



Designing & Developing a New Orchard

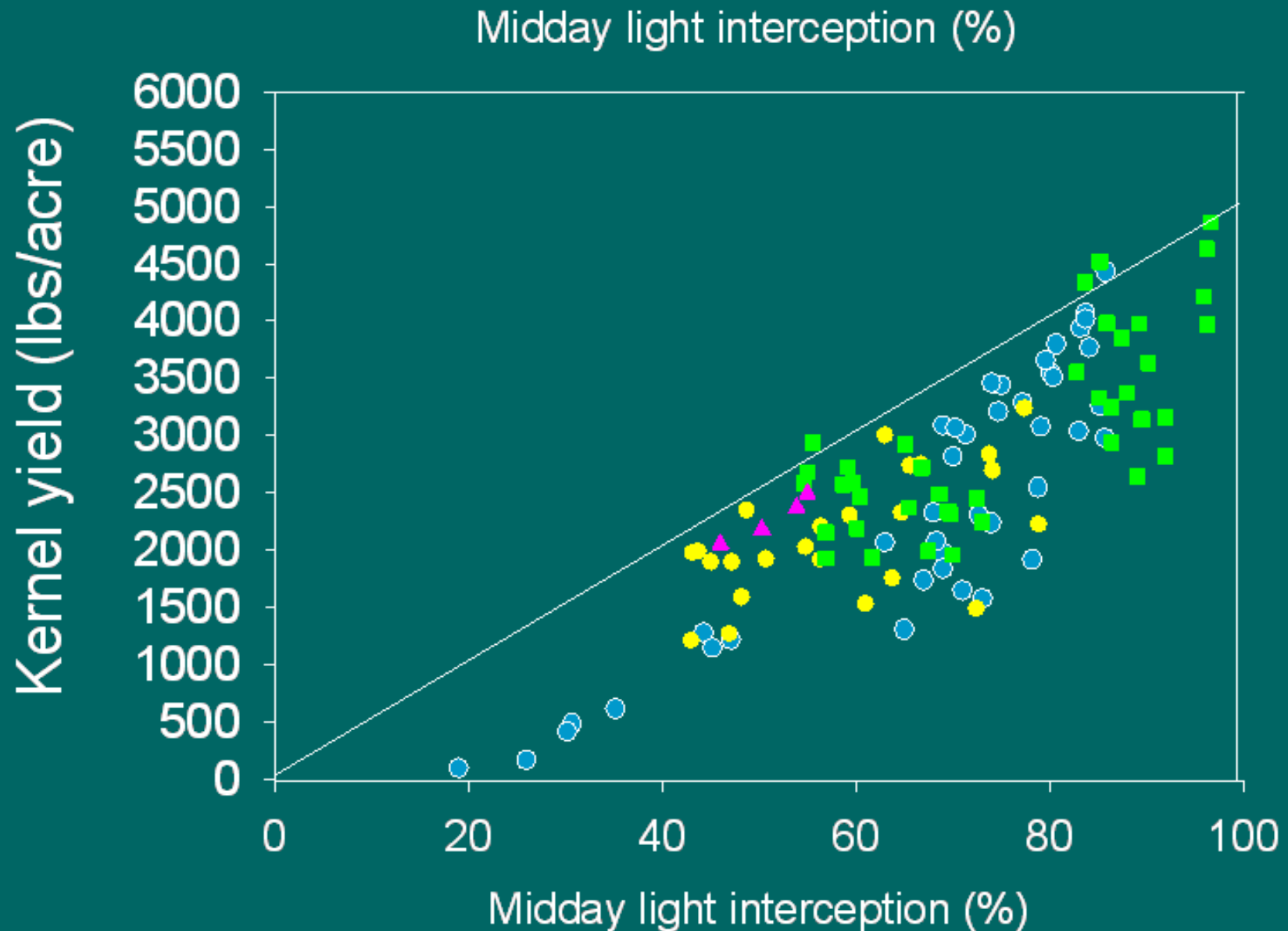
- **Rootstocks, Varieties & Orchard Design**

