Canopy Management- Managing Orchards to Maximize Yield and Quality

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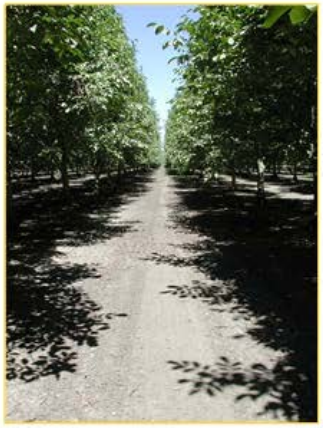
~10% midday light interception



~70% midday light interception

~45% midday light interception

~30% midday light interception

~90% midday light interception

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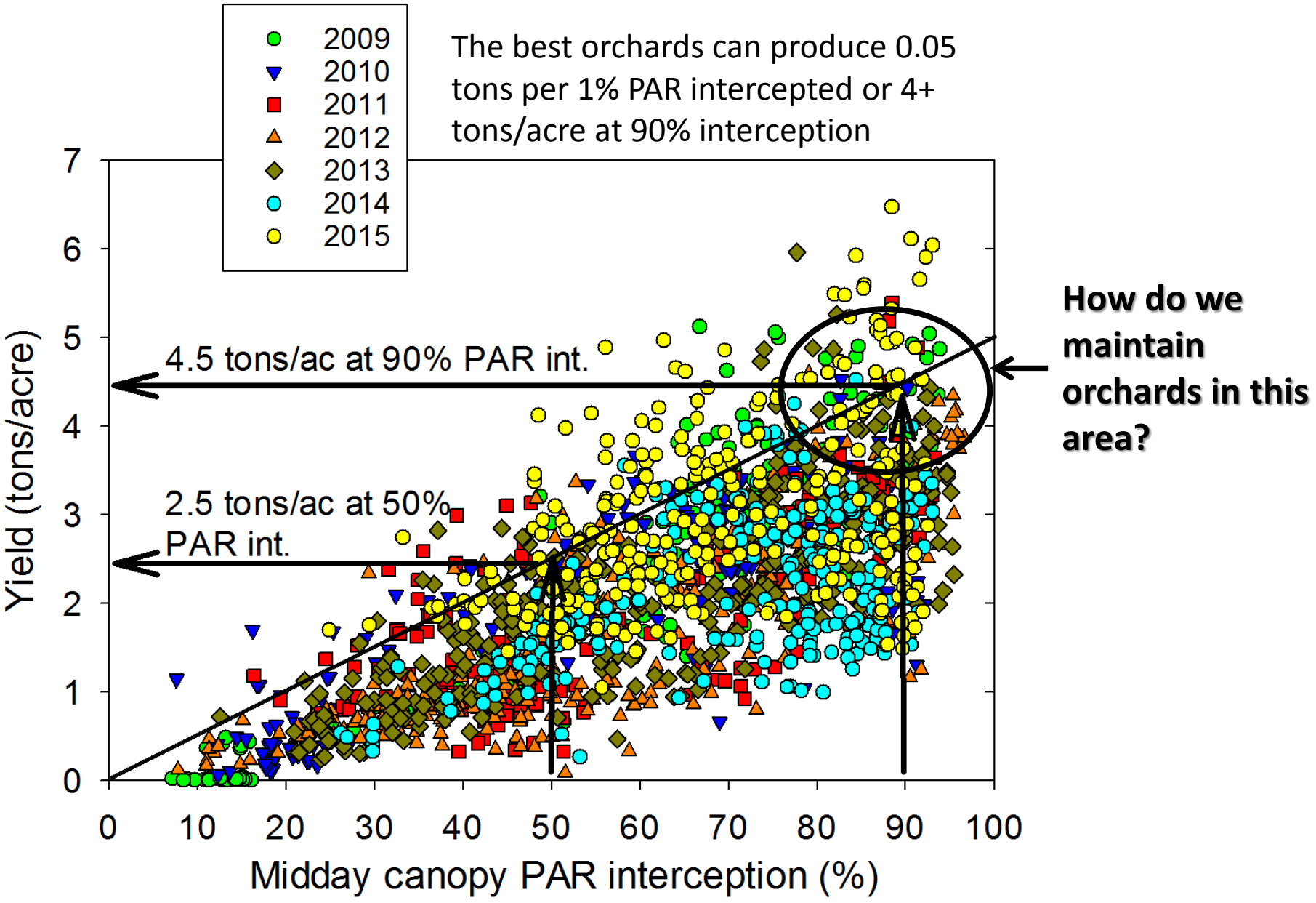
Agriculture and Natural Resources

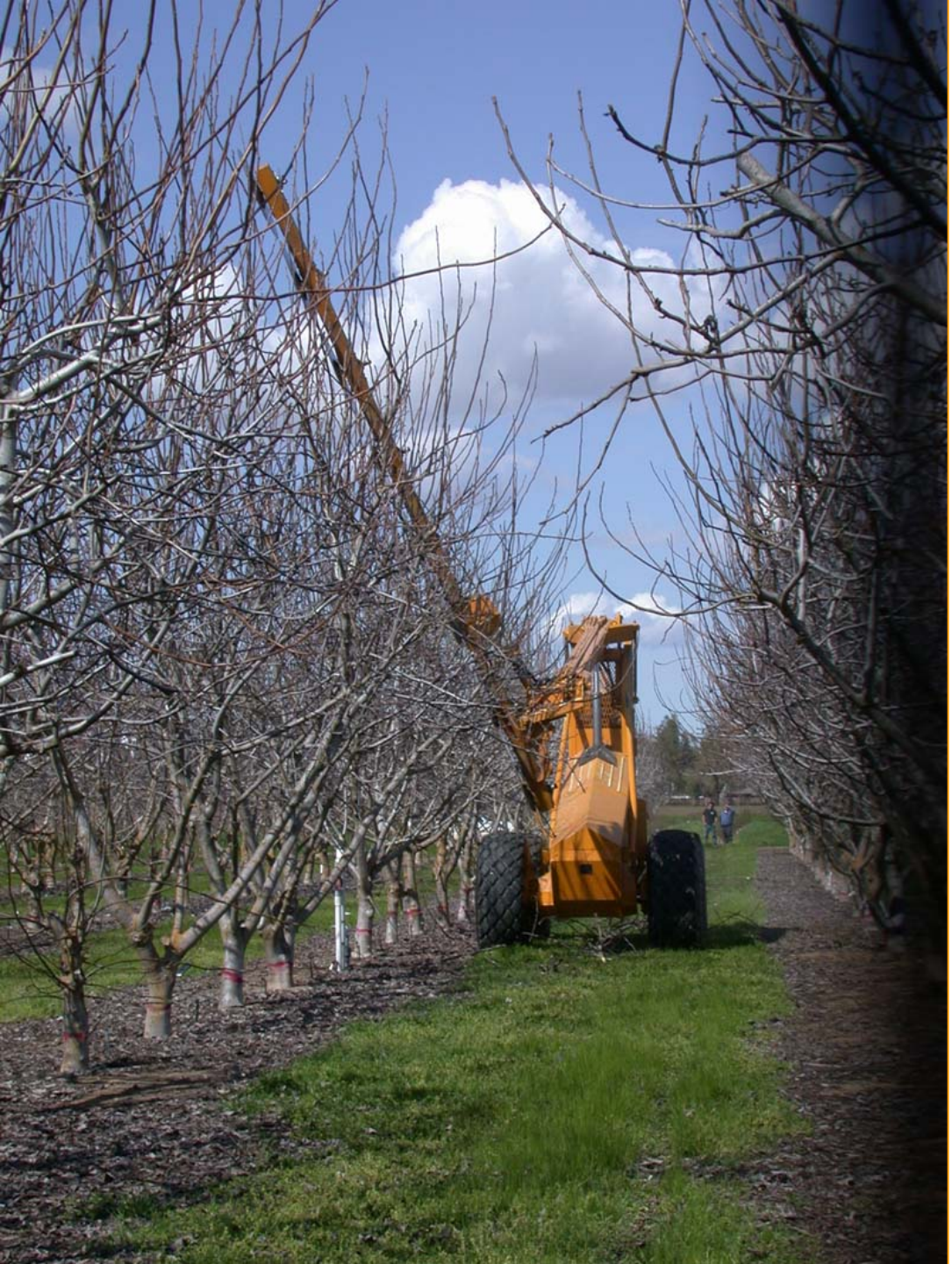
Managing canopy size to maximize yield and quality



