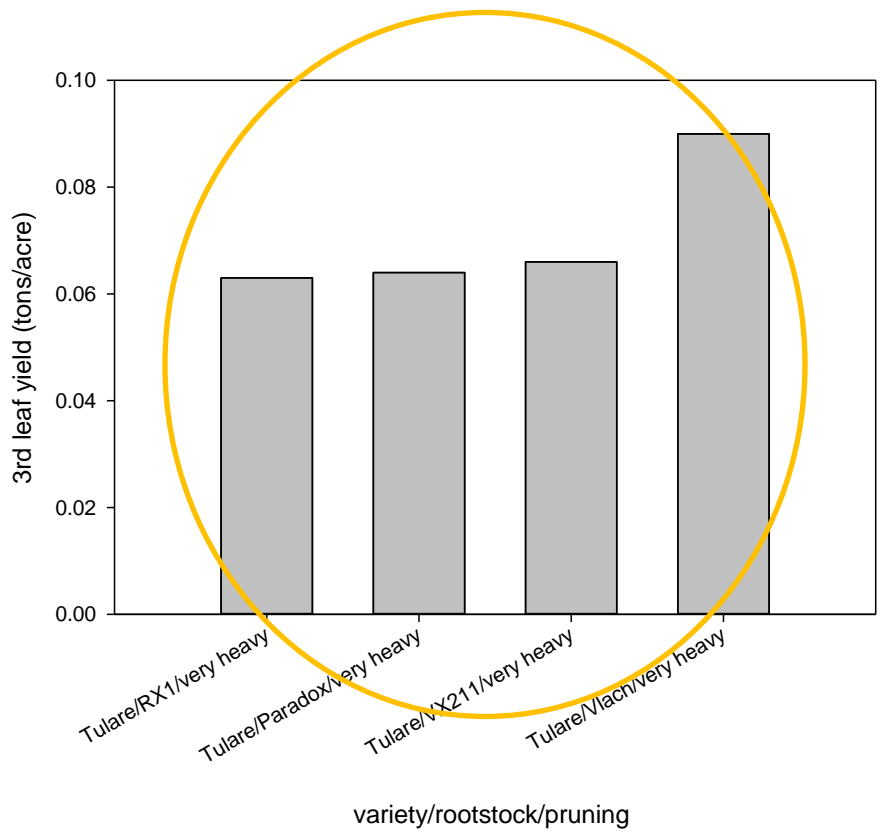
12/30/12

3rd leaf yield clonal rootstock trial in Solano County- heavily pruned by grower

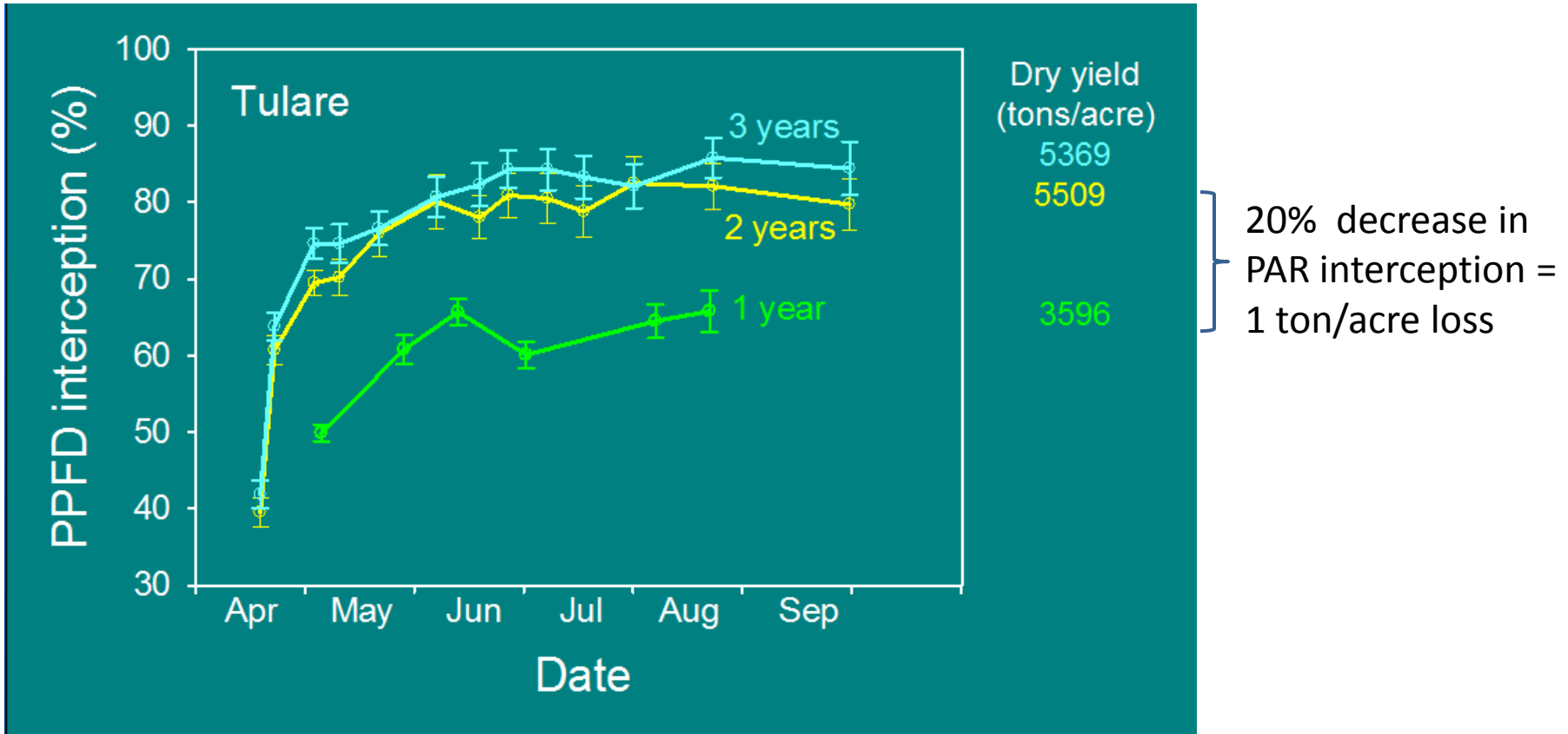


Clonal rootstock trial in Solano County and Nickels Chandler trial

Clonal rootstock trial Nickels Chandler



Tulare growth and yield responses to mechanical hedging Solano County 2003





#nuts

2

10

20

26

primary
shoot

~3 to 6+ feet

cut

branching
point

0

1

2

3

4

1

2

3

4

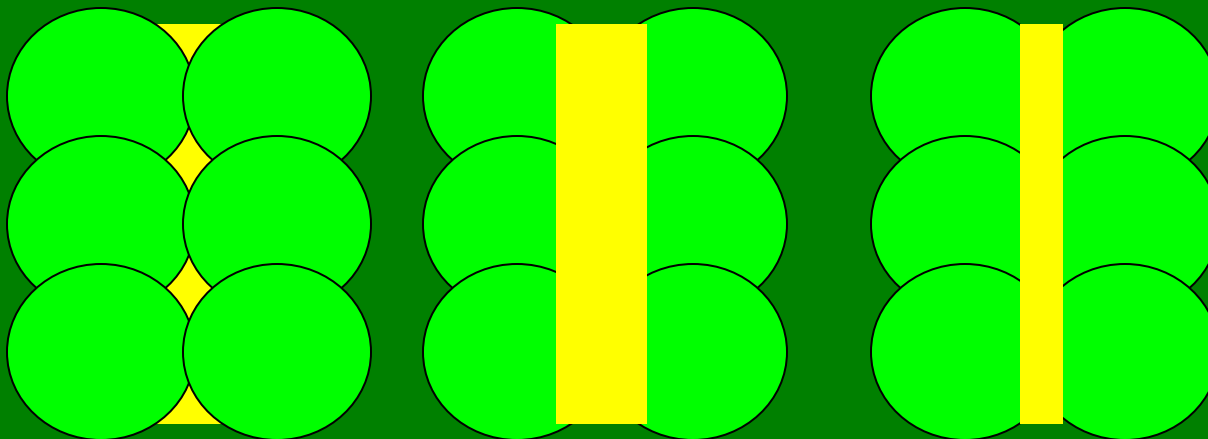
Years after hedging →

↑ Total by year

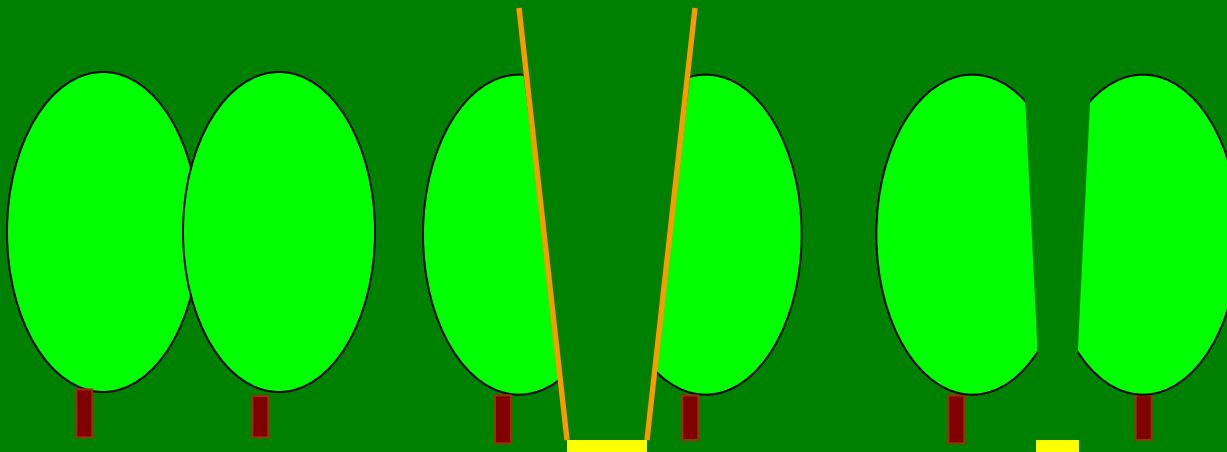
With a 3 year hedging cycle, you never make it here

High density

top view



side view



before hedging

after hedging

one year later

3 yr ave.

PAR int.