Roger Duncan

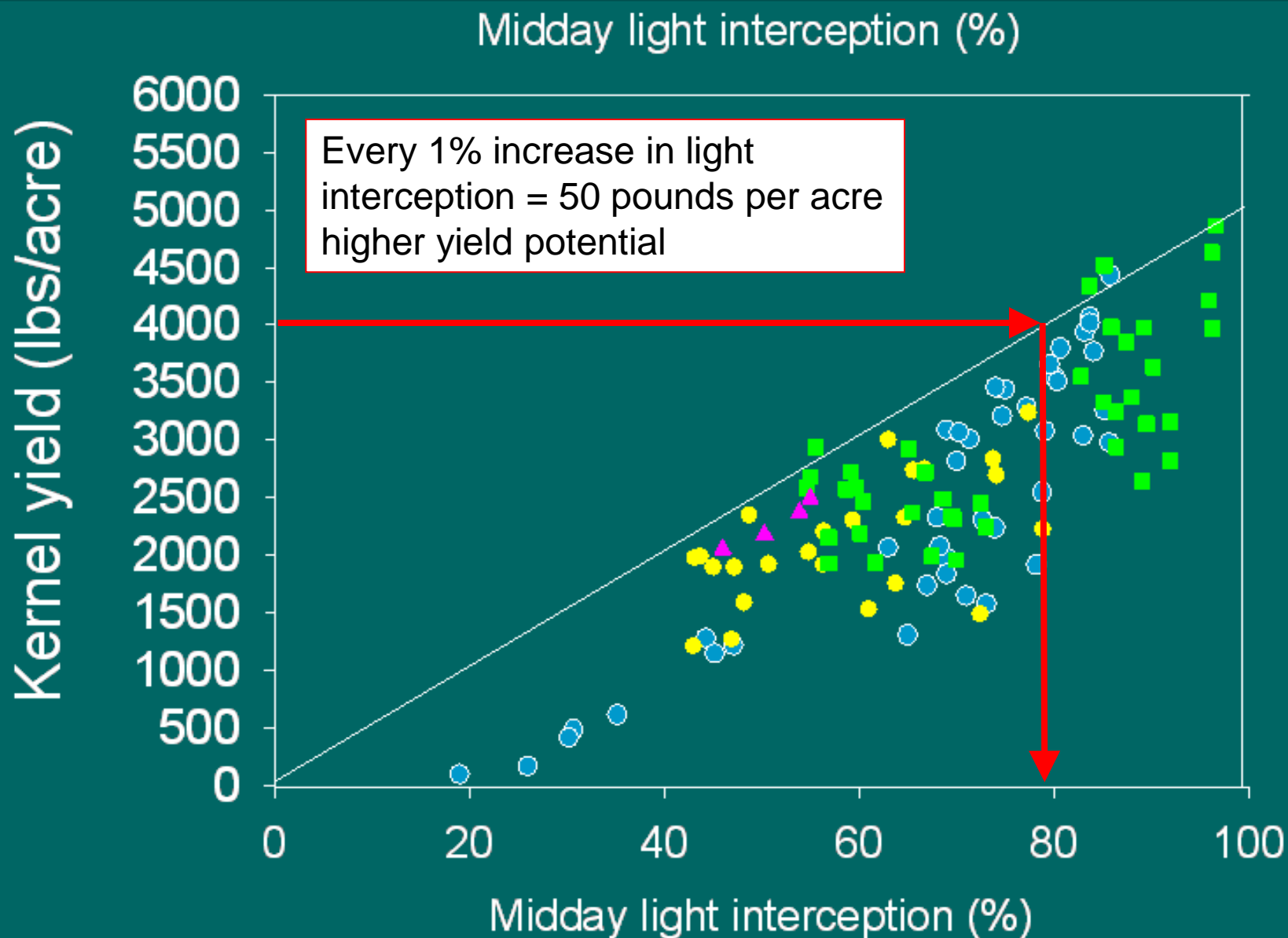
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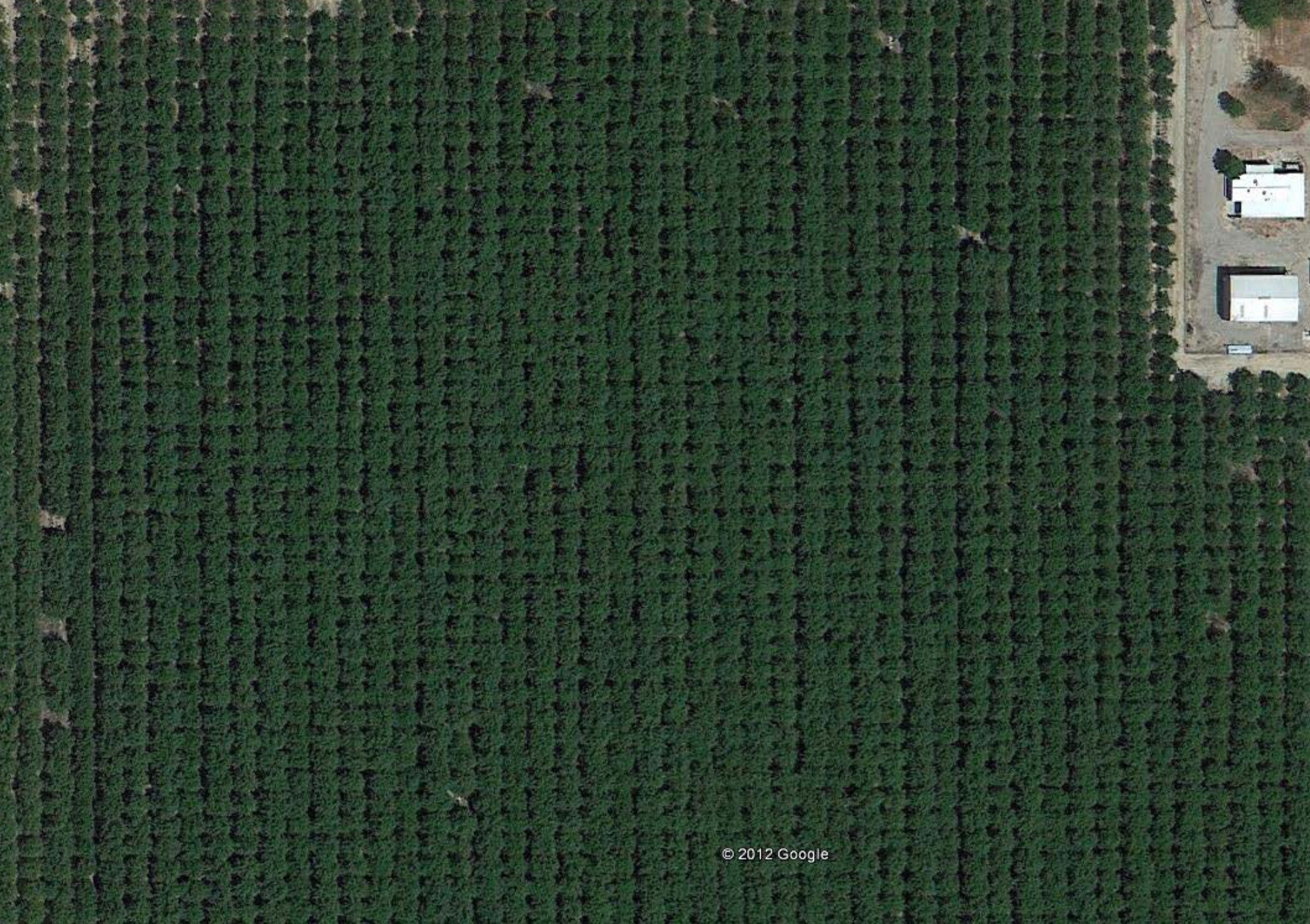
Stanislaus County

Work by Bruce Lampinen, UCD



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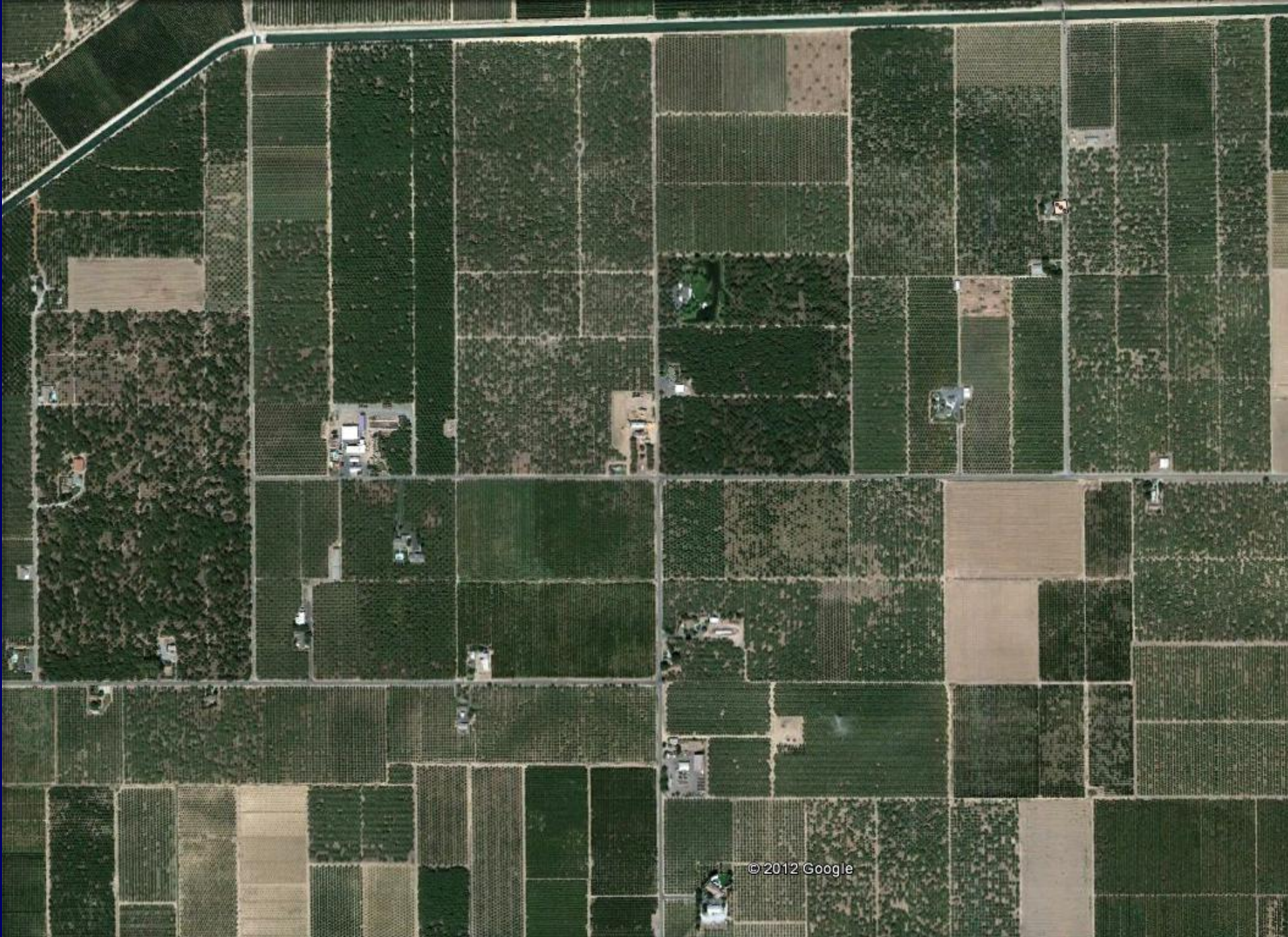