Hedgerow versus traditional square planting

Chandler 15’ x 22’ hedgerow

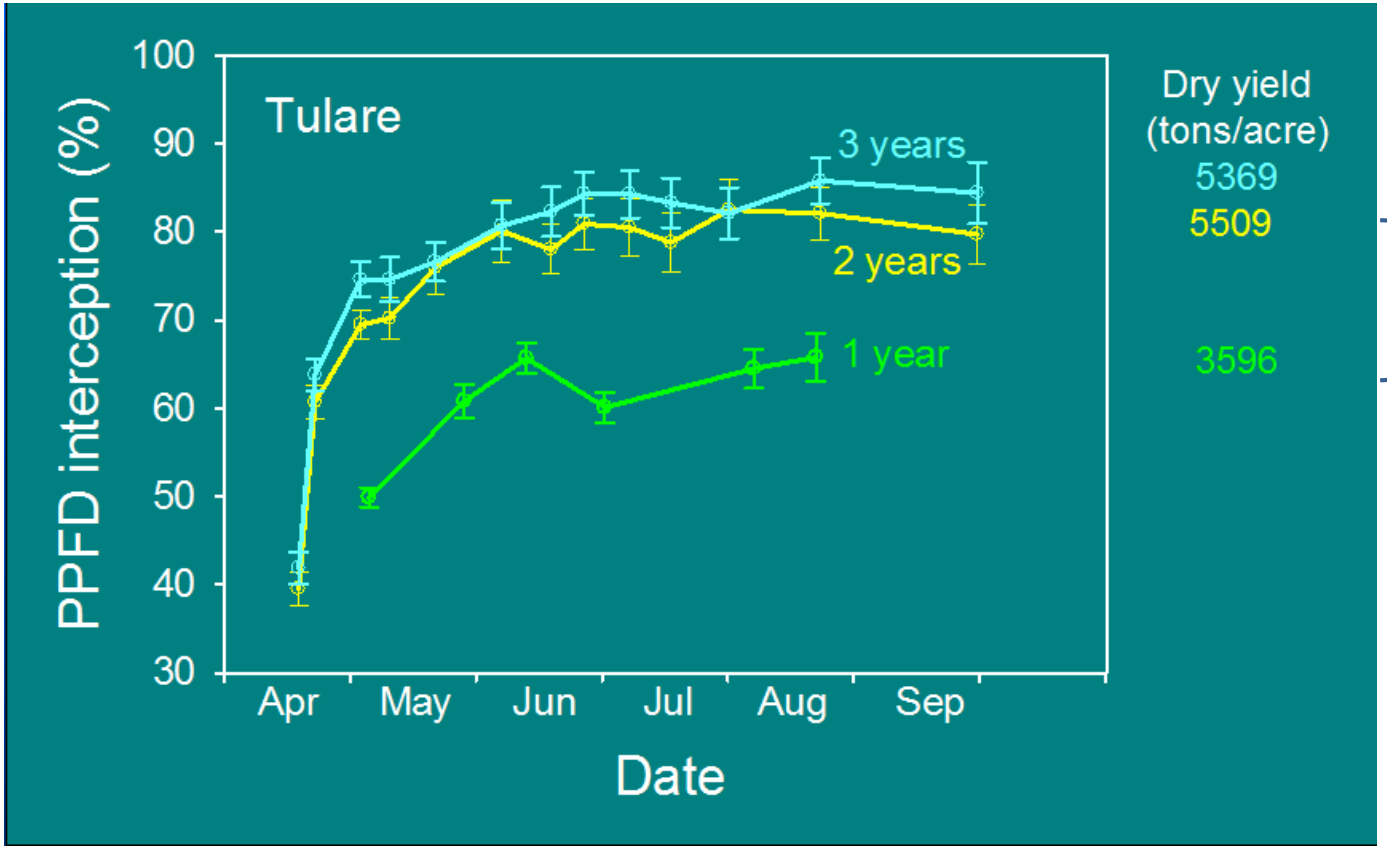
Chandler 34’ x 34’ traditional



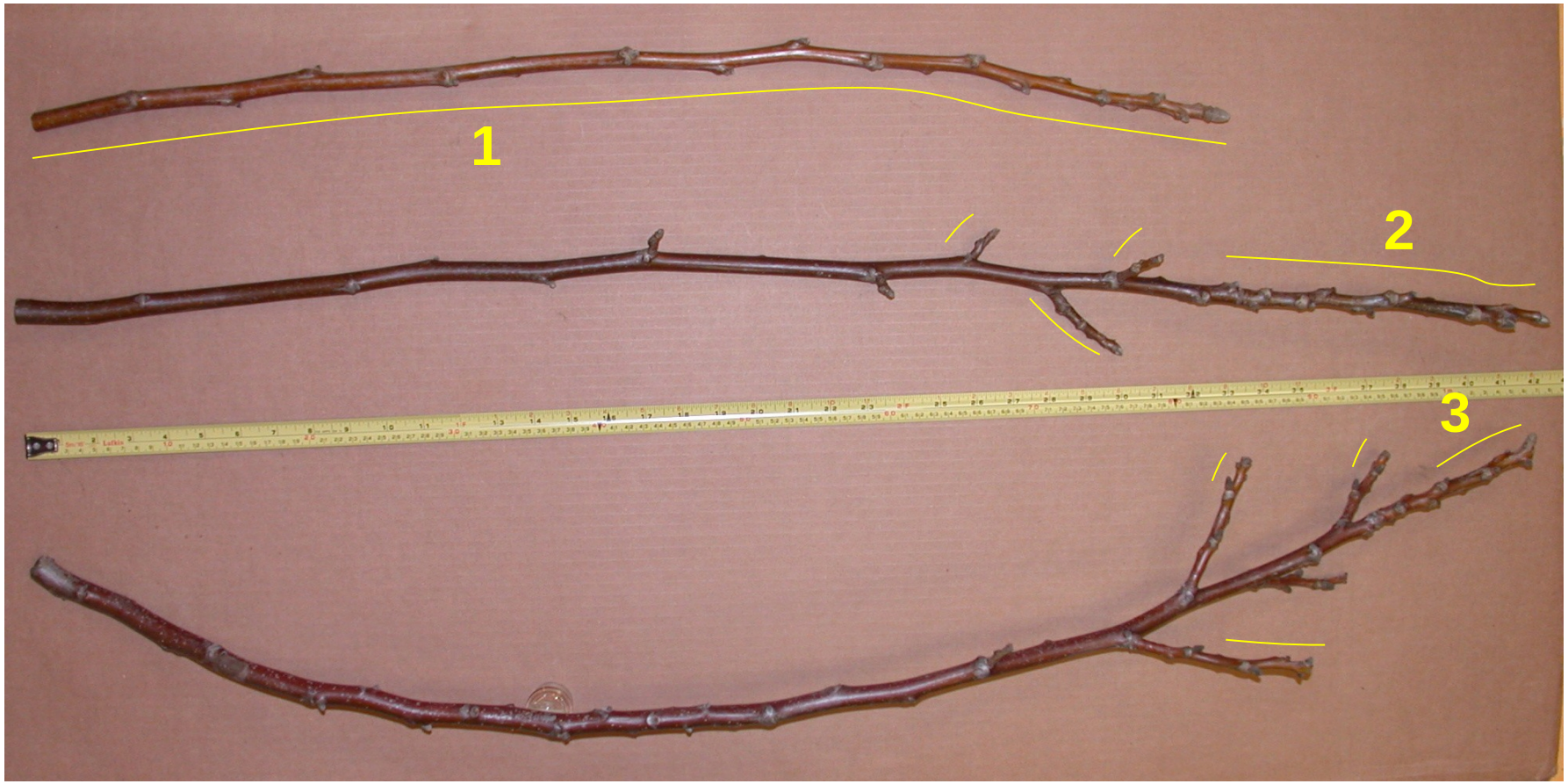
Is mechanical hedging beneficial?

Measured shoot growth in response to hedging on Tulare and Howard hedgerows

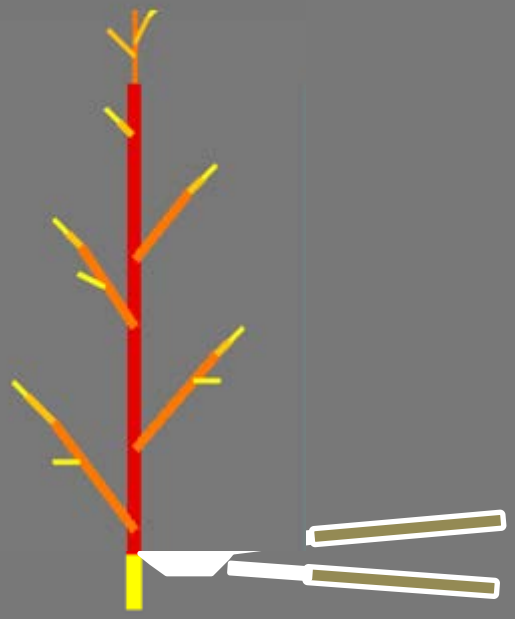
Tulare growth and yield responses to mechanical hedging Solano County 2003