85%

70%

80%

83%

Yield potential ~~4.2 tons~~

~~3.2 tons/ac~~

~~4.0 tons/ac~~

~~3.8~~

3.6 tons/ac

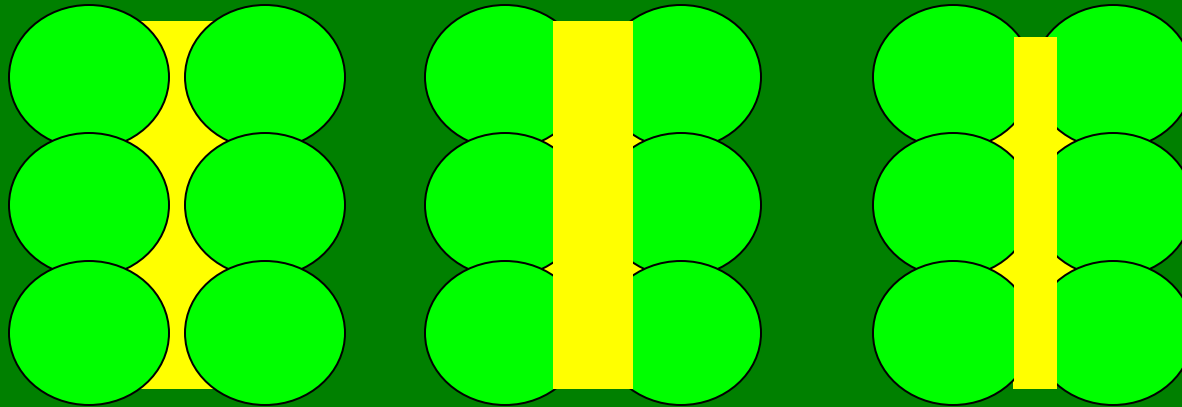
2.4 tons/ac

2.9 tons/ac

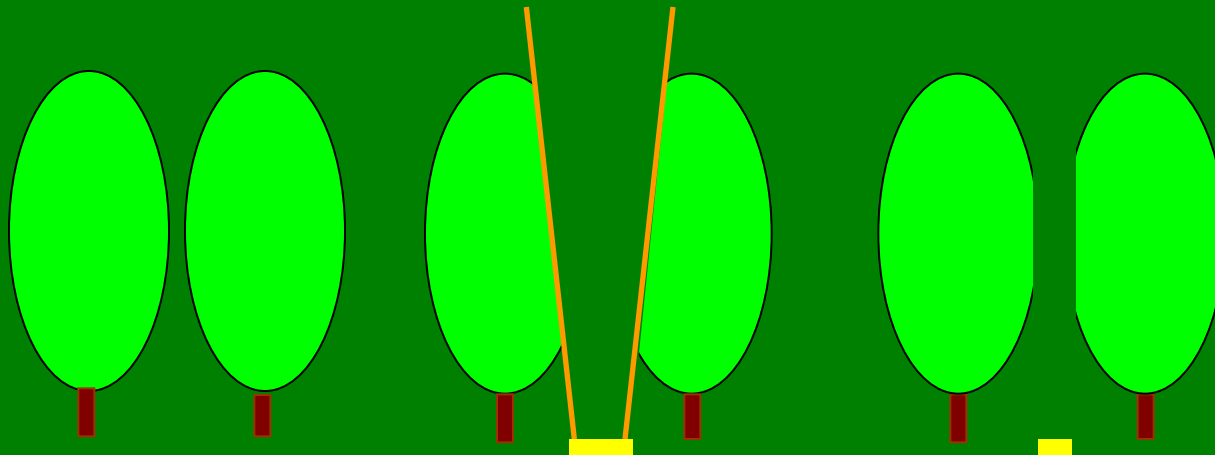
2.96

Moderately high density

top view



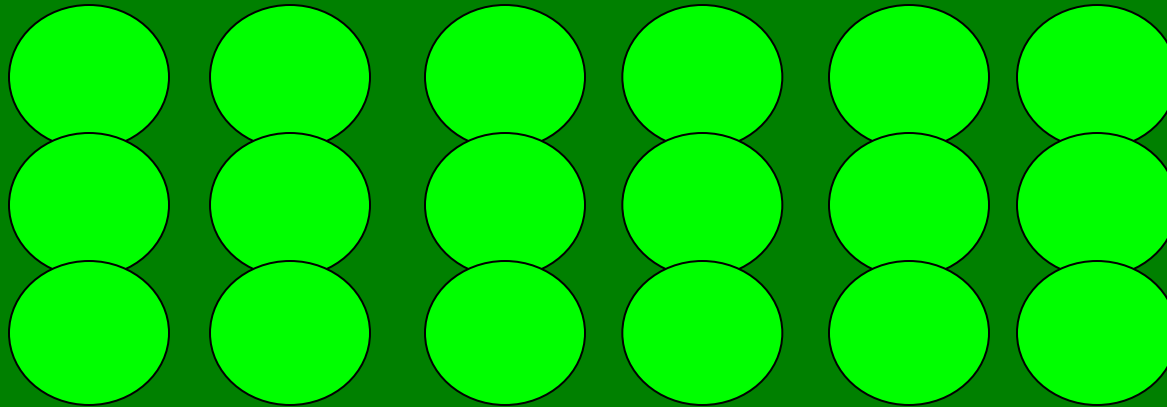
side view



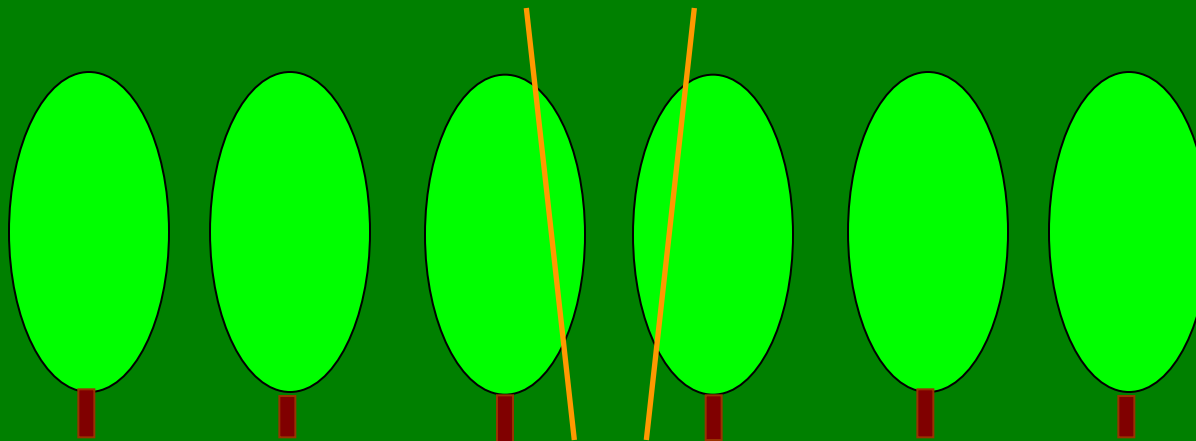
	before hedging	after hedging	one year later	3 yr ave.
PAR int.	80%	65%	75%	73%
Yield potential	4.0 tons/ac 3.4 tons/ac	2.7 tons/ac 2.5 tons/ac	3.7 tons/ac 2.8 tons/ac	3.5 tons/ac 2.9 tons/ac

Slightly lower density with no hedging

top
view

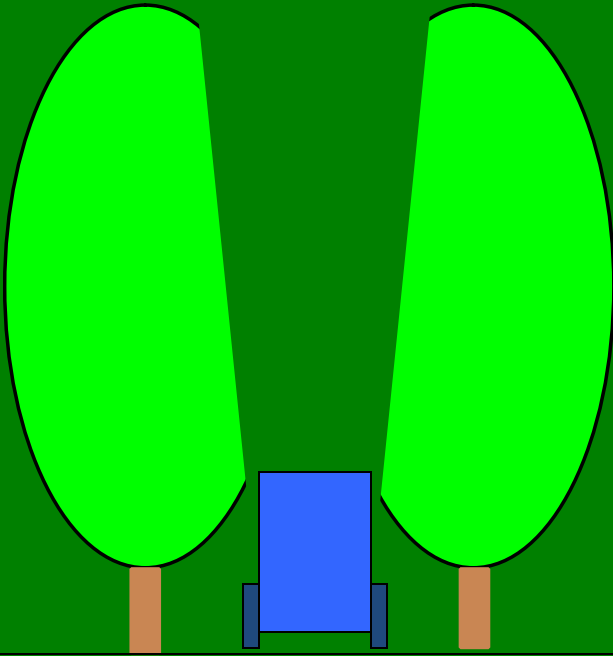


side
view

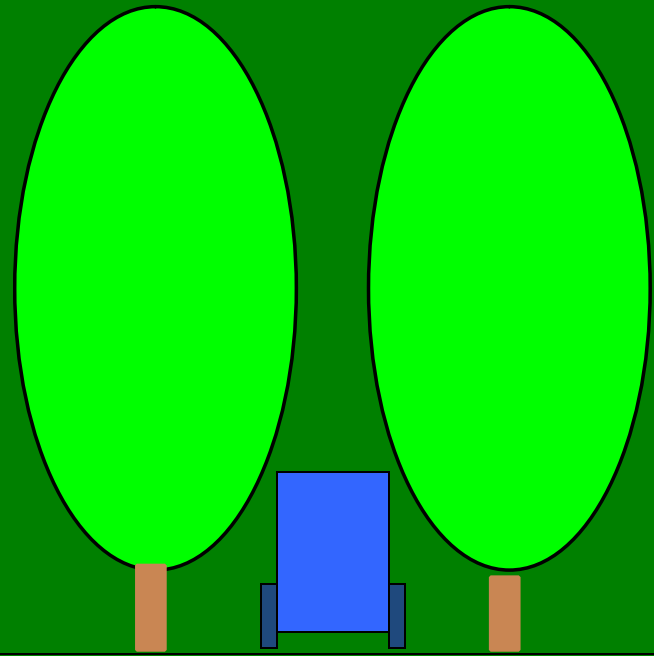


PAR int.	unpruned 75%	unpruned 76%	unpruned 77%	3 yr ave. 76%
Yield potential	3.75 tons/ac	3.8 tons/ac	3.85 tons/ac	3.8 tons/ac