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gery Date: 4/29/2011

35°27'44.22" N 119°14'59.14" W elev. 333 ft



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Goal: Maximum Light Interception

Use integration of appropriate rootstock, planting density / tree arrangement & minimal pruning to achieve maximum light interception.

Rootstocks:

The Best Offense is a Good Defense

- Think of the rootstock as your protection against premature orchard decline.



What is the best rootstock?



- Rootstock choice should be site specific
 - Anticipate possible problems with site
 - If no specific biological, chemical or physical soil challenges are present, rootstock choice may not make much difference as long as planting density is appropriate.

Nemaguard

■ Advantages

- “Immune” to rootknot nematode
- Vigorous rootstock
- Compatible with all almond varieties
- Performs well in sandy loam & loam soils
- “Decent” anchorage
- Growers are familiar with it

Nemaguard

- Disadvantages
 - *Susceptible to:*
 - Ring & root lesion nematodes
 - Bacterial canker
 - High soil pH / high lime
 - Salt (sodium, chloride, boron)
 - Phytophthora / “wet feet”
 - Oak root fungus
 - Crown gall
 - “Heart” rot / wood decay fungi

Specific Challenges...

- Alkaline / salty soil or water
 - P/A hybrid (not if heavy soil or ring nematodes)
 - Hansen, Nickels, Brights, Paramount (GF-677),
 - Atlas (not if ring nematodes)
 - Viking
 - Empyrean 1



Salinity Tolerance of P/A Hybrid Rootstocks

Atwater rootstock trial, 2006

	<i>Na (%)</i>	<i>Cl (%)</i>
Nemaguard	0.64	0.22
Lovell	0.72	0.26
Hansen	0.17	0.09
Brights	0.20	0.07
Critical level	>0.25%	> 0.3%

Peach / Almond Hybrids

- Includes Hansen, Nickels, Bright's Hybrid Cornerstone, Titan Hybrid, Paramount
- **Advantages**
 - Very high vigor
 - Tolerant to high lime / high pH soils
 - Tolerant to high boron, sodium & chloride
 - Very good anchorage
 - Resistant to rootknot nematode
 - Perform well in replanted orchards**

Specific Challenges...

- Ring nematodes (bacterial canker)

– Viking or Lovell



Complex Hybrids

- **Viking** (peach x almond x plum x apricot)
 - Similar in size to nemaguard
 - Resistant to rootknot nematode
 - Tolerant to ring nematode
 - Bacterial canker tolerance is similar to Lovell but with higher yields
 - More tolerant to high pH, sodium & chloride than peach rootstocks
 - Better anchorage than nemaguard or Lovell
 - *Unknown tolerance to saturated soils
 - **Susceptible to dehydration at planting

Specific Challenges...

- Poor drainage / heavy soil

- ~~– Marianna 26-24~~

- Krymsk 86

- Marianna 40

- ~~– Ishtara~~



More vigorous than
M 26-24 with little
suckering

Alternative Rootstocks for Almond

Krymsk 86 – Russia

Plum (Myrobalan) x peach

- 80 – 90% size of nemaguard (similar to Lovell)
- **Appears to be...**
 - Tolerant to heavy soils, Phytophthora root rot.
 - Good anchorage
 - Very little suckering
 - Minor yellow leaf roll issue with Nonpareil & Monterey*

Specific Challenges...

- Oak root fungus
 - Marianna 26-24 is the only known commercially available almond rootstock with ORF tolerance