20% decrease in PAR interception = 1 ton/acre loss


1
2
3

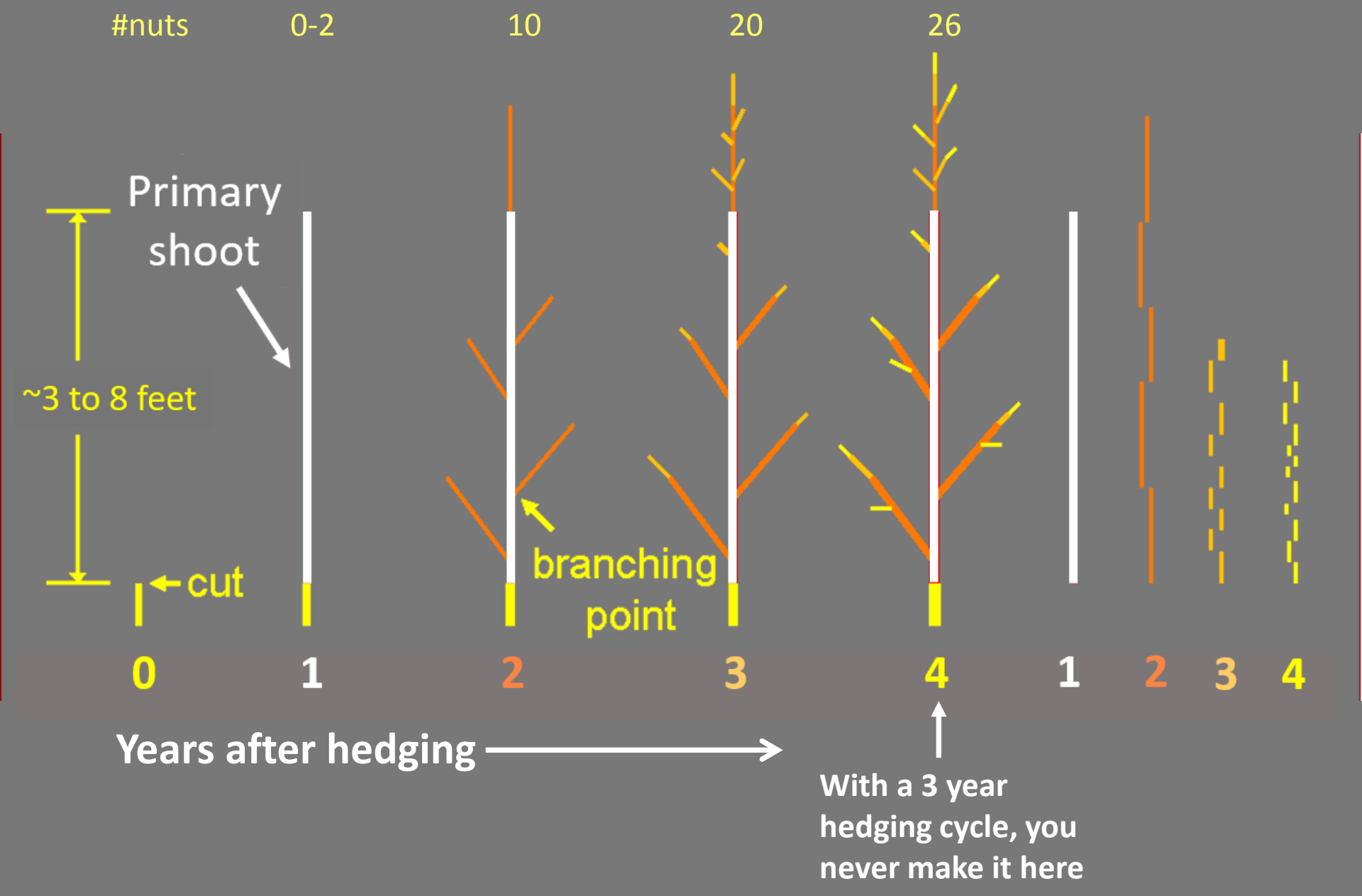
#nuts 0-2 10 20 26



0 1 2 3 4 1 2 3 4

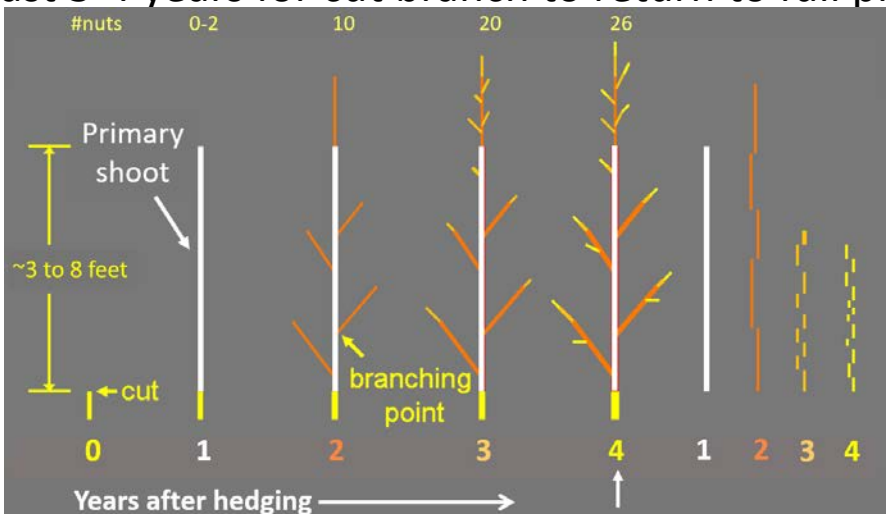
Years after hedging →

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


#nuts
0-2
10
20
26
Primary shoot
~3 to 8 feet
cut
branching point
0
1
2
3
4
1
2
3
4
Years after hedging
With a 3 year hedging cycle, you never make it here

11.5’ x 24’ Tulare hedgerow (Reil and Lampinen, 2004)

It took at least 3-4 years for cut branch to return to full production



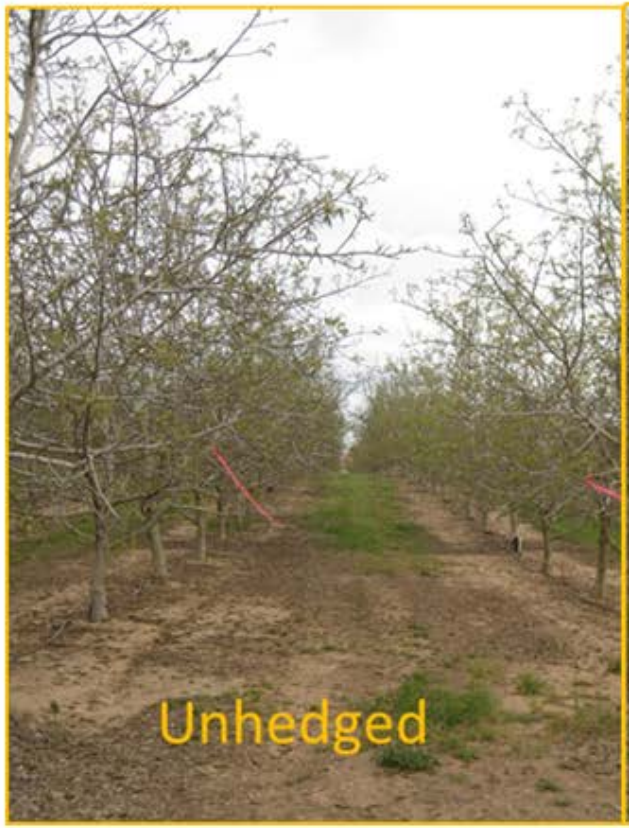
11’ x 22’ Chandler hedgerow (Kelley and Ramos, 1997)

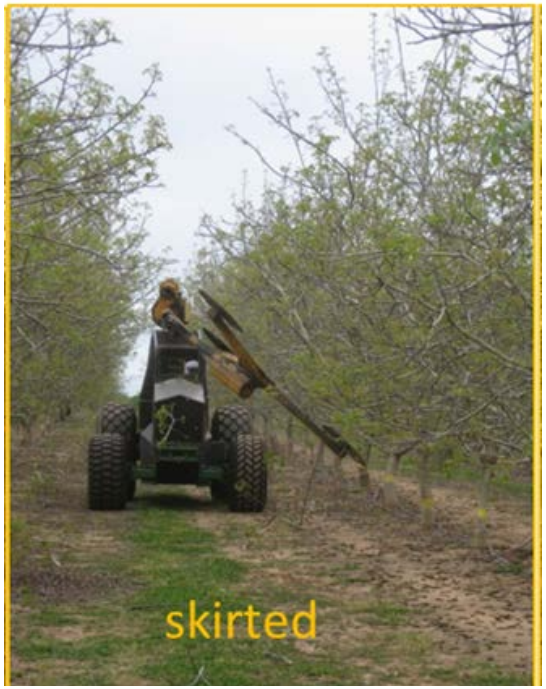
It took 3 years for hedged rows to return to precut yields

Hedging interval	Type of growth/ bearing	1996 yield	1997 yield	Mean % increase over 1st year
Year 1	New shoots	3243 b	3831 c	---
Year 2	Lateral buds	4594 a	5244 b	40
Year 3	one-year old spurs	5097 a	**6540 a**	64
Year 4	Two-year old spurs	4636 a	5620 b	45

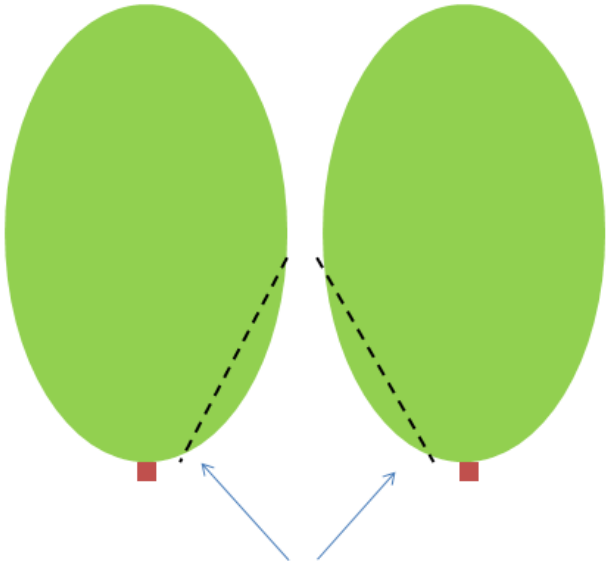
Nickels Howard Hedging/skirting Trial

Bruce Lampinen, Samuel Metcalf, Bill Stewart, John Edstrom and Franz Niederholzer