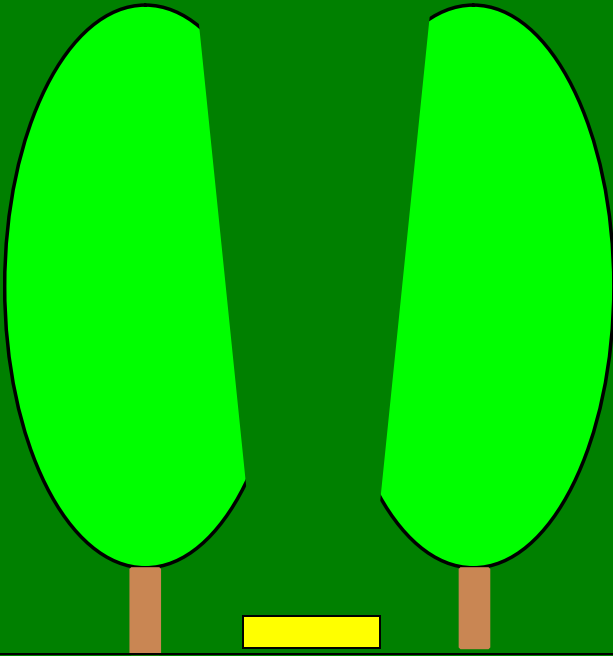
Moderate density
with hedging



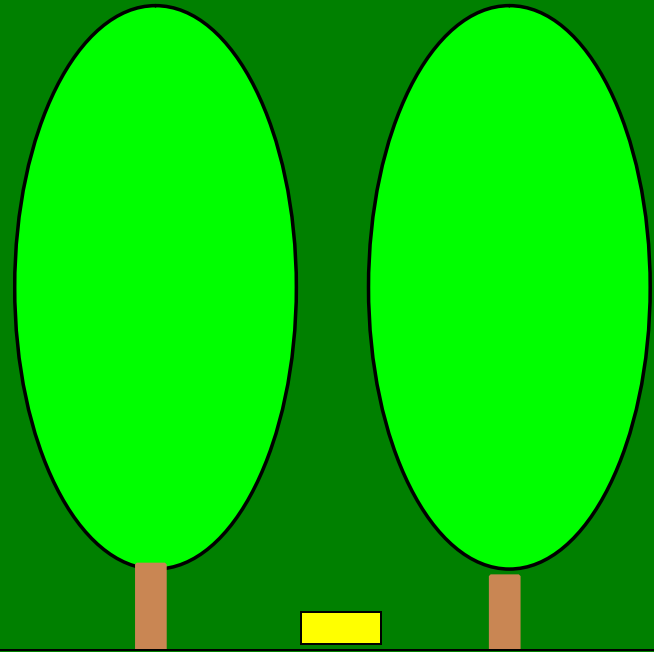
Slightly lower density
with no hedging

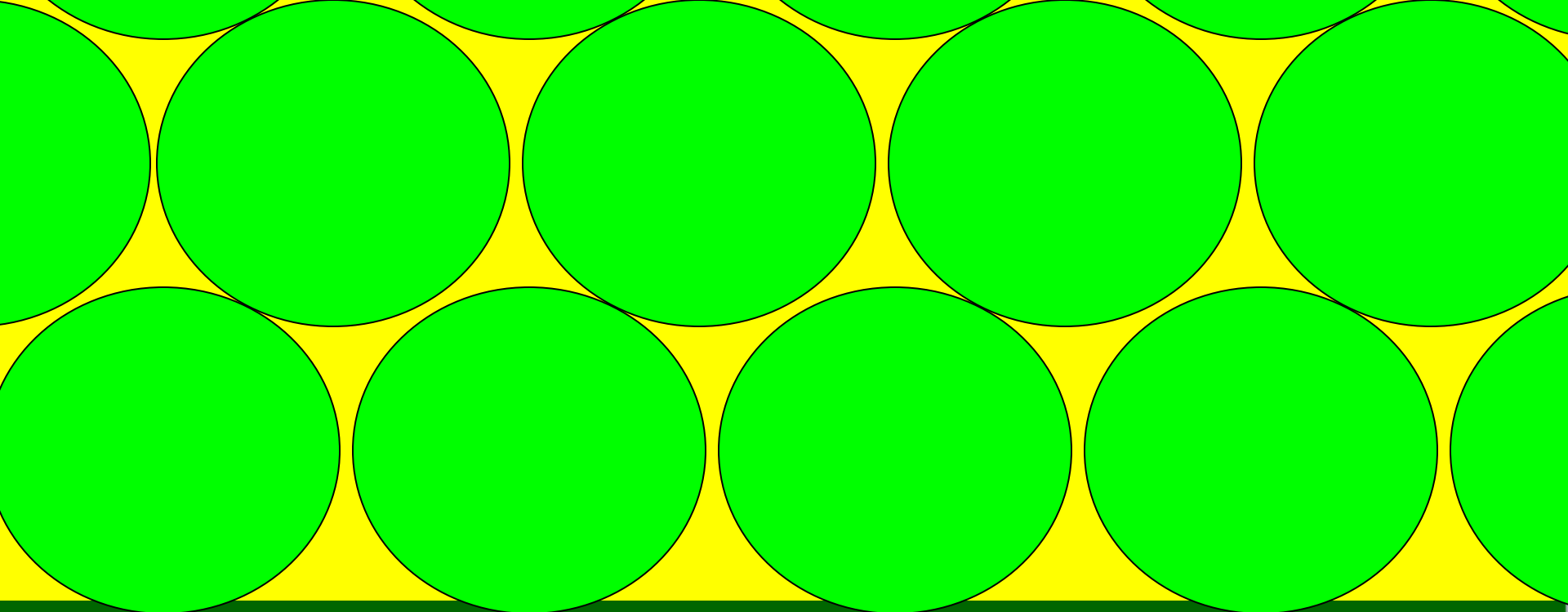


Moderate density
with hedging

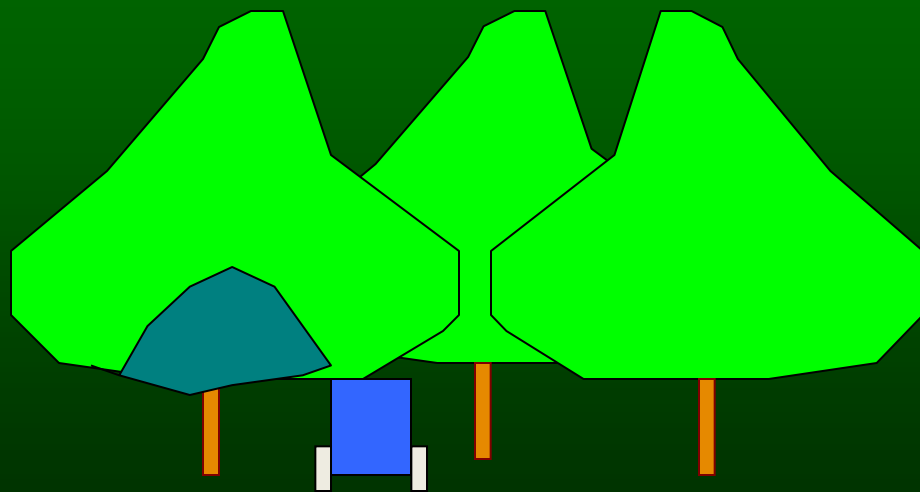
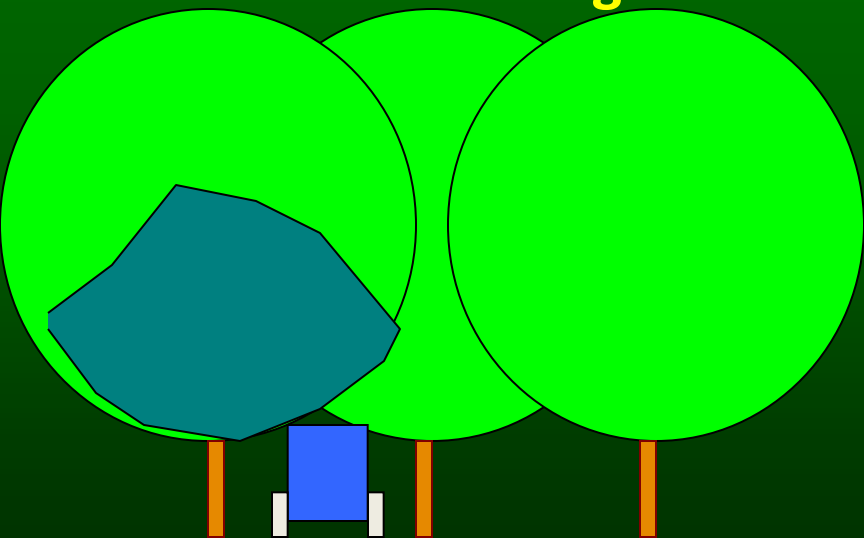


Slightly lower density
with no hedging





~90% light interception (4.5 tons/acre potential)