Alternative Rootstocks for Almond

- Empyrean 1 (Barrier 1) – Italy

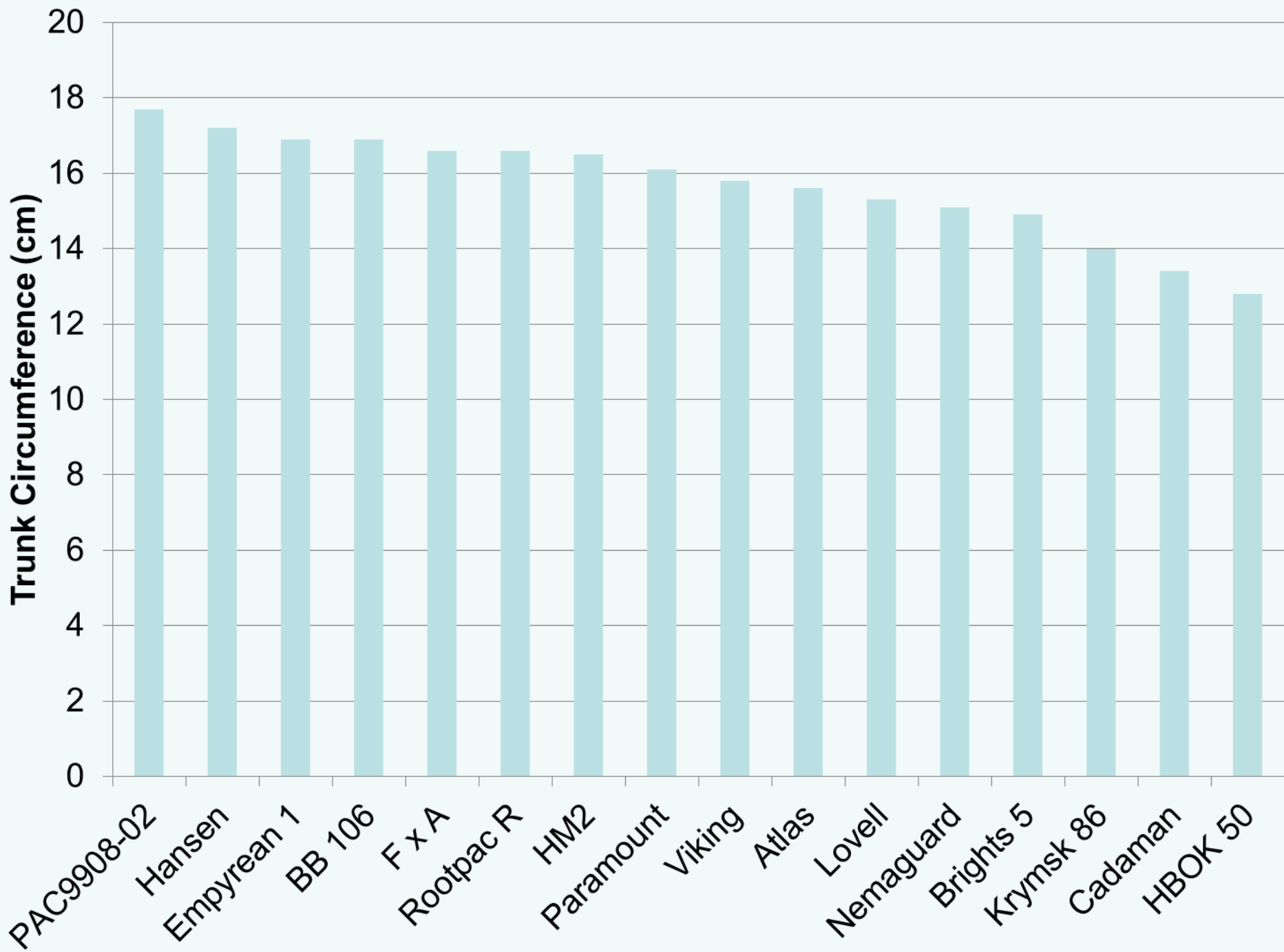
Peach

- As vigorous as peach / almond hybrids
- Resistant to rootknot nematode
- So far, very few ring nematodes in local trial
- Evidence of sodium tolerance

2012 Rootstock Trial – West Side Stanislaus County

Heavy soil, marginal water quality

1. Lovell	<i>P. persica</i>
2. Nemaguard	<i>P. persica</i>
3. Empyrean 1	<i>P. persica</i> x <i>P. davidiana</i>
4. Avimag	<i>P. persica</i> x <i>P. davidiana</i>
5. HBOK 50	Harrow blood x Okinawa peach
6. Hansen	<i>P. dulcis</i> x <i>P. persica</i>
7. Brights #5	<i>P. dulcis</i> x <i>P. persica</i>
8. BB 106	<i>P. dulcis</i> x <i>P. persica</i>
9. Paramount	<i>P. dulcis</i> x <i>P. persica</i>
10. Flordaguard x Alnem	<i>P. persica</i> x Israeli bitter almond
11. PAC9908-02	(<i>P. dulcis</i> x <i>P. persica</i>) x <i>P. persica</i>
12. HM2 +	Hansen (<i>P. dulcis</i> x <i>P. persica</i>) x Monegro (<i>P. dulcis</i> x <i>P. persica</i>)
13. Viking	<i>P. persica</i> (Nemaguard) x (<i>P. dulcis</i> [Jordanolo] x [<i>P. blireiana</i> = <i>P. cerasifera</i> x <i>P. armeniaca</i>])
14. Atlas	<i>P. persica</i> (Nemaguard) x (<i>P. dulcis</i> x <i>P. blierianna</i>)
15. Krymsk 86	<i>P. cerasifera</i> x <i>P. persica</i>
16. Rootpac R	almond x plum



Variety Choice Depends on:

- Yield
 - Price
- } Gross income
- **Bloom time (overlap with main variety)**
 - **Harvest date**
 - **Insect pressure**
 - **Disease pressure**
 - **Kernel quality**
 - **Size of farming operation**
 - **Farming style / personal preference**
 - **Are you a risk taker?**



Statewide Average Yield Comparison for Nonpareil vs. Butte & Padre (lbs / acre)*

*based on Almond Board of California Almanac

	2000	2001	2002	2003	2004	2006	2007	2008	2009	Avg.
NP	1425	1613	2267	1927	1853	2333	2539	2486	2103	2061
Butte & Padre	1563	1912	2441	2689	2296	1775	2433	2506	2281	2211

Butte & Padre produced 150 lb. per acre more than Nonpareil on average from 2000 - 2009

Average Gross Income for Nonpareil vs. Butte & Padre

	2000	2001	2002	2003	2004	2006	2007	2008	2009	Avg.
NP	\$1553	\$1694	\$2924	\$3372	\$4466	\$5319	\$5078	\$4425	\$4080	\$3657
Butte & Padre	\$1375	\$1683	\$2587	\$4141	\$5005	\$3408	\$3771	\$2932	\$2965	\$3096
	+\$178	+\$11	+\$337	-\$769	-\$539	+\$1911	+\$1307	+\$1493	+\$1115	+\$561

Average Yield per Acre for the Nine Most Commonly Planted Almond Varieties

*based on Almond Board of California Almanac & 2009 prices

	2008	2009	Average	\$ / acre
Nonpareil	2486	2103	2295	\$4590
Aldrich	2868	1995	2432	\$3843
Monterey	2615	2127	2371	\$3746
Butte / Padre	2506	2281	2394	\$3711
Fritz	2559	1979	2269	\$3585
Carmel	2259	1643	1951	\$3239
Sonora	2004	1614	1809	\$3003
Price	1981	1491	1736	\$2743

Full Bloom Time Relative to Nonpareil*

*Data taken from Butte County
Variety Trial:

average of 1996 – 2003

Fritz not included in Chico trial



Sonora	-6.4
Sano	- 5.3
Winters	- 3.4
Donna	- 3.3
Aldrich	- 1.4
Jenette	- 0.8
Price	+ 0.4
Carmel	+ 1.4
Wood Colony	+ 1.4
Monterey	+ 1.9
Plateau	+ 2.8
Butte	+ 4.3
2-19E	+ 4.4
Padre	+ 5.1
Livingston	+ 5.6
Mission	+ 6.1
Ruby	+ 9.8

“New” Varieties

- Avalon, Bluegum, Capitola, Durango, Folsom, Independence, Kochi, Marcona, Sweetheart, Supareil, Winters, 2-19E
- Planting a new variety represents a risk
- Is potential return worth the risk?