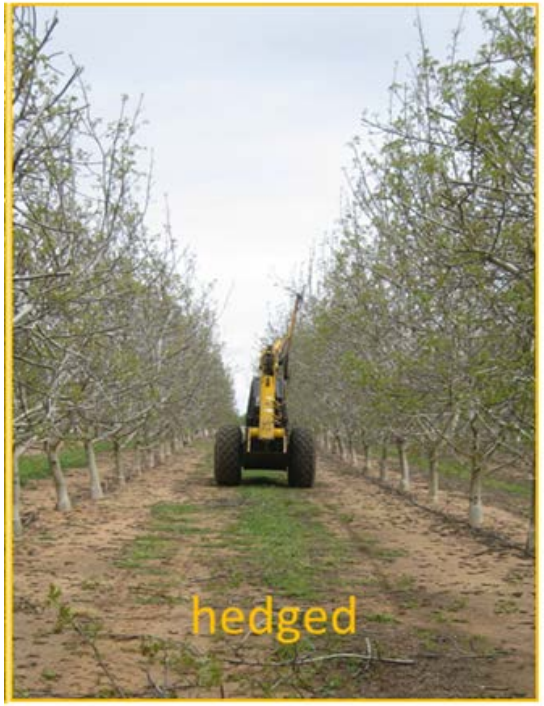




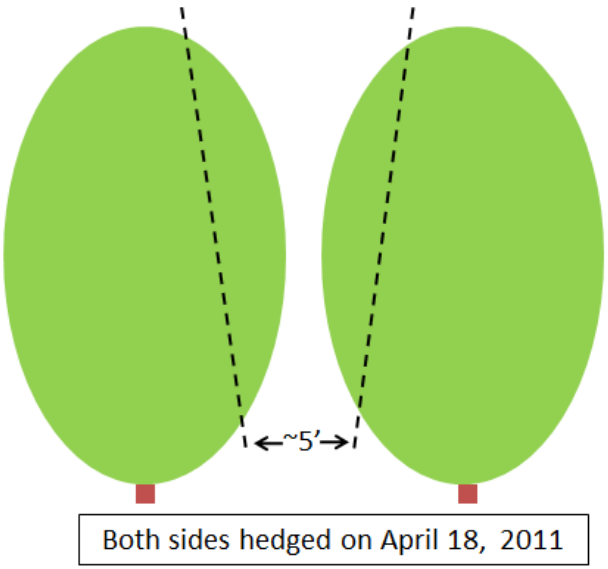
Skirted



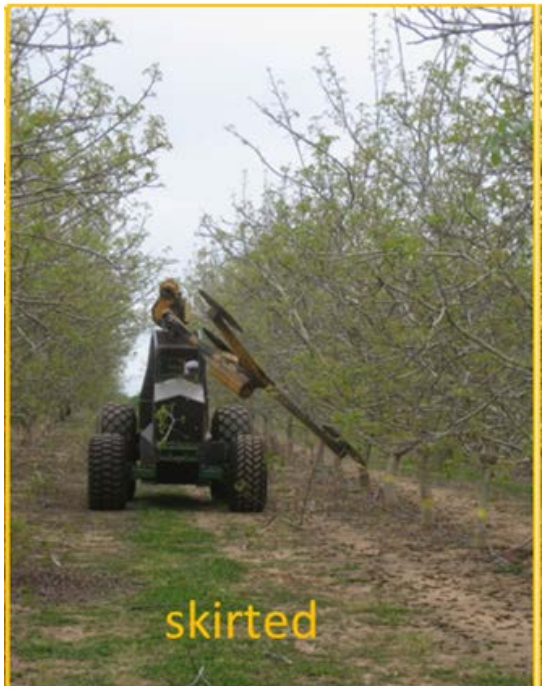
both sides skirted on May 18, 2011



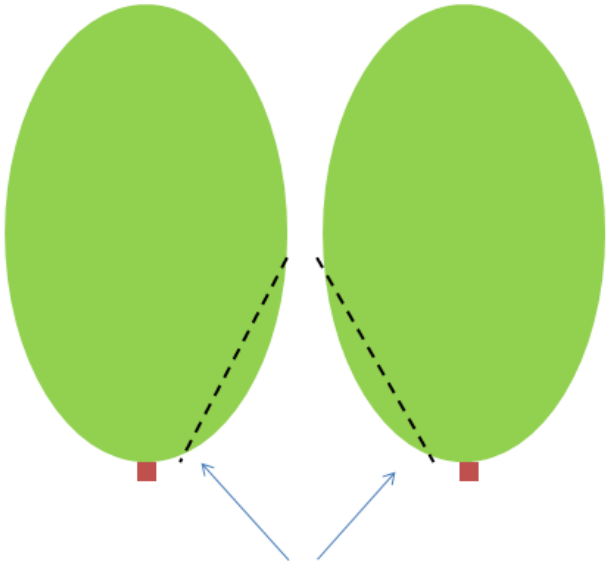
Hedged



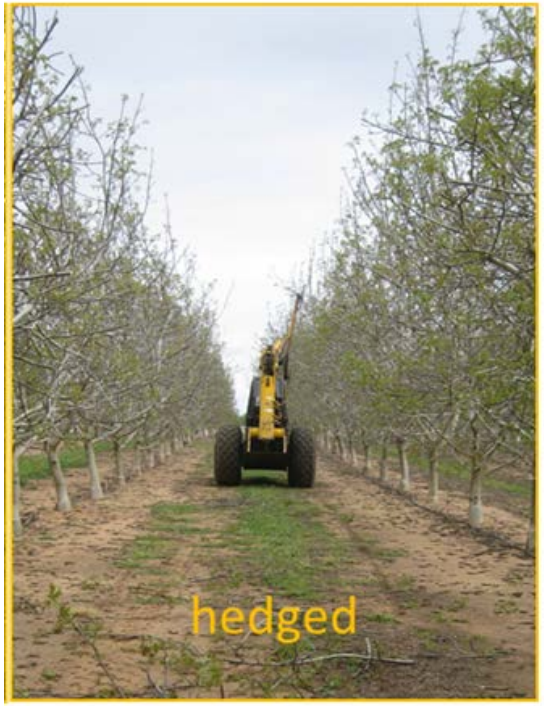
Both sides hedged on April 18, 2011



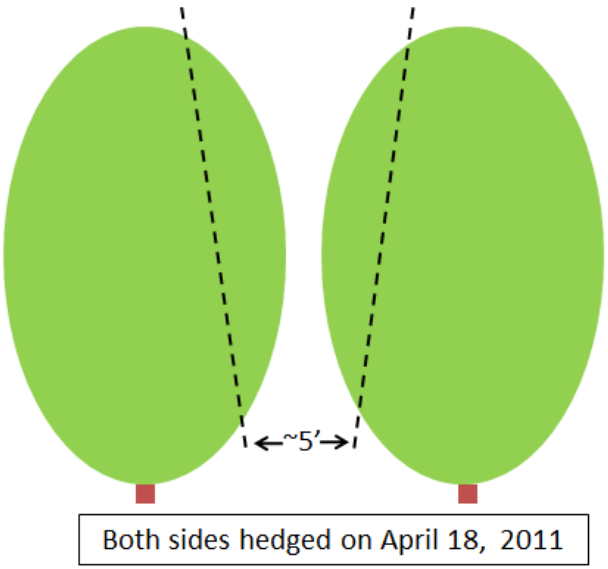
Skirted



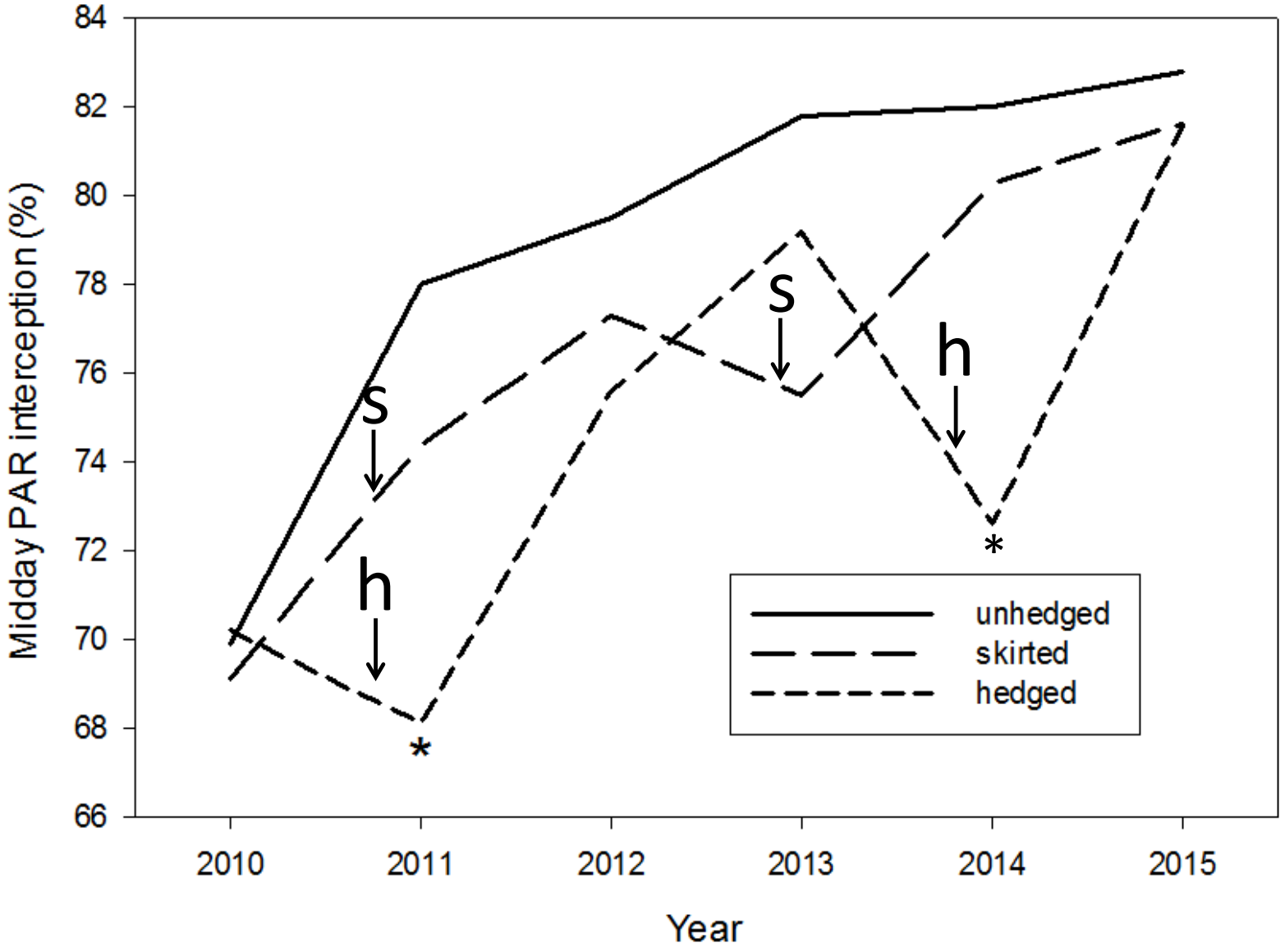
both sides skirted on May 18, 2011

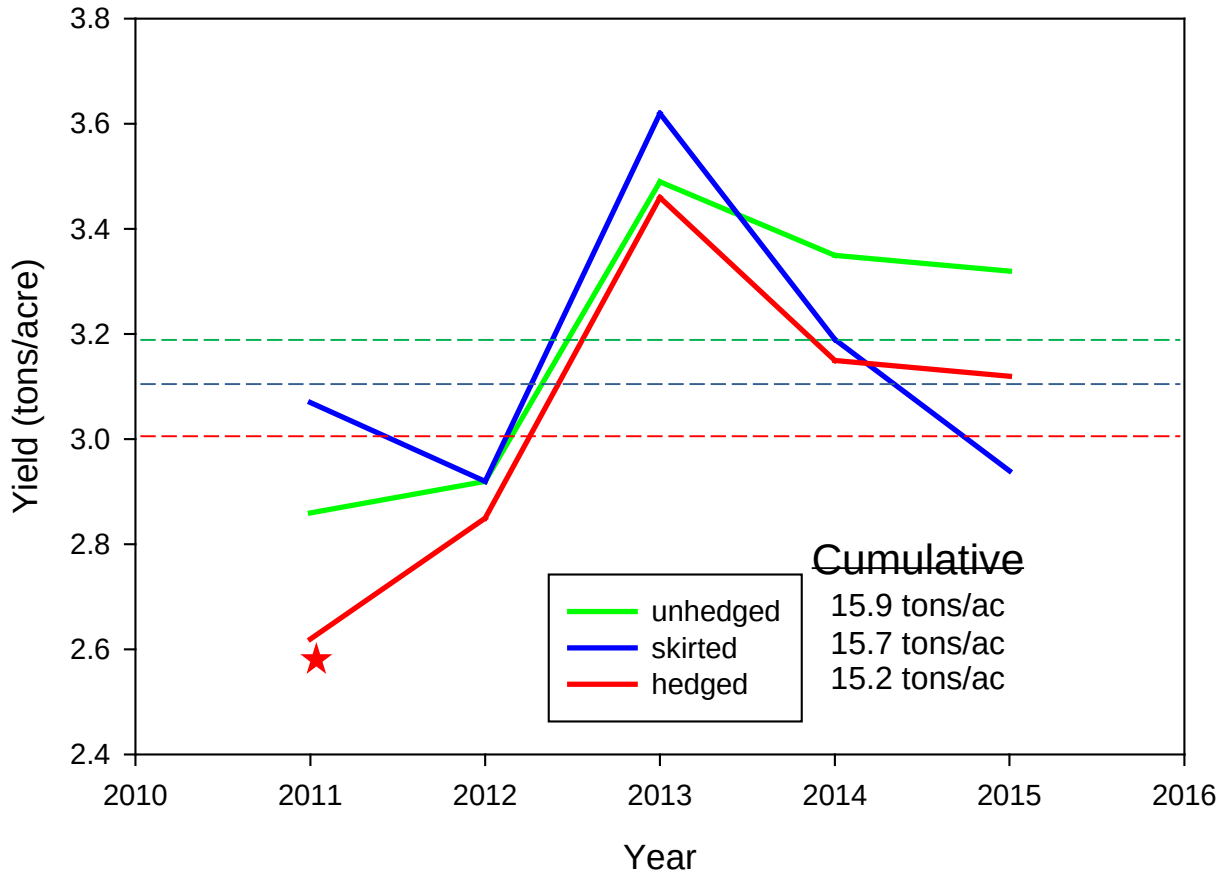


Hedged



Both sides hedged on April 18, 2011


Midday PAR interception (%)
84
82
80
78
76
74
72
70
68
66
2010
2011
2012
2013
2014
2015
Year
s
h
s
h
*
*
unhedged
skirted
hedged

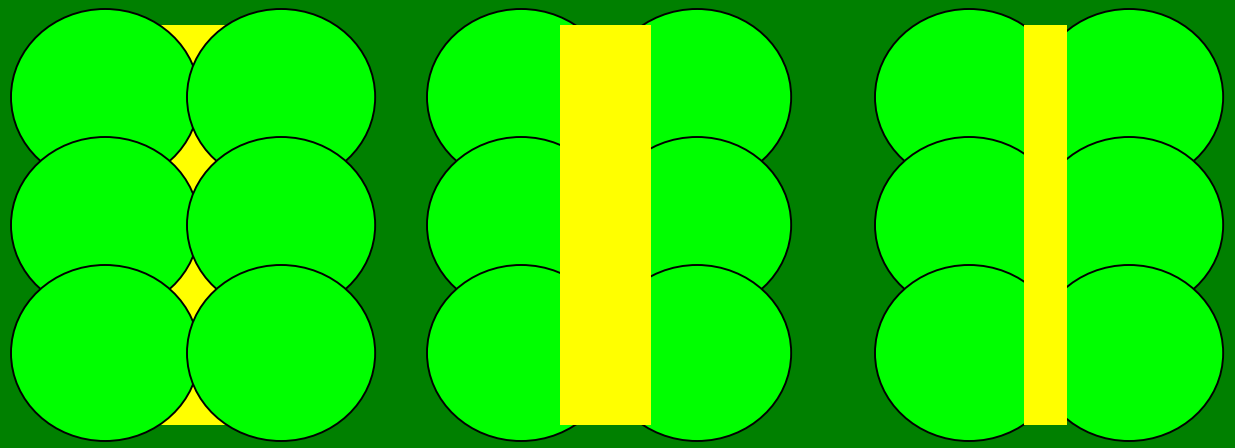

3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
Yield (tons/acre)
2010
2011
2012
2013
2014
2015
2016