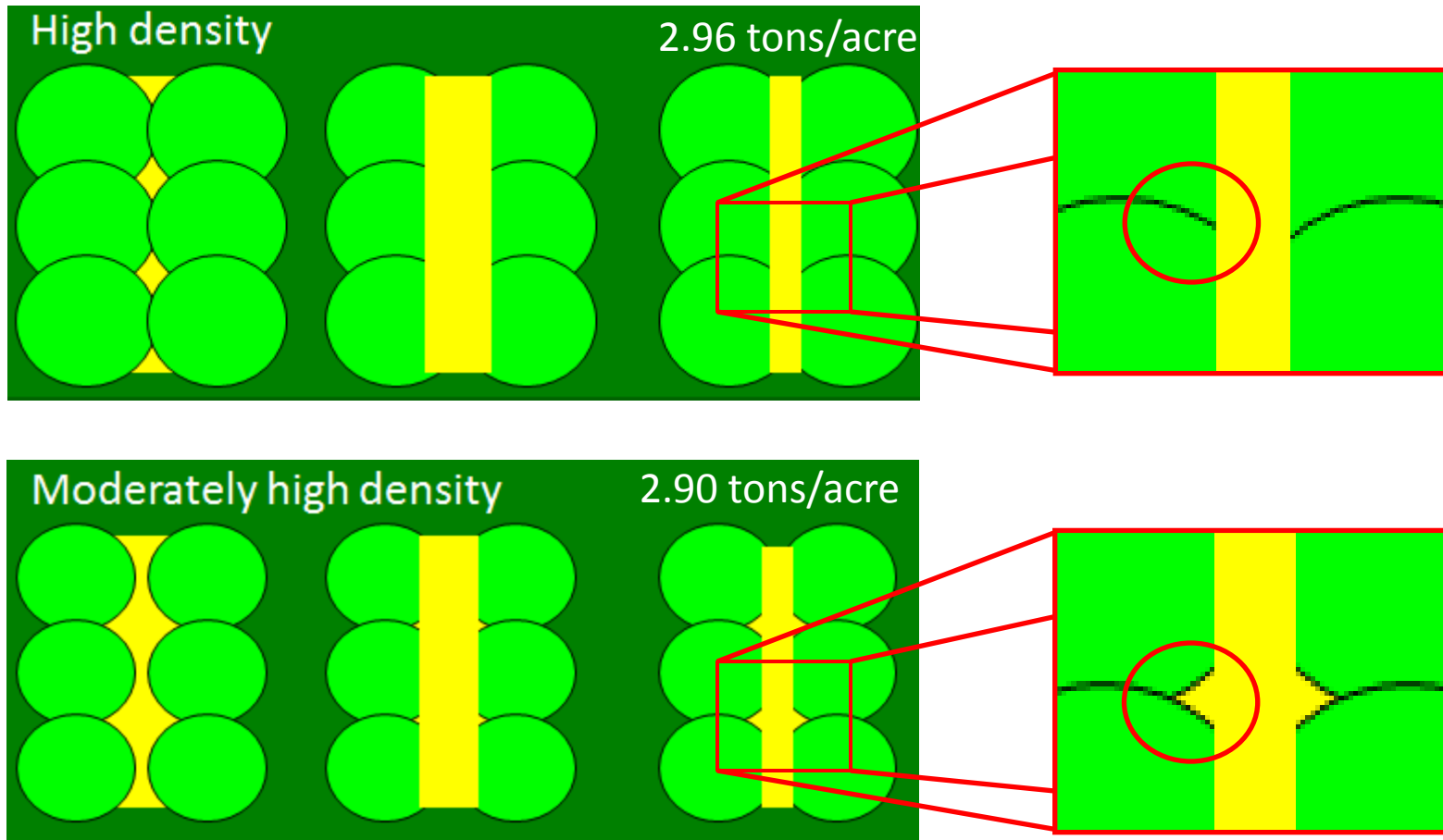


Conventional planting

Summary of 4 scenarios

Scenario	Year 1	Year 2	Year 3	Average
High density	85%	70%	80%	83%(int.)
	4.2	3.5	4.0	3.8 (potential)
	3.6	2.6	2.9	2.96 (actual)
Moderately high density	80%	65%	75%	73%
	4.0	2.7	3.7	3.5 (potential)
	3.4	2.5	2.8	2.9 (actual)
Unpruned, slightly wider spacing	75%	76%	77%	76%
	3.75	3.8	3.85	3.8
Conventional spacing	90%	91%	92%	91%
	4.5	4.55	4.6	4.55

Why was high density planting more productive than moderately high density?