Finally,

Talk to handlers / sellers

Tree Planting Density

10' x 22'

22' x 22'

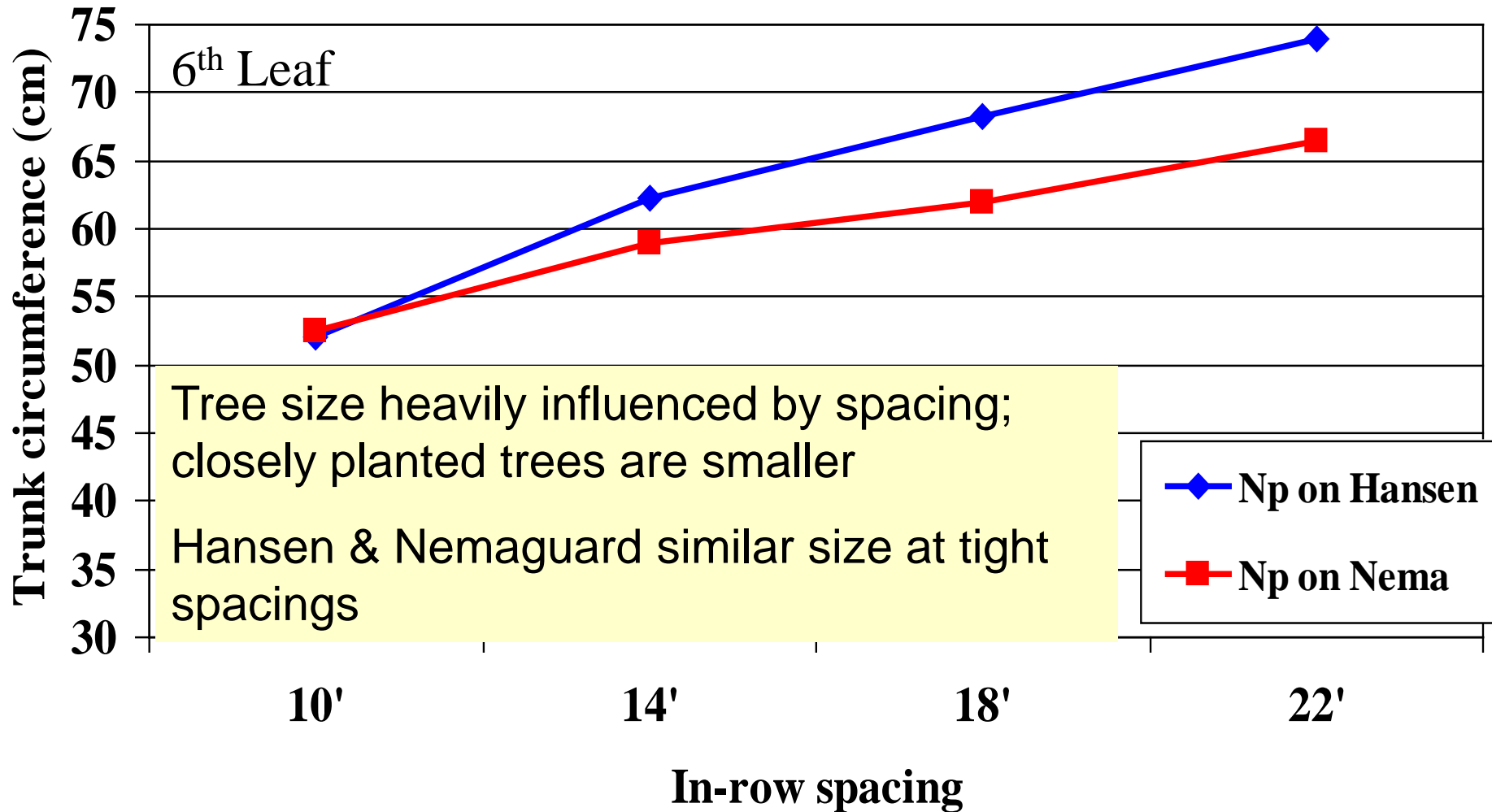


22' x 22' 6th leaf



10' x 22' 6th leaf

Effect of Tree Spacing & Rootstock on Trunk Circumference.

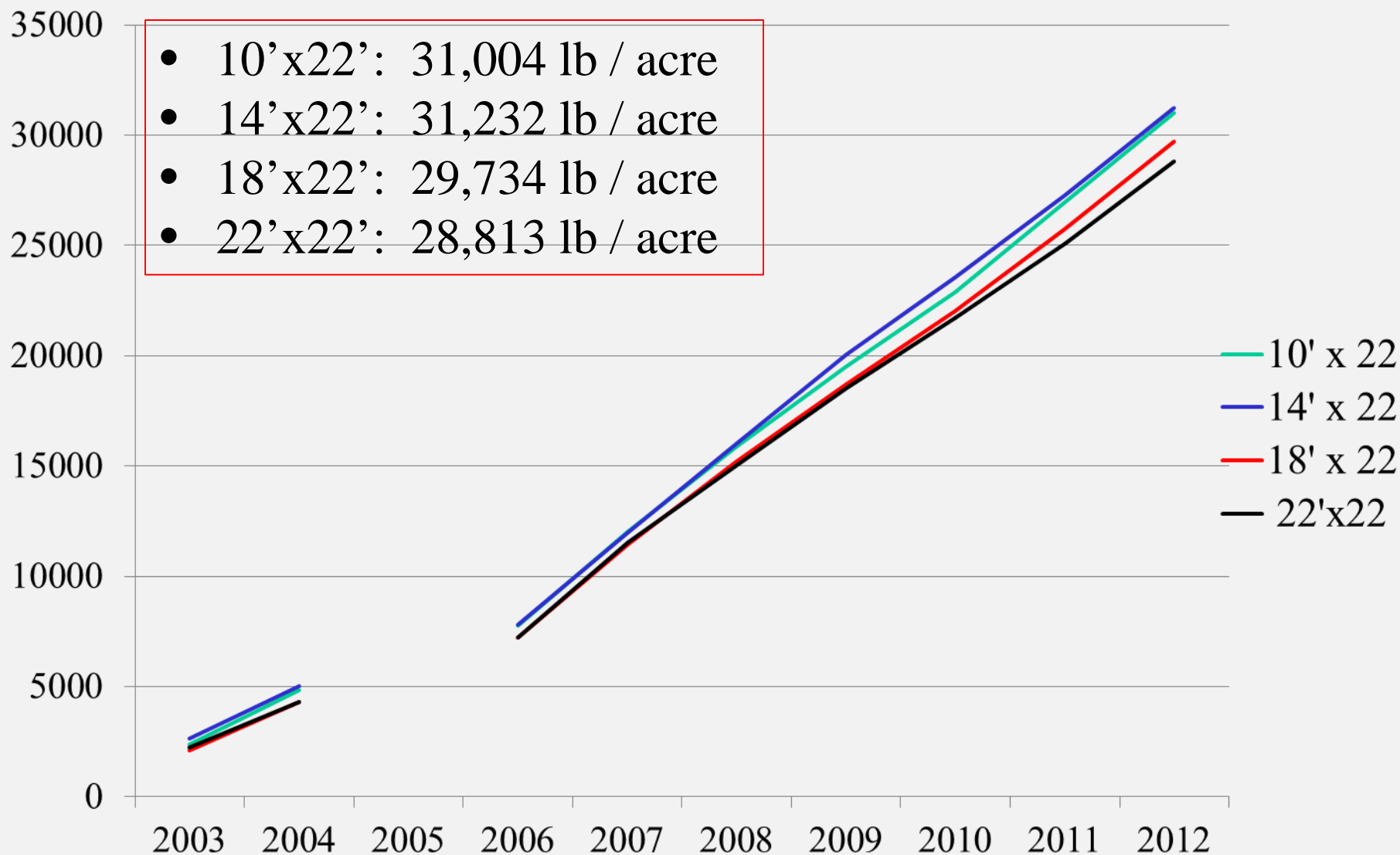


The Effect of Tree Spacing on Height (feet)