Year
unhedged
skirted
hedged
Cumulative
15.9 tons/ac
15.7 tons/ac
15.2 tons/ac

Treatment	Fresh pruning weight (lb/tree)
T1- unhedged	0 c
T2- skirted	1.2 b
T3- hedged	8.2 a

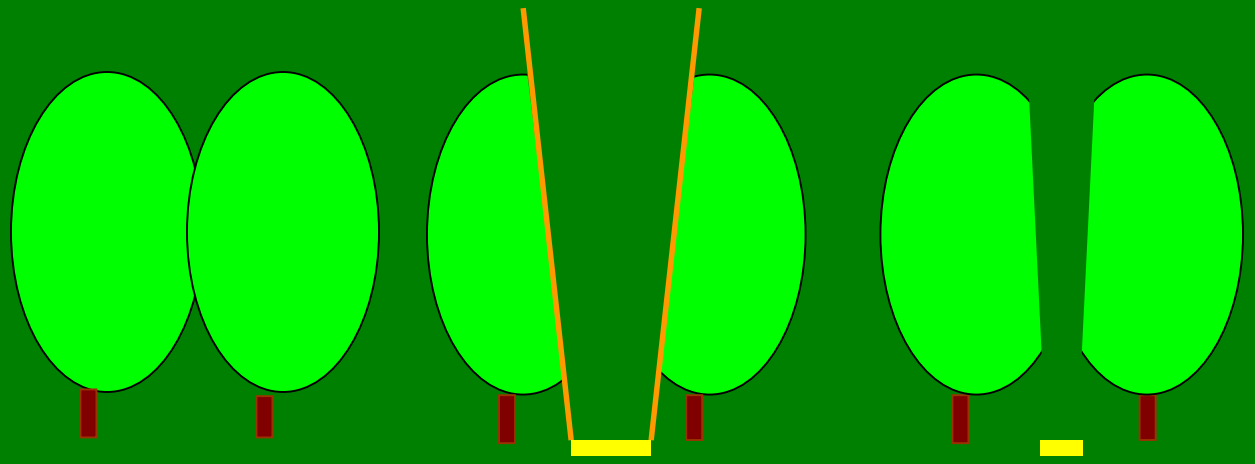
Quality problems tend to be worse in mechanically hedged orchards since weak buds that were produced in shaded areas one year are exposed to full sun the year after hedging (this will be discussed in more detail in the Orchard Management Impacts on Quality talk on Wednesday)

High density

top view



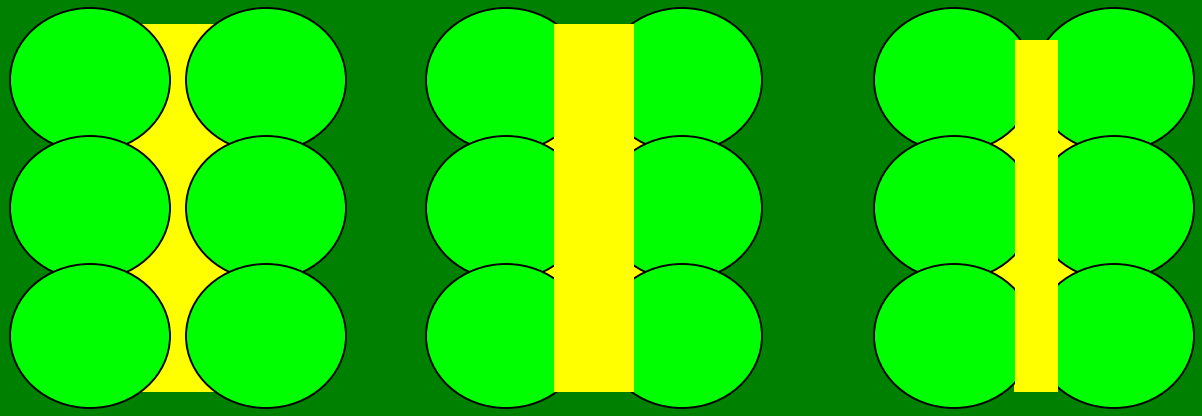
side view



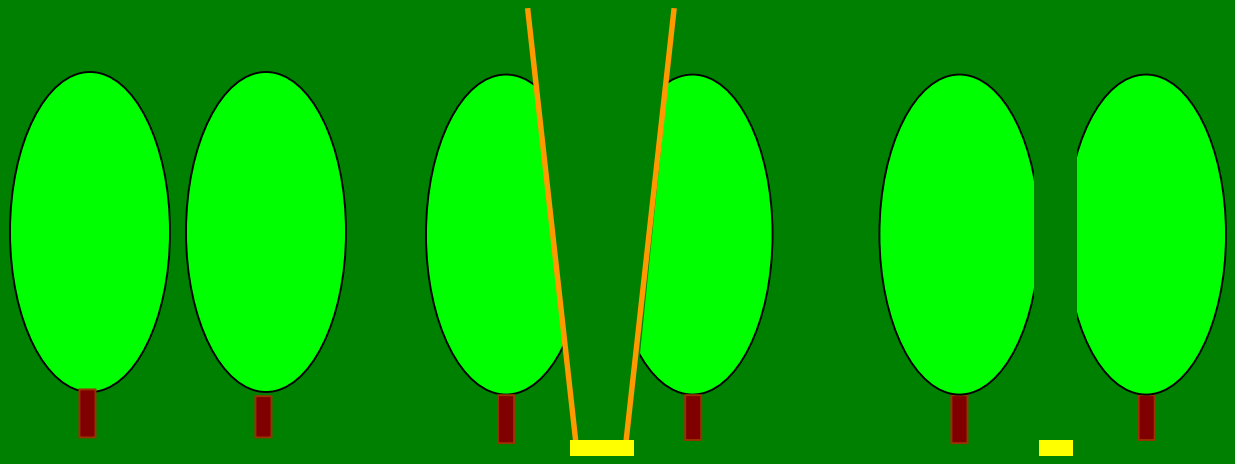
	before hedging	after hedging	one year later	3 yr ave.
PAR int.	85%	70%	80%	78%
Yield potential	~~4.2 tons~~ 3.6 tons/ac	~~3.2 tons/ac~~ 2.4 tons/ac	~~4.0 tons/ac~~ 2.9 tons/ac	~~3.9~~ 3.0