5 seasons of growth
on 11 year old tree



5 seasons of growth
on 5 year old tree

Pruning related problems



7 Year old Howard orchard in Solano County-
tremendous breakage problem in 2011

Pruning related problems



8/9/2005

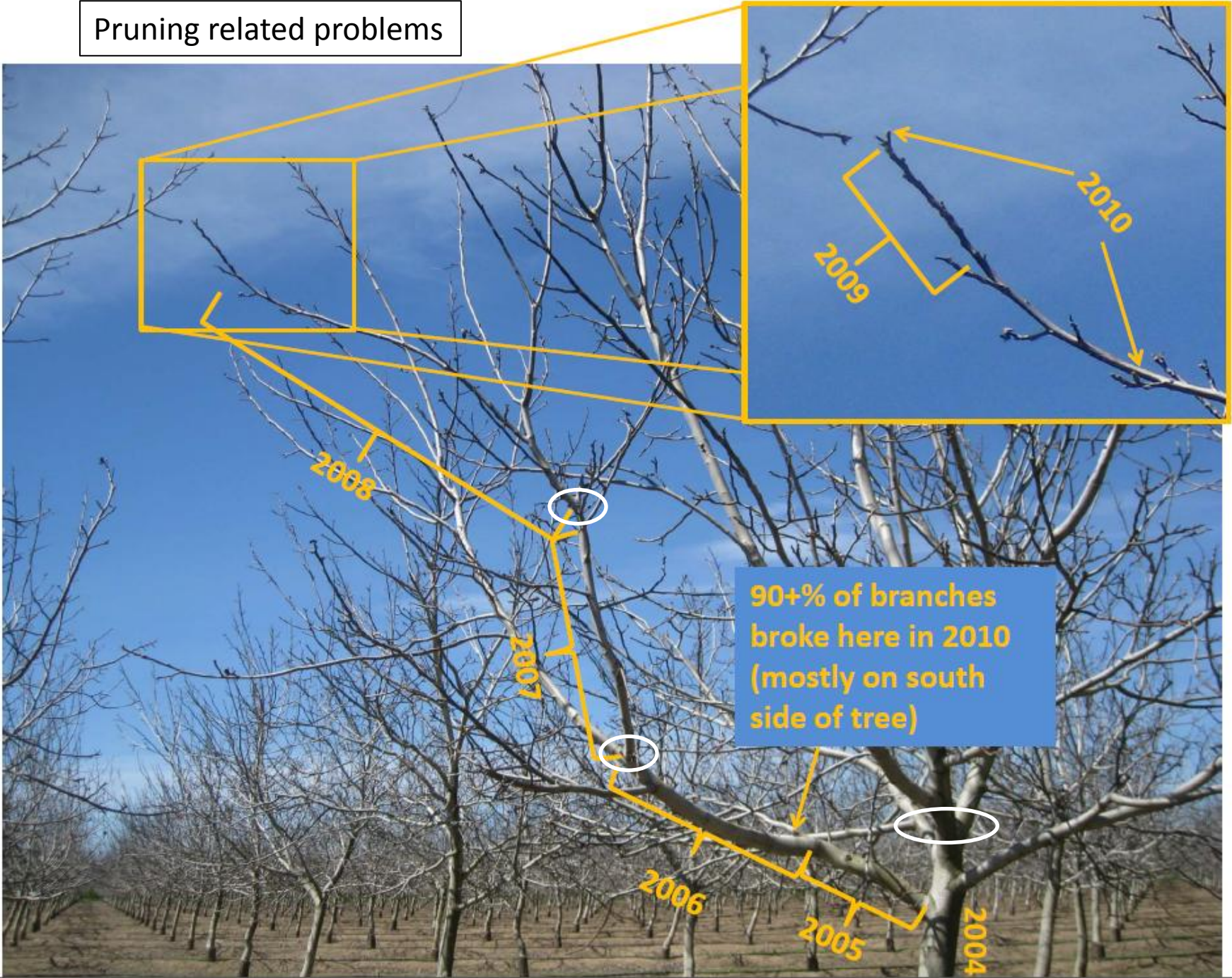


5/3/2006



4/4/2011

Pruning related problems





Pruning related problems

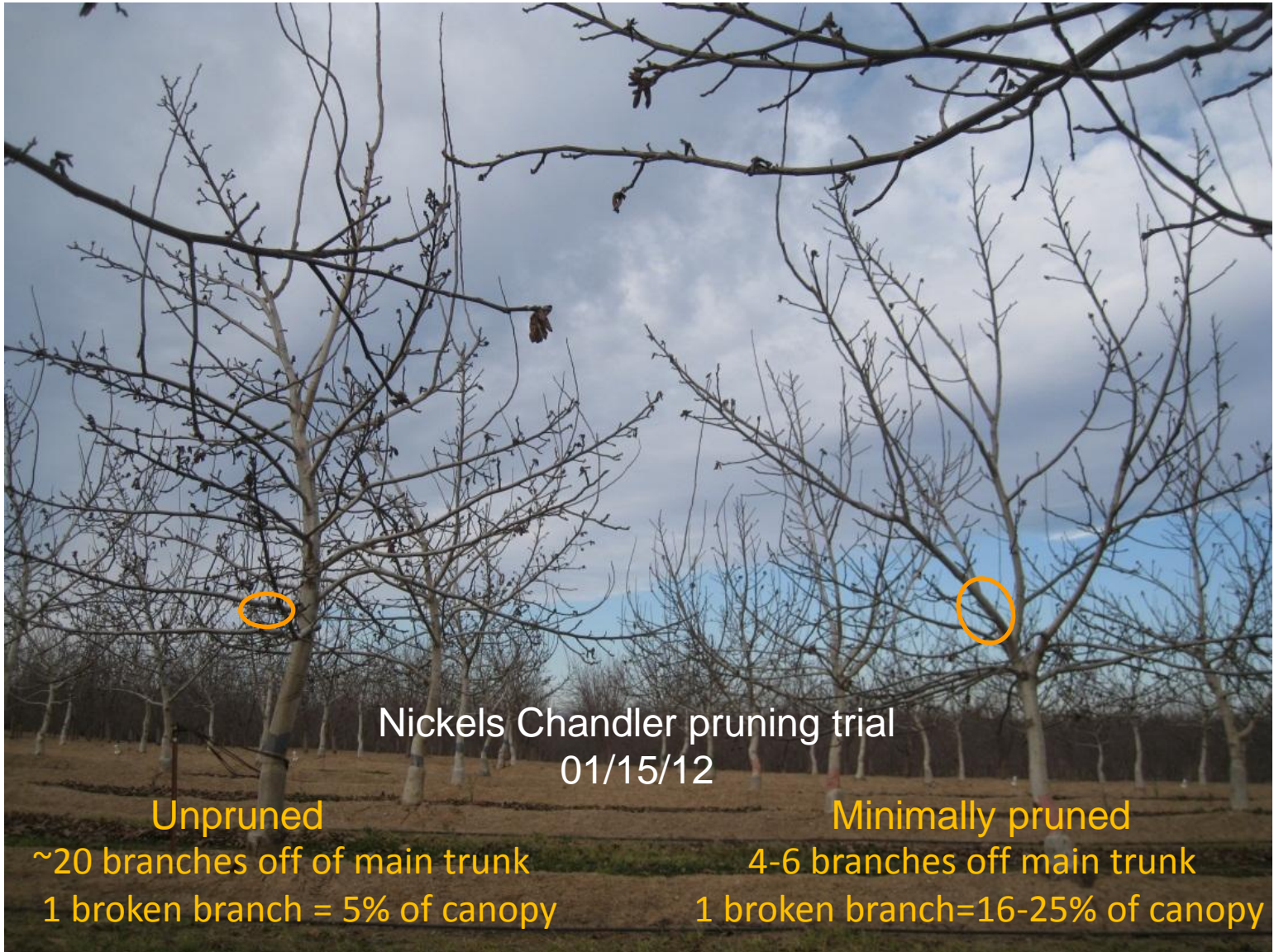