	8 th Leaf	12 th Leaf
10' x 22'	16.9	21.5
14' x 22'	17.8	23.1
18' x 22'	17.6	23.1
22' x 22'	18.1	24.2

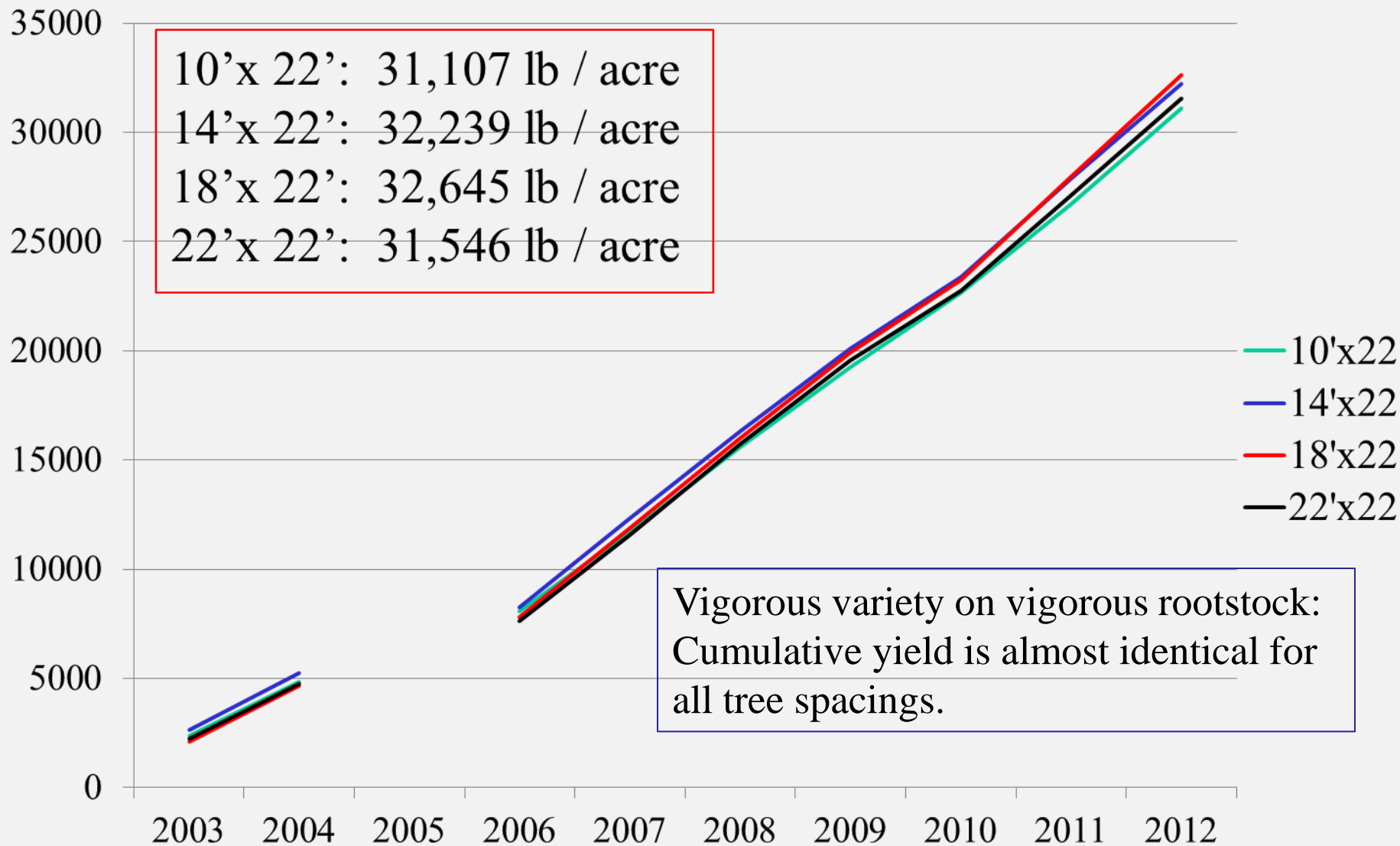
The Effect of Tree Spacing on Cumulative Yield Through 13th Leaf

Nonpareil on Nemaguard



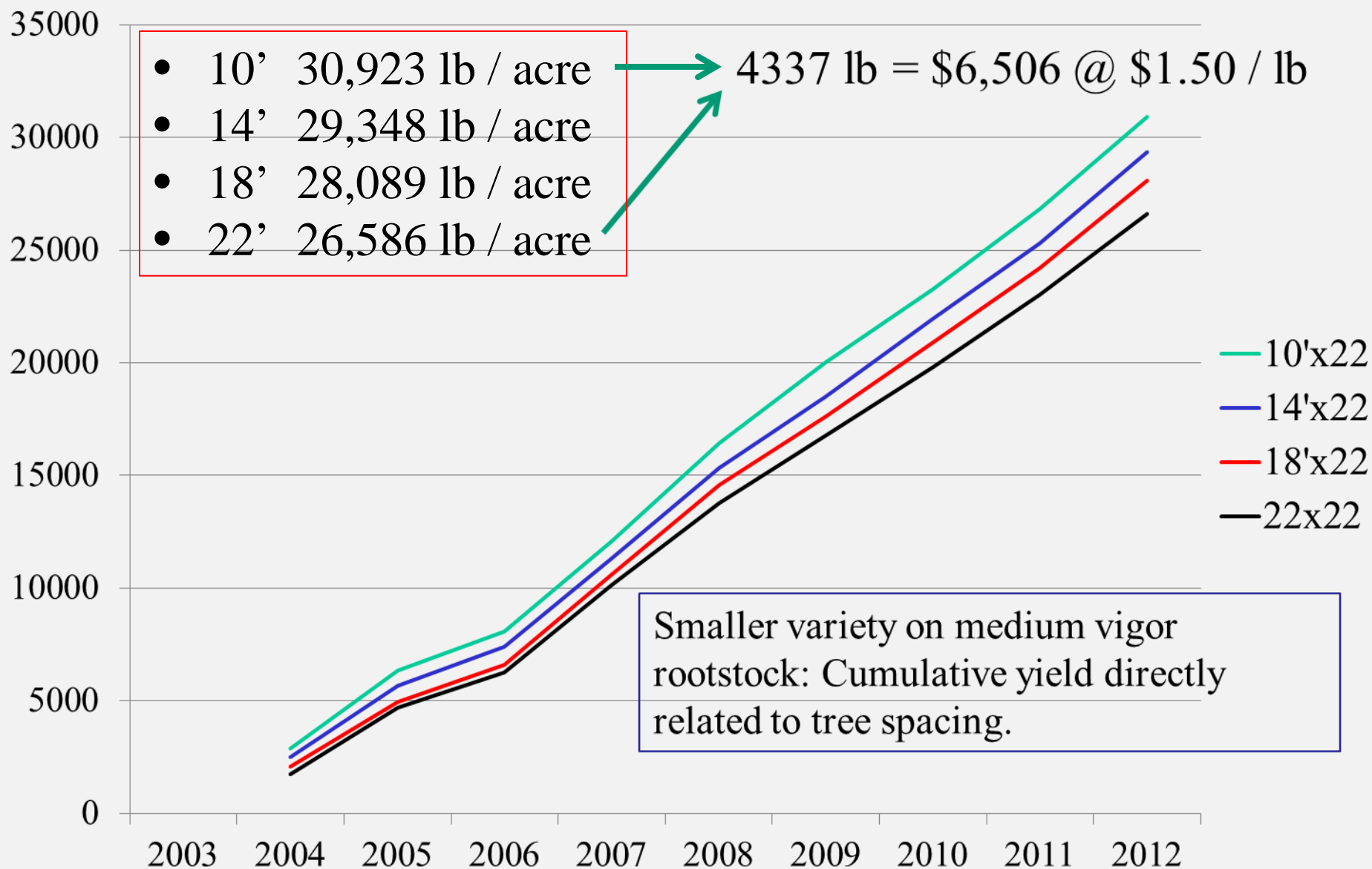
The Effect of Tree Spacing on Cumulative Yield Through 13th Leaf