Moderately high density

top view



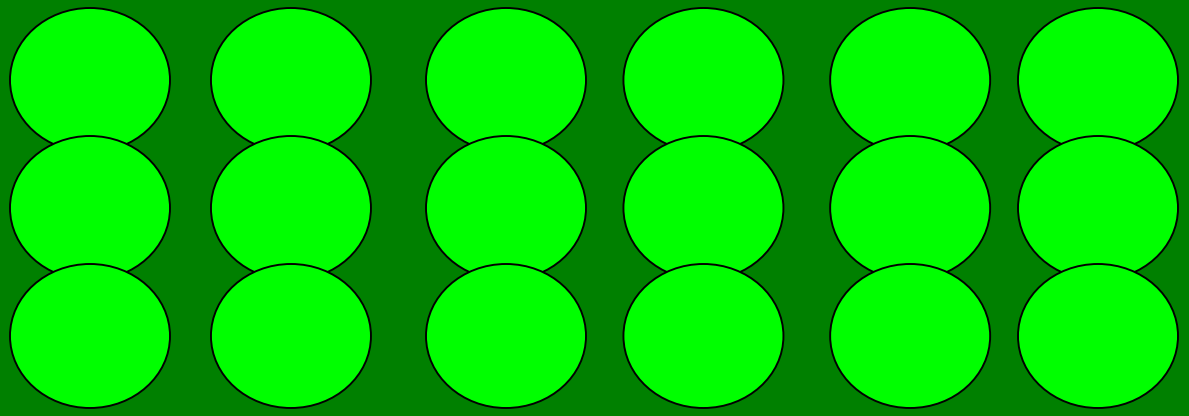
side view



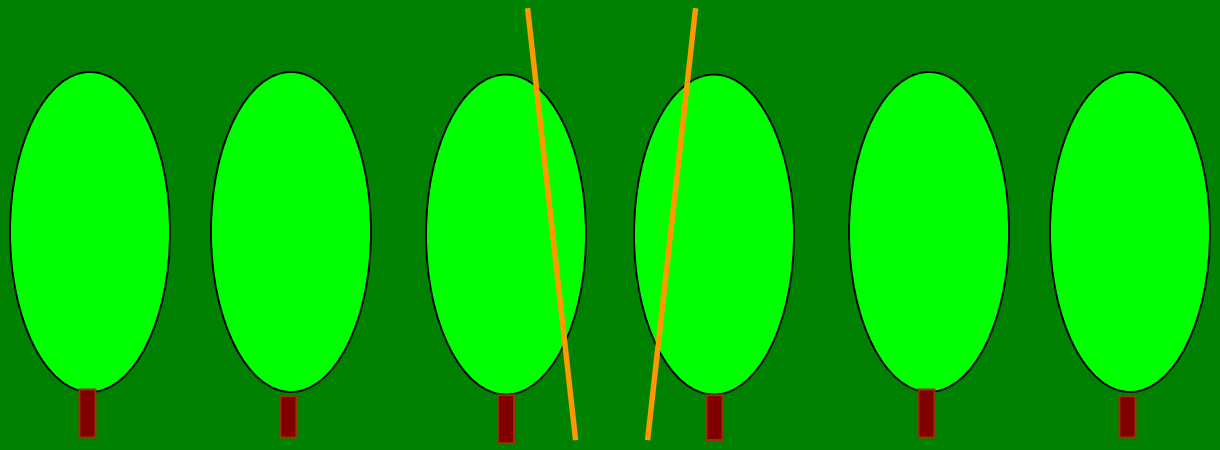
	before hedging	after hedging	one year later	3 yr ave.
PAR int.	80%	65%	75%	73%
Yield potential	~~4.0 tons/ac~~ 3.4 tons/ac	~~2.7 tons/ac~~ 2.5 tons/ac	~~3.7 tons/ac~~ 2.8 tons/ac	~~3.6 tons/ac~~ 2.9 tons/ac