Pruned tree in Chandler pruning trial Nickels July 2012

Pruning related problems



Breakage in 10 year old Lake
County Chandler orchard July 5,
2012





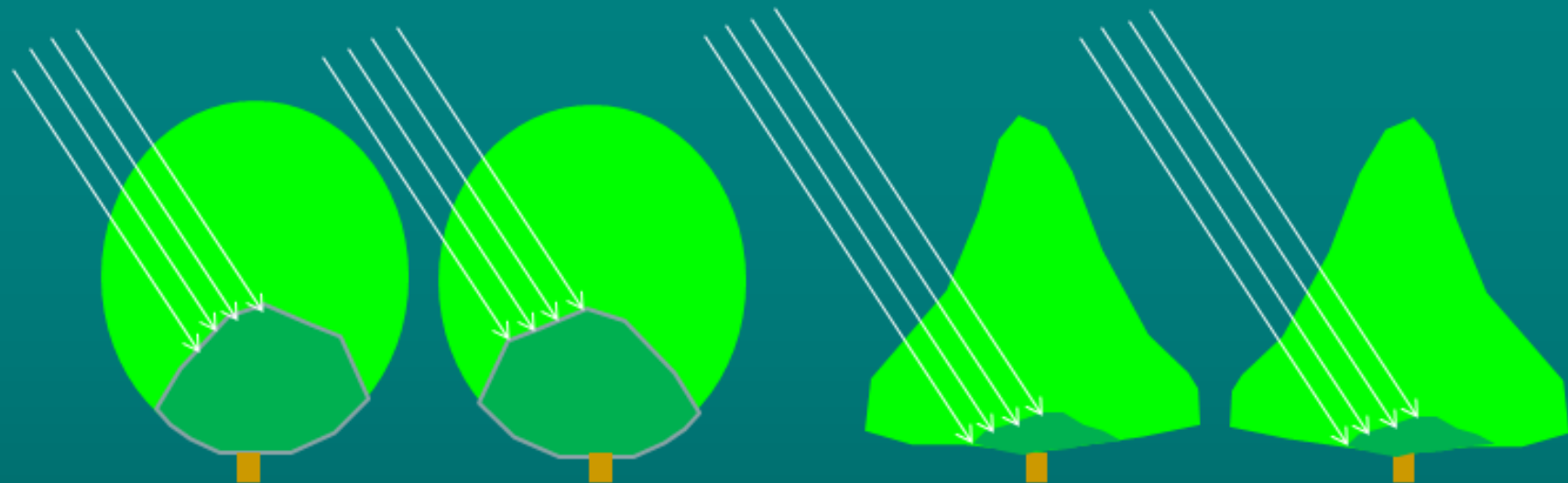
Nickels Chandler pruning trial
01/15/12

Unpruned
~20 branches off of main trunk
1 broken branch = 5% of canopy

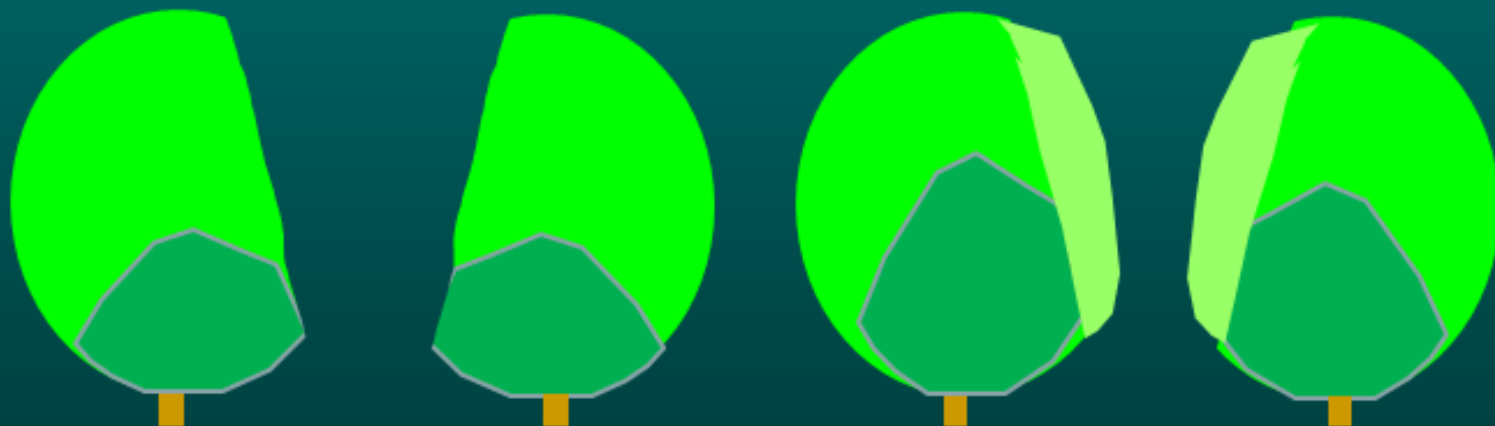
Minimally pruned
4-6 branches off main trunk
1 broken branch=16-25% of canopy