Nonpareil on Hansen



The Effect of Tree Spacing on Cumulative Yield

Carmel on Nemaguard

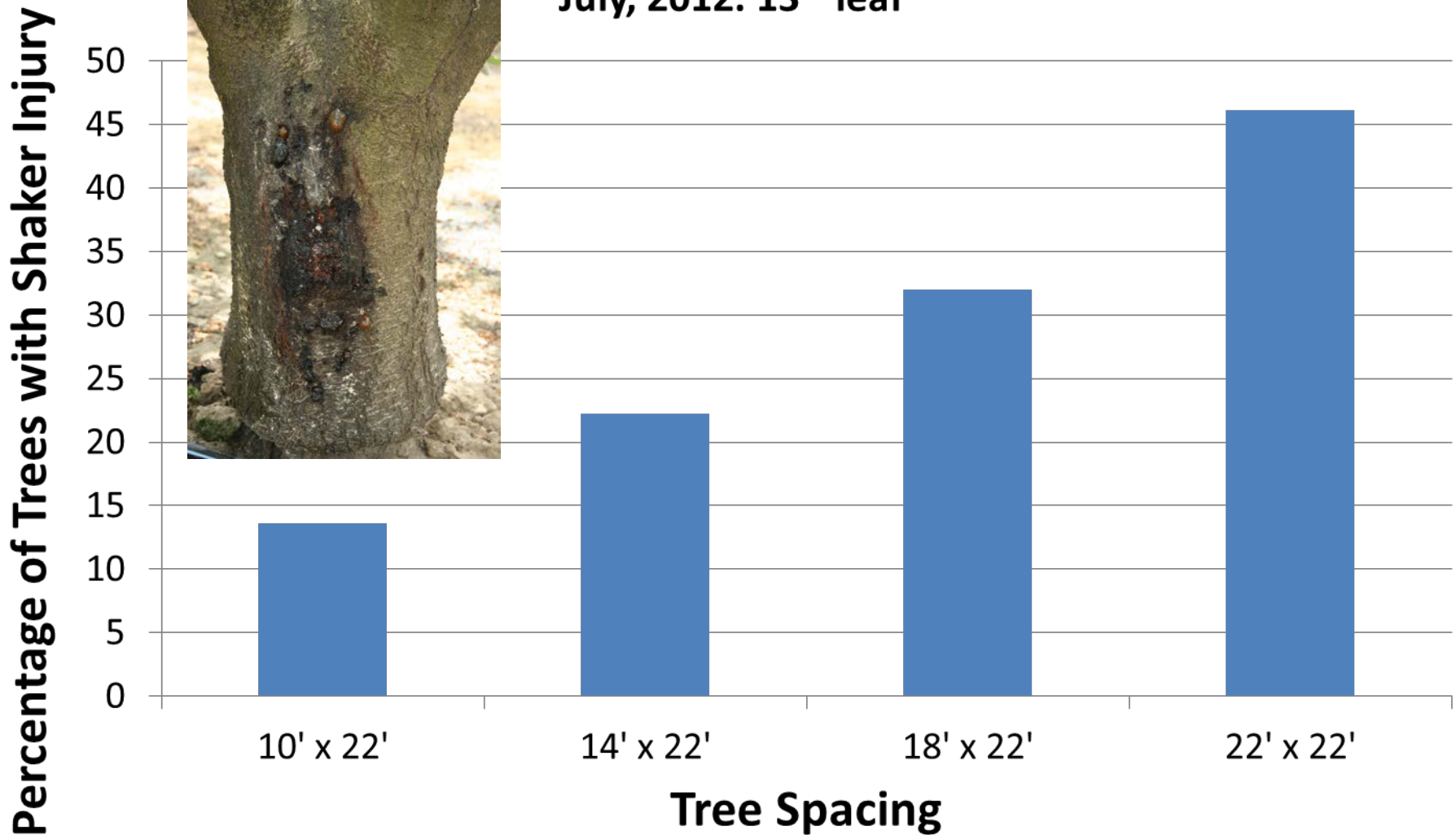


The Effect of Tree Spacing on Scaffold Splitting of Almond Trees



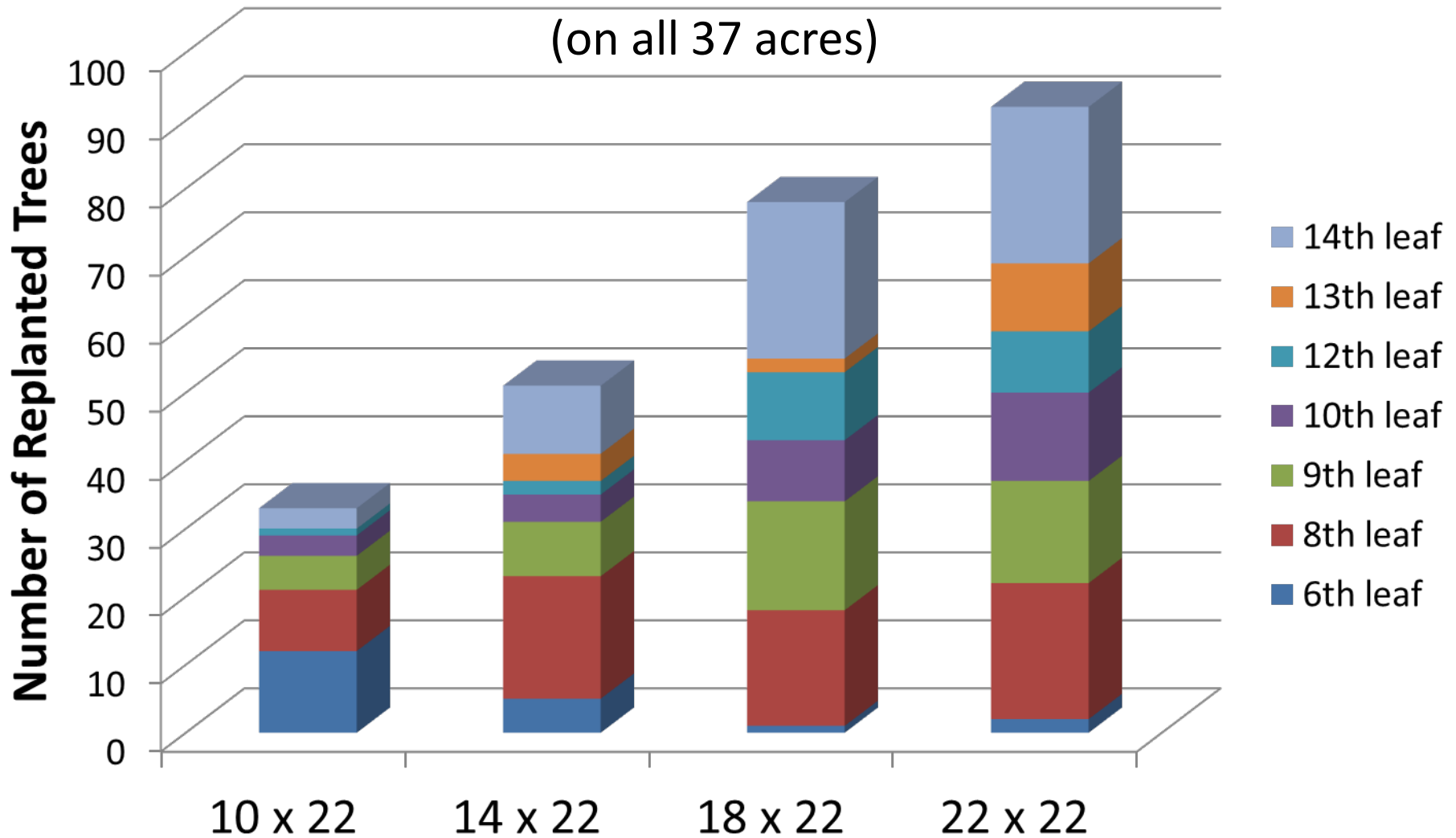
The Effect of Tree Spacing on Trunk Shaker Injury

July, 2012. 13th leaf



The Influence of Tree Spacing on the Number of Missing Trees

(on all 37 acres)



The Influence of Tree Spacing on Missing Canopy

	Cumulative Number of Replants	Square Footage of Missing Canopy
10 x 22	33	7,260
14 x 22	51	15,708
18 x 22	78	30,888
22 x 22	92	44,528

The Influence of Tree Spacing on Unharvested Nuts (Mummies)

	Mummies per acre January 15, 2010				
	10 x 22	14 x 22	18 x 22	22 x 22	X
Standard Pruning	4,297	9,545	12,386	10,845	9,268
Trained 2 years, Unpruned	5,207	6,179	10,527	12,276	8,547
Minimal training & pruning	5,841	7,650	15,059	13,473	10,506
Untrained & Unpruned	3,802	5,090	7,557	9,729	6,545
x	4,787	7,116	11,382	11,581	

	Mummies per acre February 17, 2012				
	10 x 22	14 x 22	18 x 22	22 x 22	X
Standard Pruning	4752	8767	6710	9630	7,465
Trained 2 years, Unpruned	6138	4666	4950	7200	5,739
Minimal training & pruning	5148	9757	6380	15,750	9,259
Untrained & Unpruned	6534	7636	6160	13,590	8,481
x	5,643	7,707	6,050	11,543	

Costs Associated with Shaking Trees at Different Planting Densities



	Time (minutes) / acre	Cost (Dollars / acre)*
10' x 22'	54.8	\$91
14' x 22'	45.2	\$75
18' x 22'	44.6	\$74
22' x 22'	49.4	\$82

*Cost of shaker is calculated at \$100 / hour

Benefits of Closer Spacing (other than yield):

More closely planted trees are:

- Smaller
- Less likely to have scaffold breakage problems regardless of how they are trained.
- Easier to prune - may need less pruning??
- Easier to shake at harvest – fewer mummies & less shaker injury (longer orchard life?)
- Better spray coverage – less insect & disease pressure?
- May not fall over as easily (longer orchard life?)
- If one tree dies, it effects yield less

Yields in Long-term Almond Pruning Trial

Spacing = 7' x 22'. John Edstrom, et. al., Nickels Estate (1984 – 1999)

	18 th leaf	19 th leaf	20 th leaf	21 st leaf	Cumulative Yield
Annually pruned	2624	2498 a	2494 a	2136	34,176