Slightly lower density with no hedging

top view



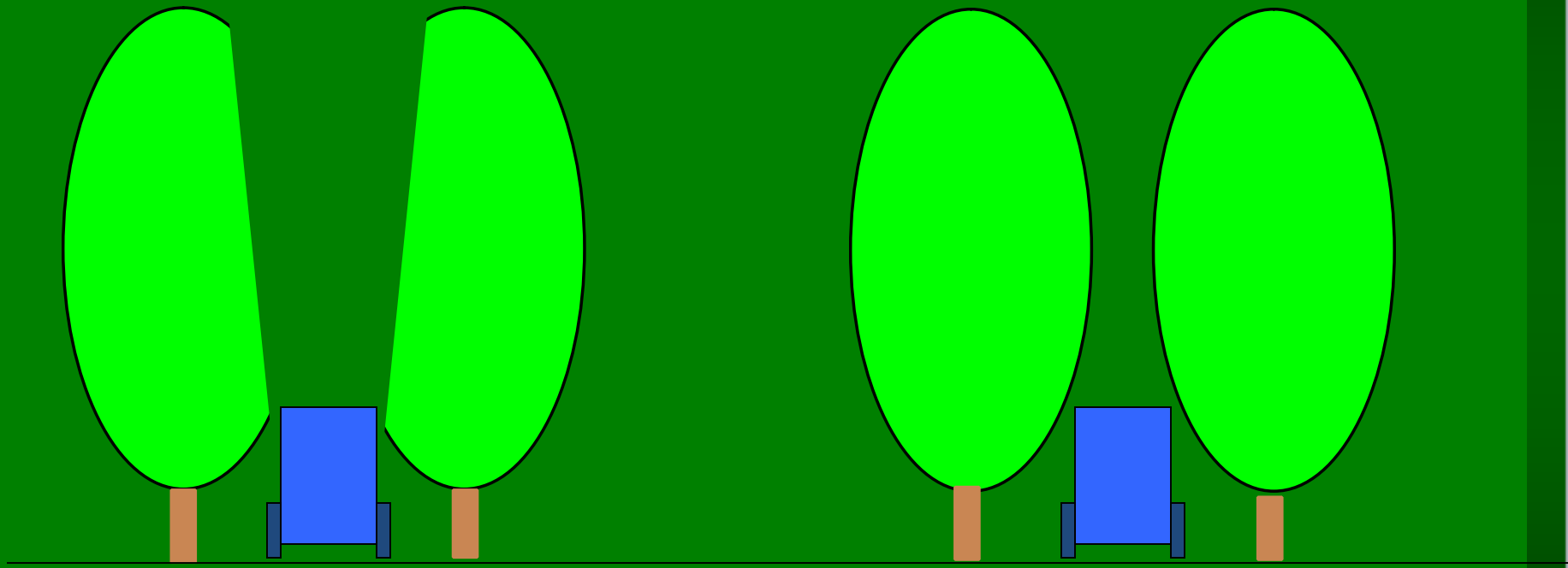
side view



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

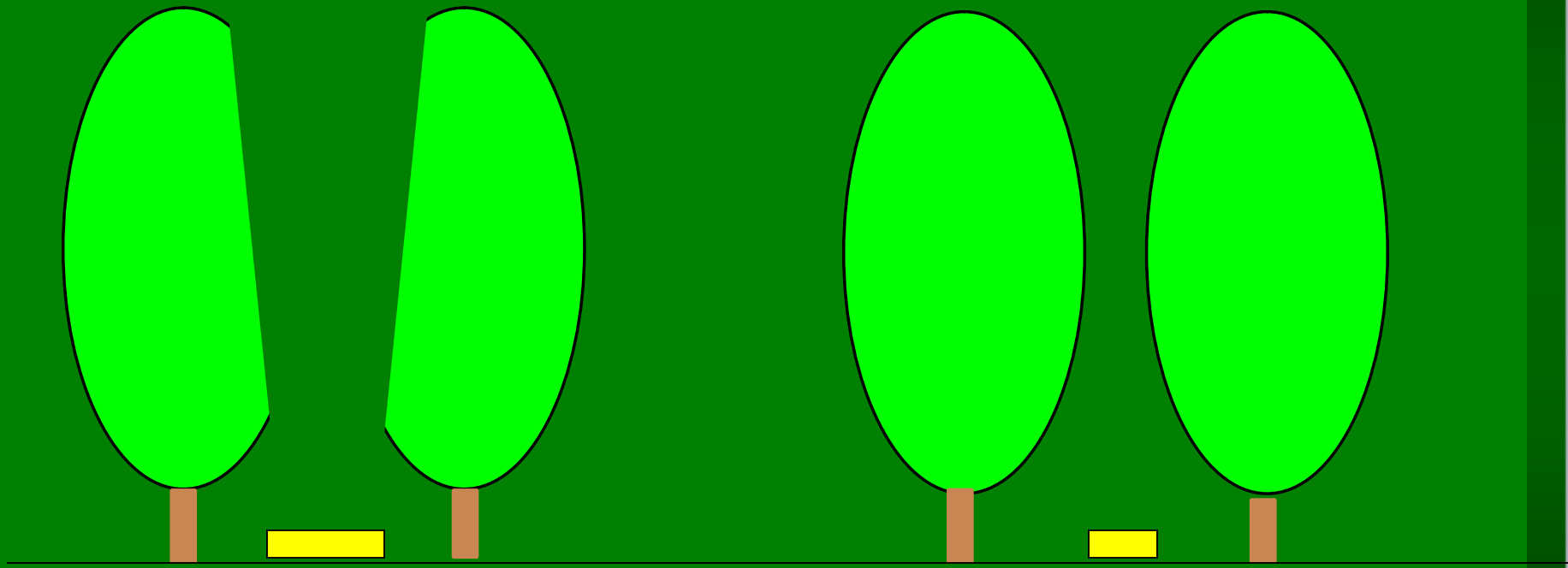
Moderate density with hedging

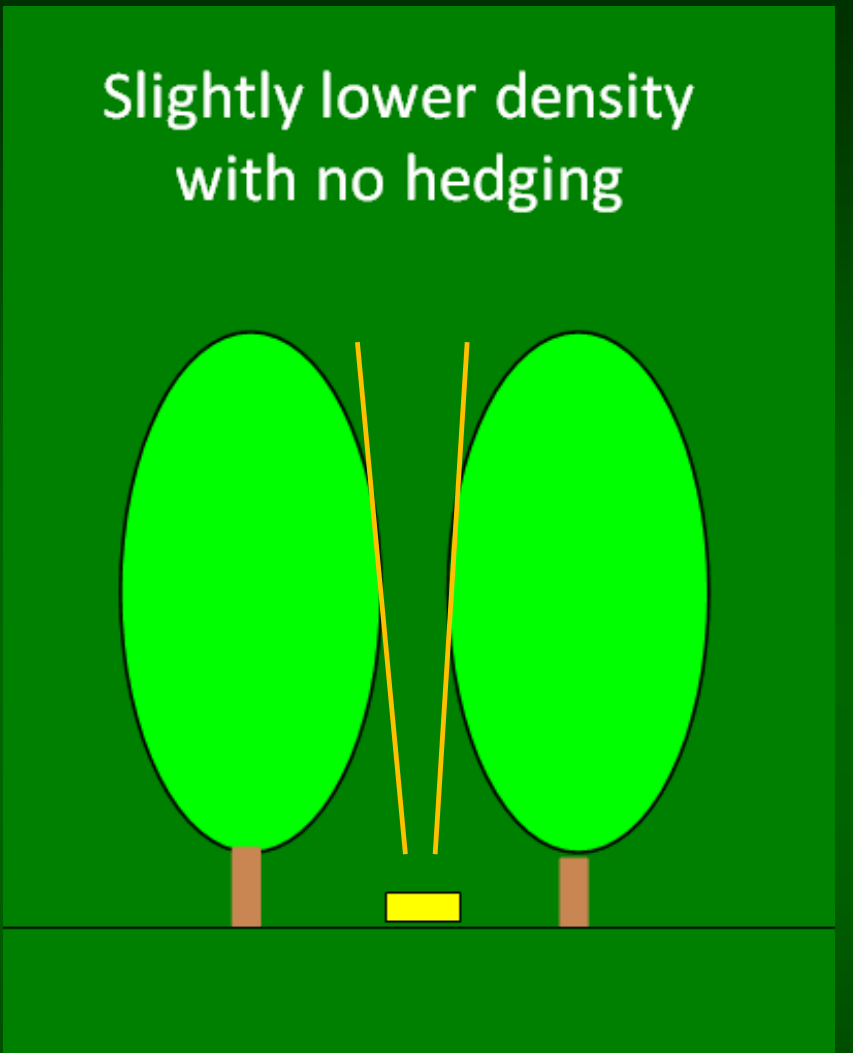
Slightly lower density with no hedging



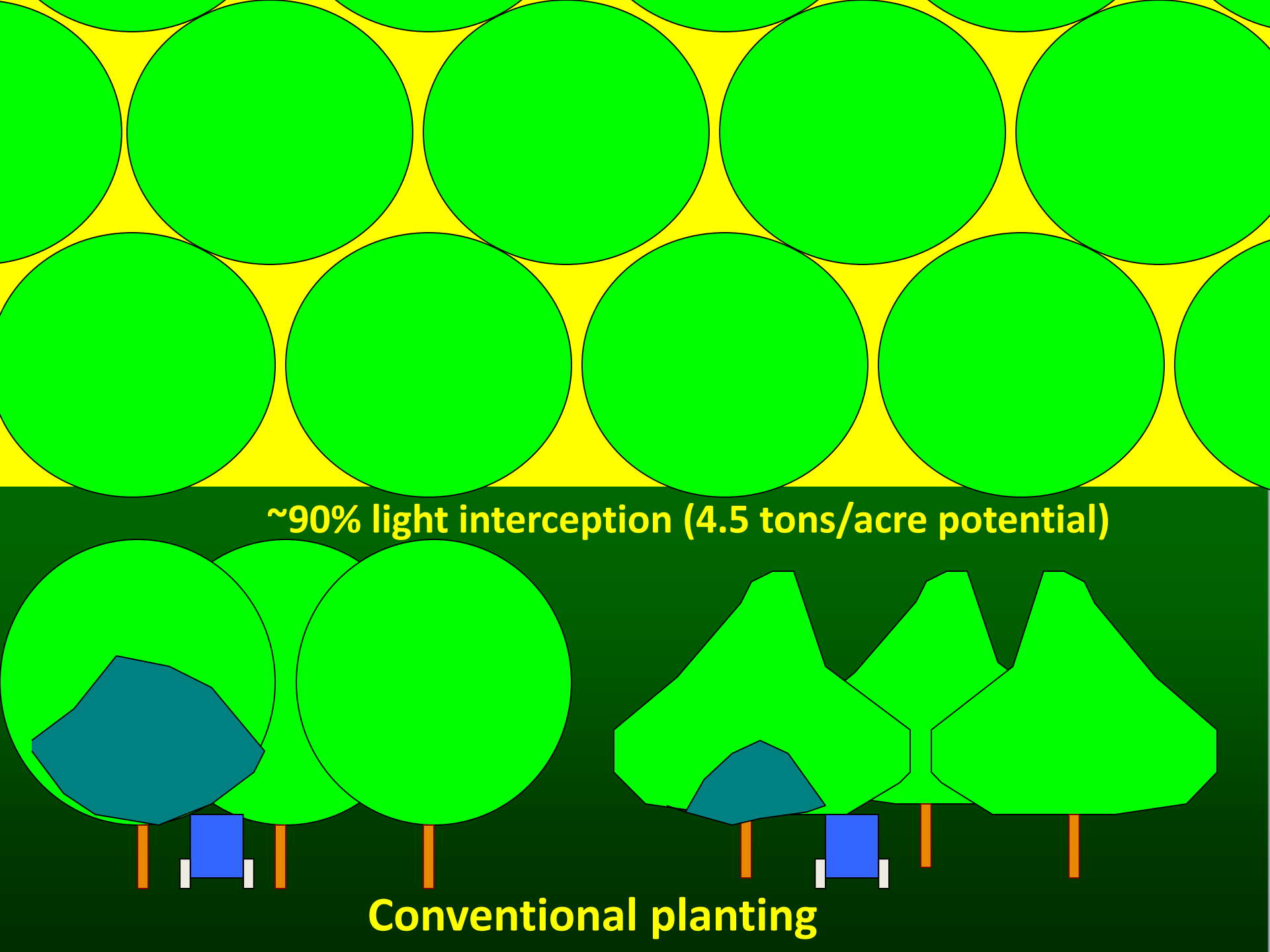
Moderate density with hedging

Slightly lower density with no hedging





The ideal hedgerow is one where the hedger just misses the trees
(but yields will still be lower than a traditional planting)


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

Summary of 4 scenarios

Scenario	Year 1	Year 2	Year 3	Average
High density	70% ~~3.2~~ 2.4	80% ~~4.0~~ 2.9	85% ~~4.2~~ 3.6	78%(int.) ~~3.9~~ (potential) 3.0 (actual)
Moderately high density	65% ~~2.7~~ 2.5	75% ~~3.7~~ 2.8	80% ~~4.0~~ 3.4	73% ~~3.6~~ (potential) 2.9 (actual)
Unpruned, slightly wider spacing	75% 3.75	76% 3.80	77% 3.85	76% 3.8
Conventional spacing	91% 4.55	92% 4.60	93% 4.65	92% 4.60