Pruning related problems

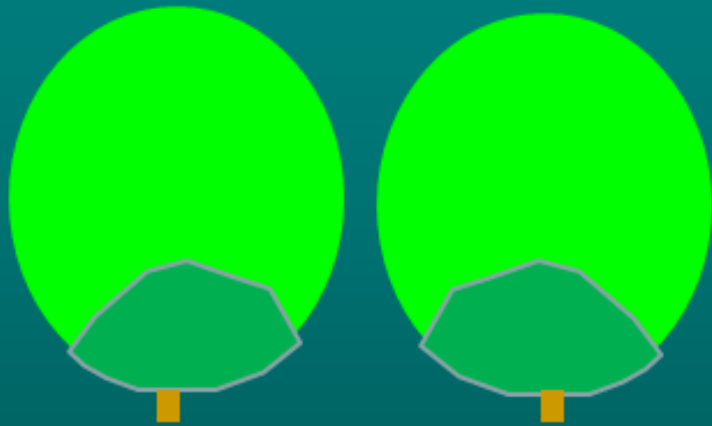




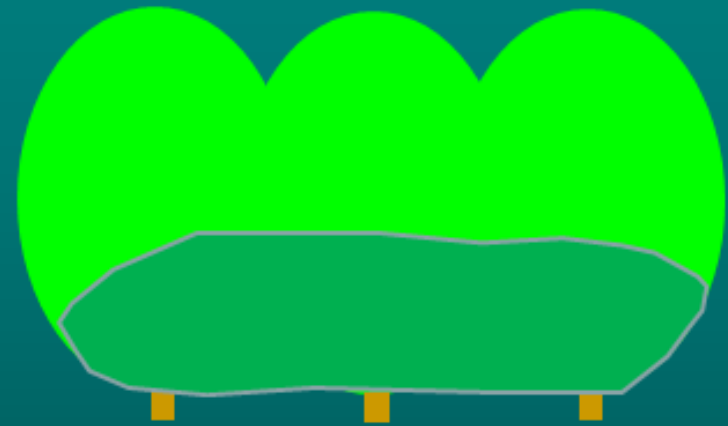
Quality problems in center of tree tend to be less severe with central leader tree structure- shorter light path through tree



Most severe quality problems occur in orchards planted in hedgerow configuration and mechanically hedged- due to dense vegetative growth in response to cut and exposing positions that were currently shaded to full sun

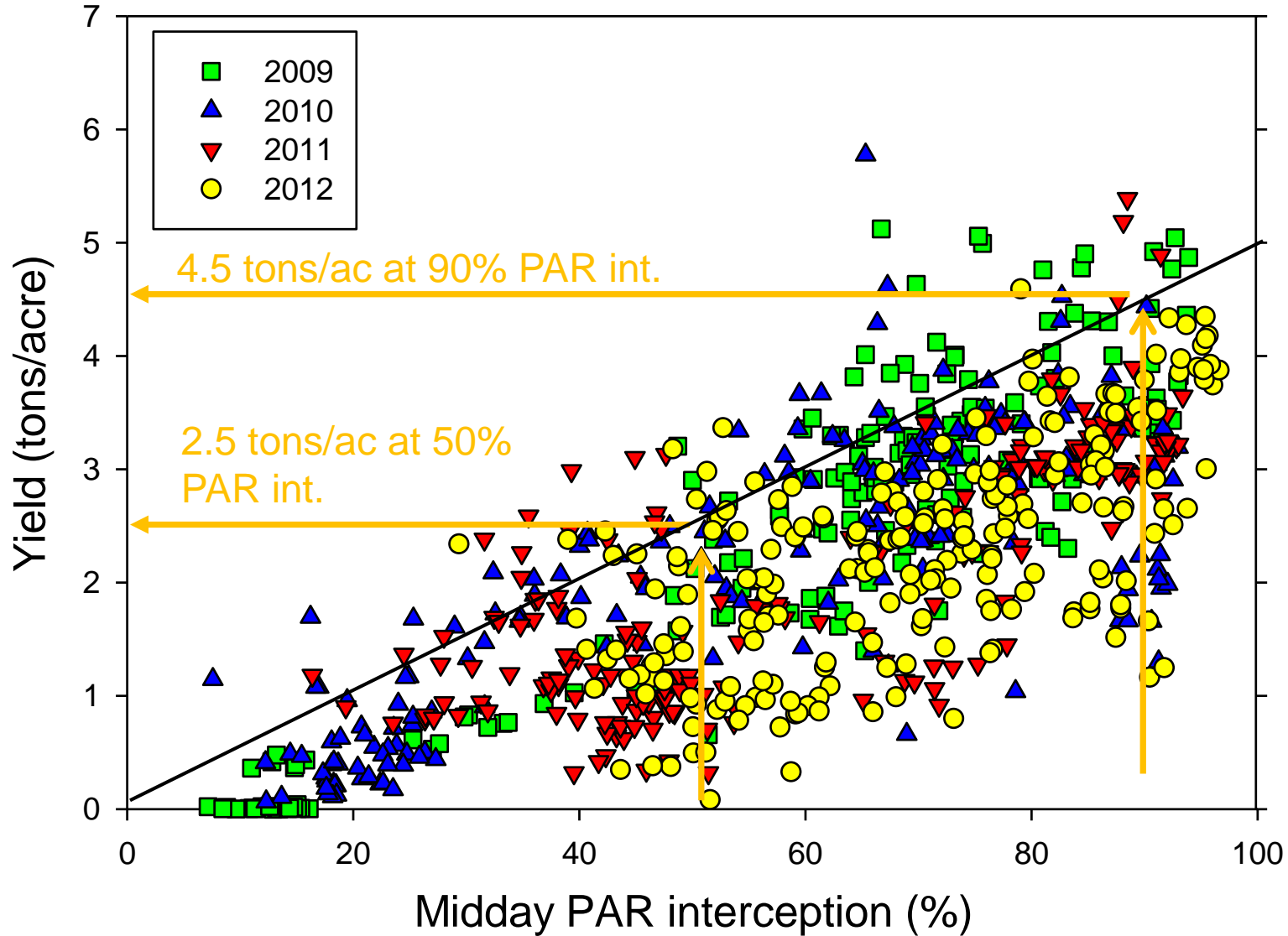


Traditional spacing (in tree row)