Unpruned	2833	2680 a	1958 ab	2307	35,082
2 scaffolds	2968	2953 a	2296 a	2483	36,820
Temporary trees removed	2076	2081 b	1757 b	1662	27,861

Yields in Long-term Almond Pruning Trial

Spacing = 7' x 22'. John Edstrom, et. al., Nickels Estate (1984 – 1999)

	Pruning Costs	Gross Profit / acre	Net Profit
Annually pruned	\$3675	\$51,264	\$47,589
Unpruned	\$175	\$52,623	\$52,448
2 scaffolds	\$3675 +	\$55,230	\$51,555
Temporary trees removed	?	\$41,792	?

Pruning costs @ \$175 per acre, including stacking & shredding

Almond price of \$1.50 / pound

Cumulative Yields – Kern County through 11th leaf

Pounds per acre

	Nonpareil	Carmel	Monterey
Annual pruning	19,245	21,698	20,841
Pruned every other year	20,585	20,363	21,313
Topped & hedged annually	20,667	22,771	22,153
Mechanical alternate years	20,088	22,561	20,831
Mechanical + hand pruned	18,643	20,248	20,096
Unpruned	21,536	23,577	21,843

Stanislaus County Pruning Trial 2000 - 2012

The Effects of Pruning on Current (13th Leaf) & Cumulative Yield

	Nonpareil		Carmel	
	2012 Yield (lb/acre)	Cumulative	2012 Yield (lb / acre)	Cumulative
Training & Pruning				
Trained to 3 scaffolds; Annual, moderate pruning	4209 ab	29,338	3126 b	25,620
Trained to 3 scaffolds; unpruned after 2 nd year	4387 a	30,670	3508 ab	27,535
Trained to multiple scaffolds; Three annual pruning cuts	3979 b	28,769	3308 ab	27,080
No scaffold selection; no annual pruning	4220 ab	30,683	3685 a	28,836

Conservatively, the cost of pruning, stacking brush and shredding every year, plus the value of reduced yield would have cost the grower over \$7000 per acre to date.

Why Prune Almond Trees?

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There are real reasons to prune

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There are real reasons to prune

- Allow equipment access (shakers, weed sprayer, etc.)
- Safety for tractor driver
- Sunlight on orchard floor to improve drying
- Remove dead or diseased limbs
- Reduce sticks at harvest
- Reduce disease (Alternaria, hull rot, rust, etc.)??

**There are many reasons to
prune an almond orchard.
Yield does not appear to be
one of them.**



Questions? Comments?

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