Pruning related problems

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

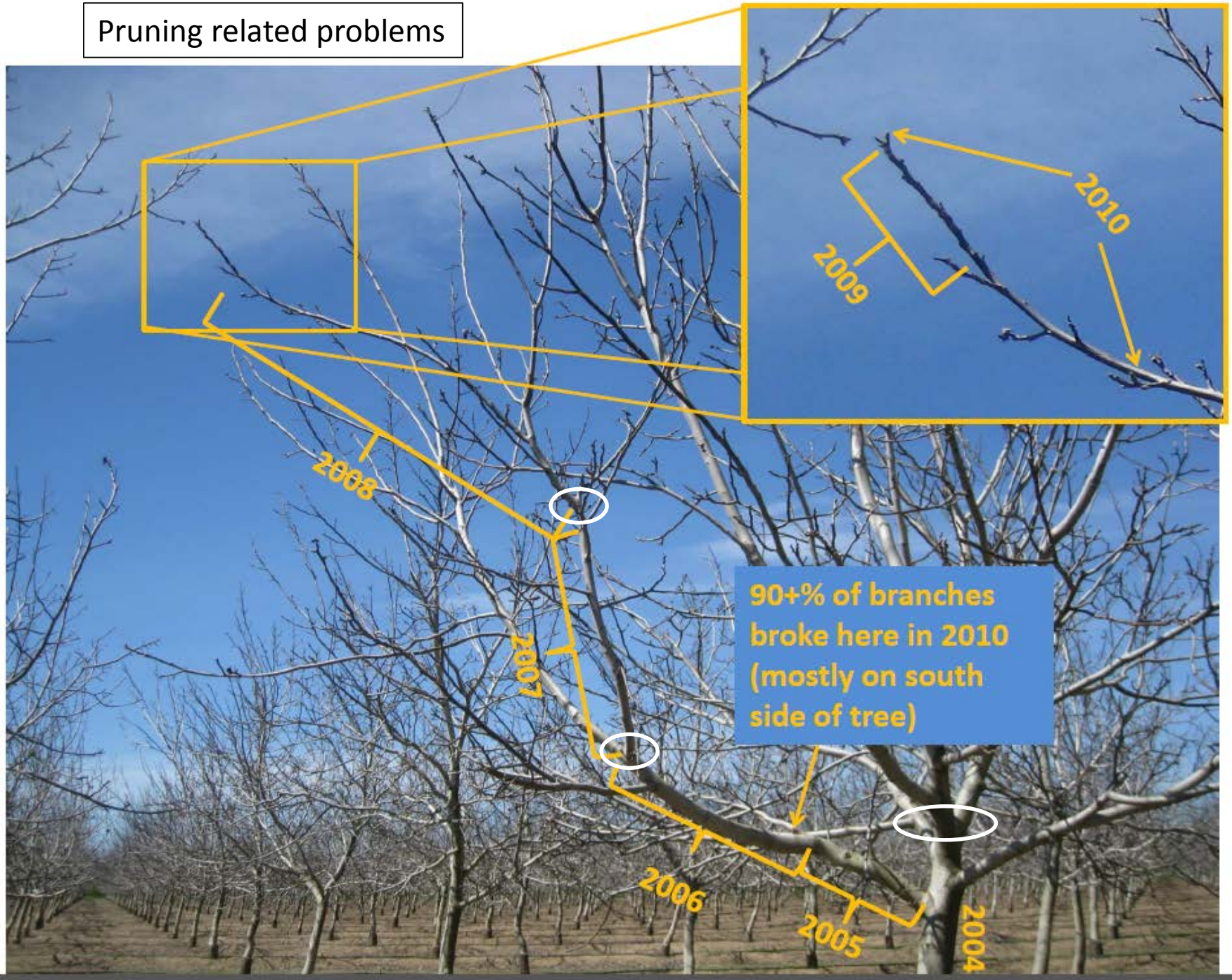
Pruning related problems

8/9/2005

5/3/2006

4/4/2011

Pruning related problems

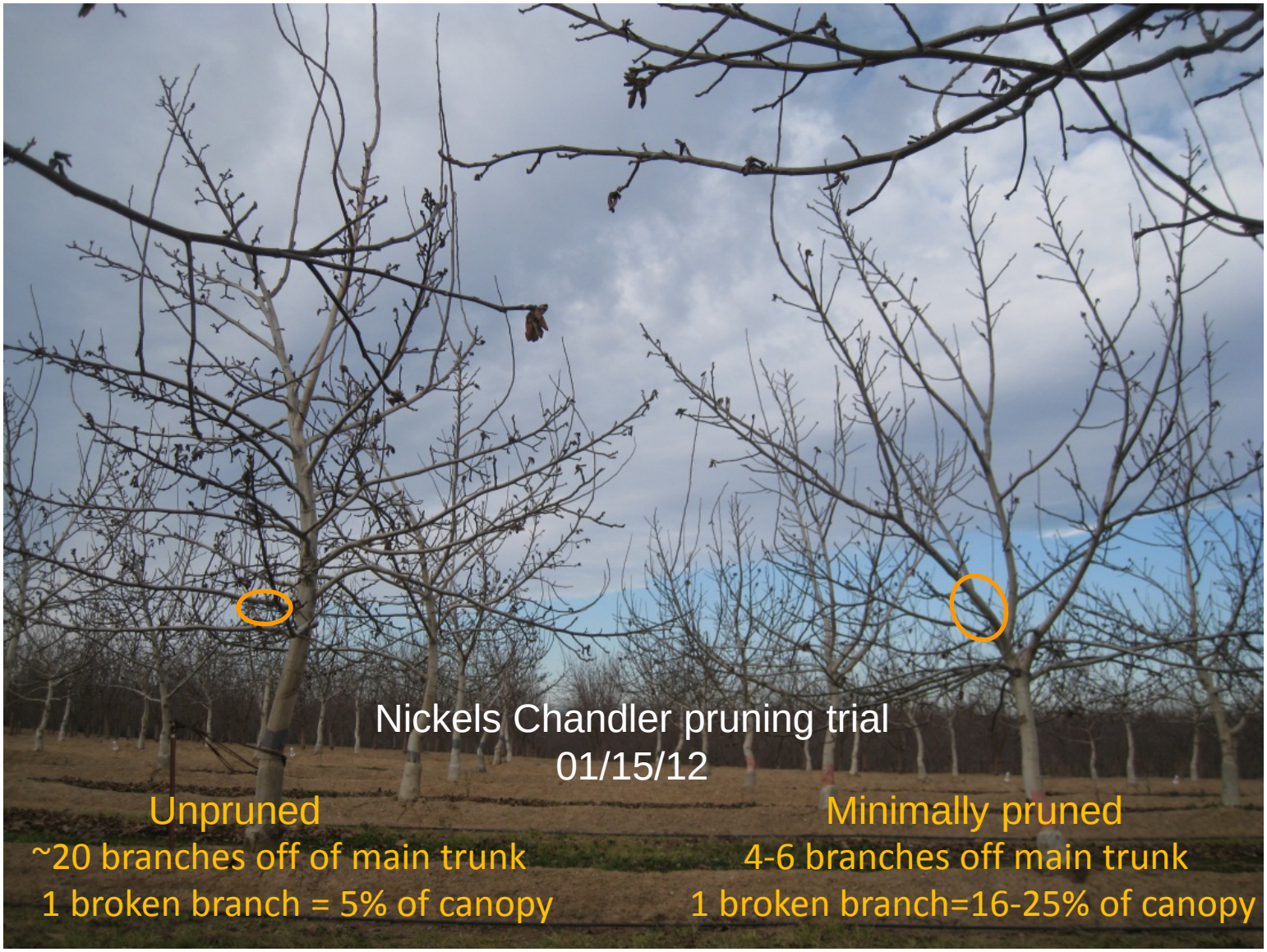


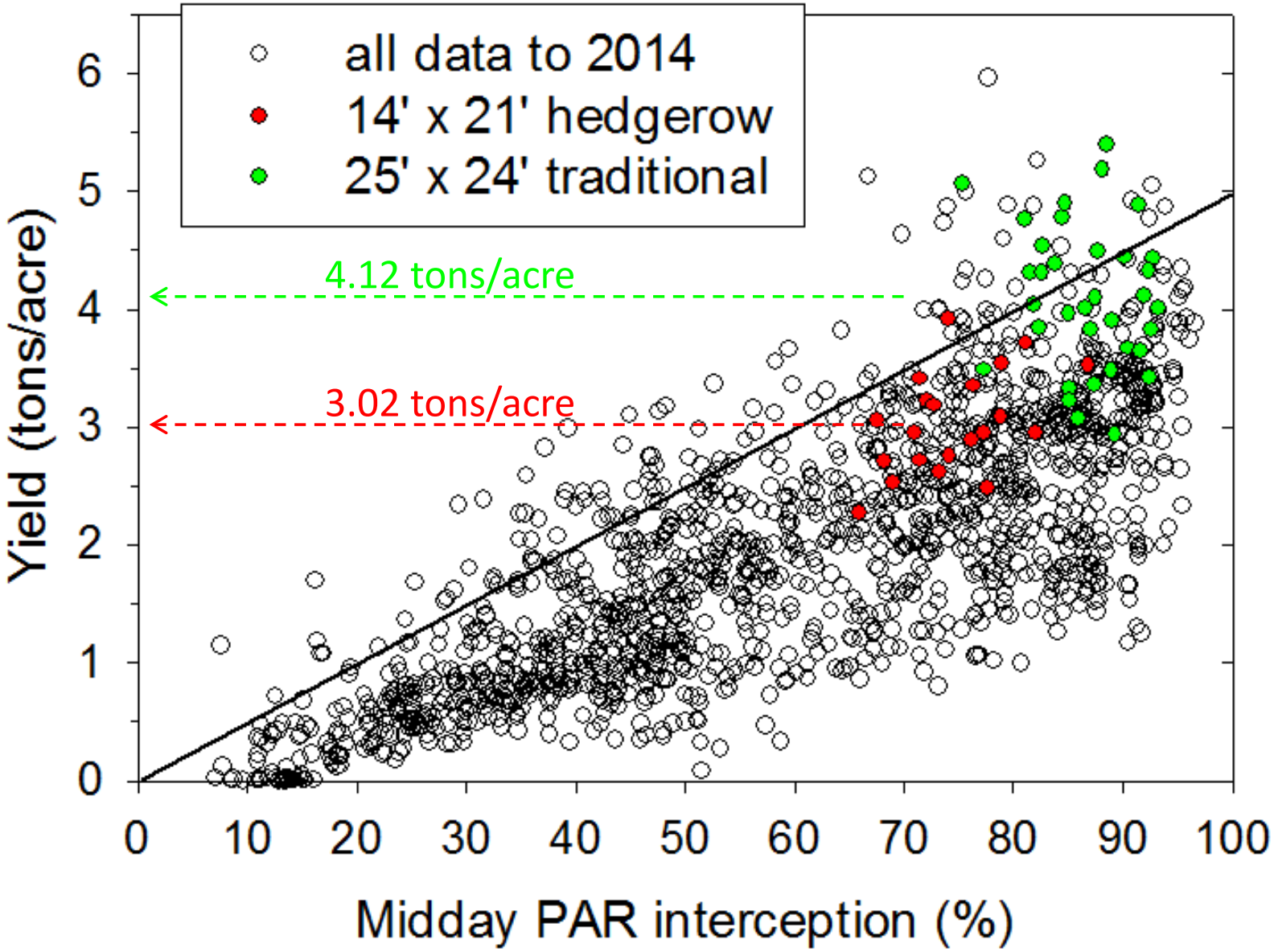

Pruning related problems
Pruned tree in Chandler pruning trial Nickels July 2012

Pruning related problems

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

Pruning related problems


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



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

Optimal Spacing

13 year old
14’ x 21’ Howard (on Paradox seedling) hedgerow
PAR interception ~70%
Yield ~ 3.0 tons/acre over last 5 years
(more quality problems)

13 year old
25’ x 24’ Tulare (on Paradox seedling) planting
PAR interception ~90%
Yield ~ 4.1 tons/acre over 5 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

It is important to consider soil type, rootstock, and variety in making the choice of spacings

The ideal outcome is an orchard where at 10 years of age the trees are still several feet from touching and surrounded by light (I could not find any orchards in our studies with this outcome)

Conclusions

- Although you can potentially get higher yields in years 3-8 with higher density plantings, ultimately the highest yields come from a more traditional spacing with minimal pruning
- Overall yield and yield per unit light intercepted will be lower when any pruning or hedging takes place
- If you are going to mechanically hedge, try to make cycles as long as possible
- Mechanical hedging can result in decent but not high yields but also tends to result in decreased quality
- In general, the less the tree is disturbed by cutting the better

Thanks to the California Walnut Board for funding various aspects of this work