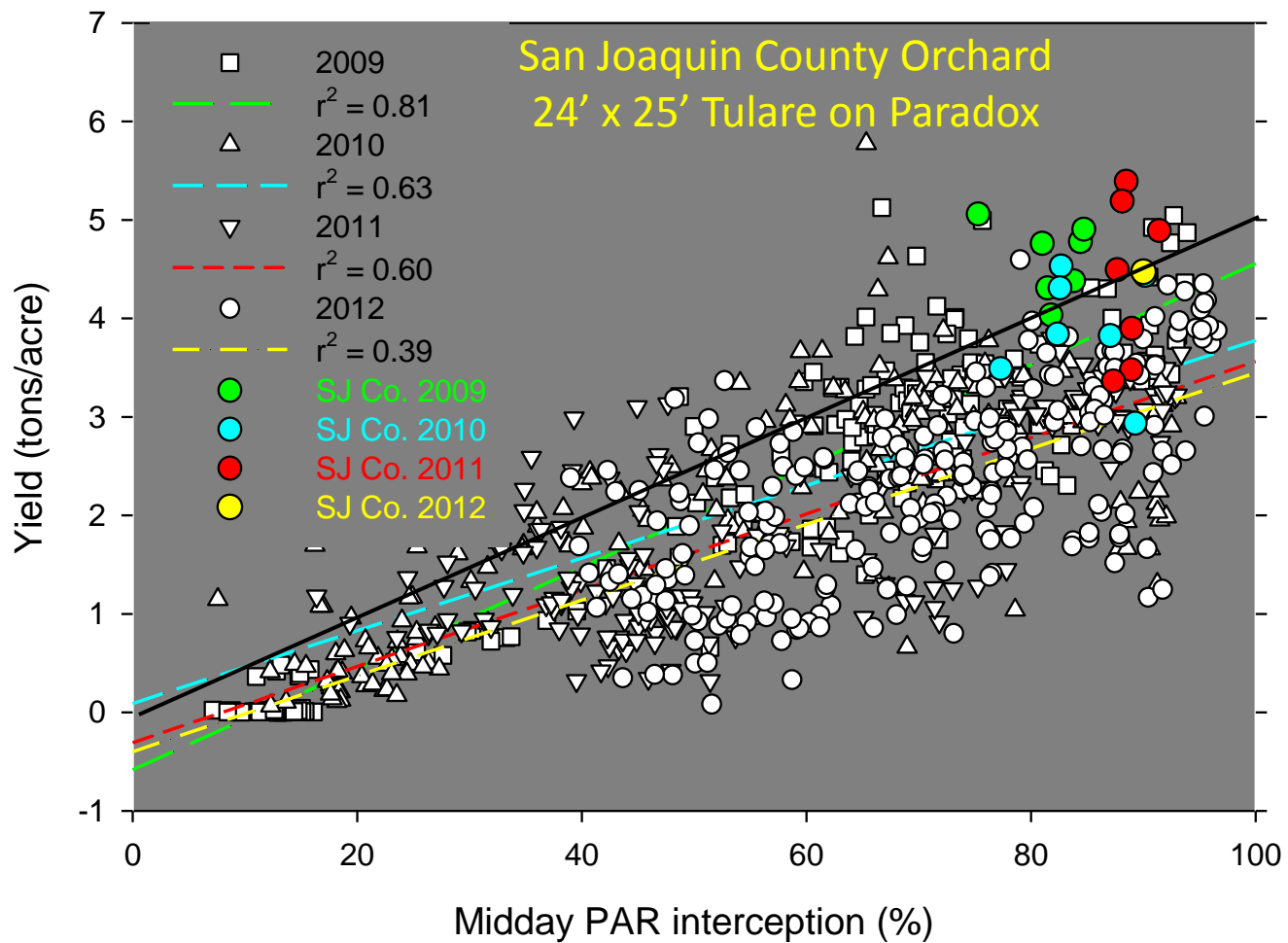


Hedgerow spacing (in tree row)

All walnut data 2009-2012

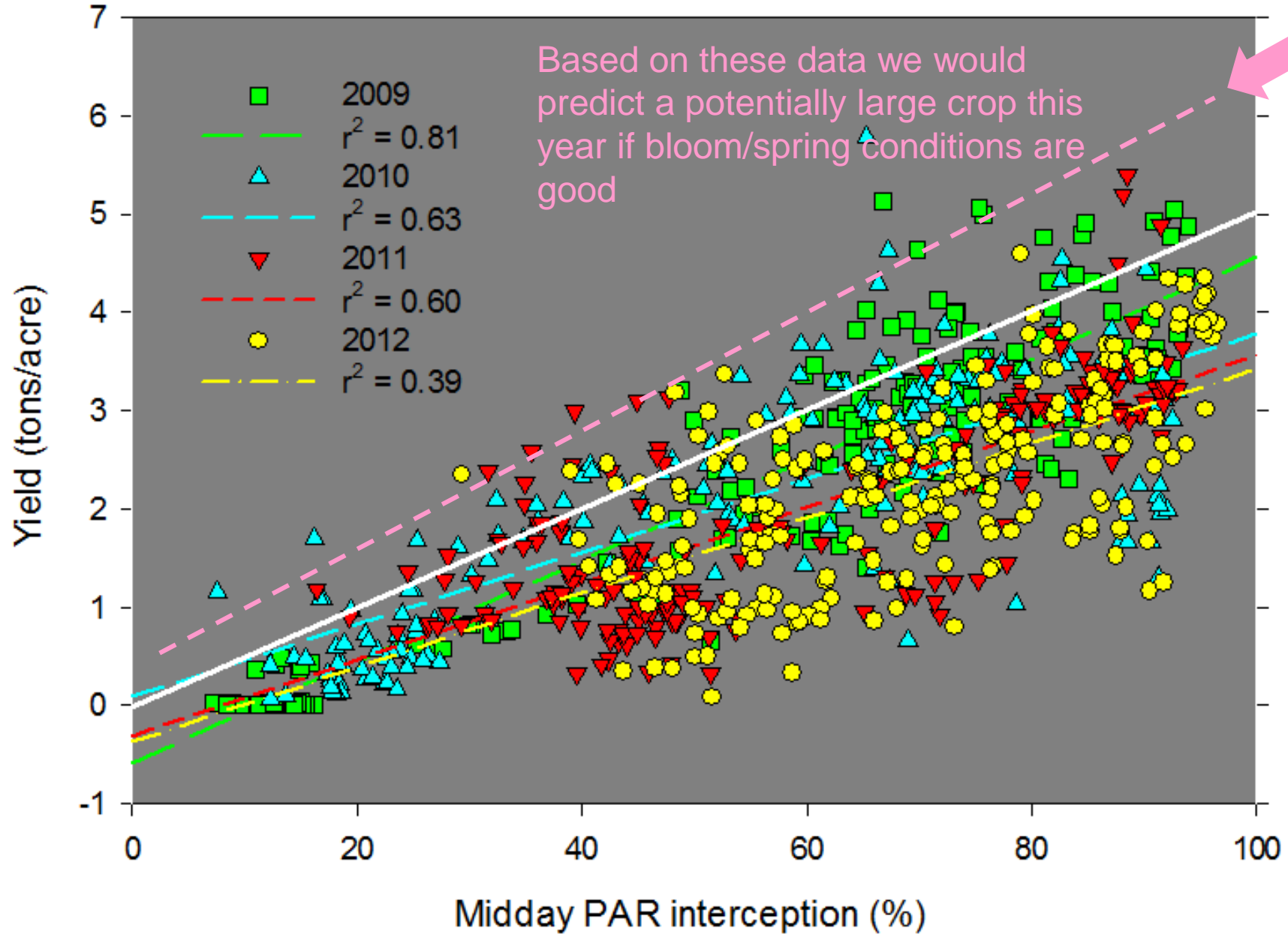


Potential production is about 100 in-shell pounds/acre (0.05 tons/acre) for each 1% of the total midday PAR you can intercept



Year	Orchard age (years)	Midday PAR interception (%)	Yield (tons/ac)	Yield per unit PAR intercepted
2009	9	81.8 b	4.60 a	0.056 a
2010	10	84.5 ab	3.91 a	0.046 b
2011	11	86.4 a	4.38 a	0.051 ab
2012	12	89.8 a	4.47 a	0.050 a
4 year average =		85.6	4.34	0.051

All walnut data 2009-2012



Conclusions

- Although you can potentially get higher yields in years 3-8 with higher density plantings, ultimately the highest yields come from more traditional spacings with minimal pruning
- Yield per unit light intercepted is always lower when any pruning or hedging takes place
- 7 year Howard pruning trial and 5 year Chandler pruning trial have shown no benefits to pruning
- Each pruning cut tends to generate more work for the next 1-4 years
- Pruning tends to result in increased potential for limb breakage when pruning eventually stops
- Mechanical hedging can result in decent but not high yields and decreased quality
- More work is needed on managing canopy in mature orchards