# Update on UCCE Field Trials in Stanislaus County

Roger Duncan, UC Cooperative Extension, Stanislaus County

- Rootstocks
- Pruning
- Topping Young Trees
- Tree Planting Density
- Application of Composts

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# Field Evaluation of Rootstocks for the Westside of the San Joaquin Valley

- In cooperation with Lee Del Don, Westley CA

- Zacharias clay loam soil
- Soil and irrigation water alkaline, moderately high in Cl and/or boron, depending on year / water source
- Following decades of row crops (tomatoes & melons)

# List of Rootstocks. Planted Dec. 2012

| | |
|---|---|
| Lovell | *P. persica* |
| Nemaguard | *P. persica* |
| Empyrean 1 (a.k.a. Barrier 1) | *P. persica x P. davidiana* |
| Avimag (a.k.a. Cadaman) | *P. persica x P. davidiana* |
| HBOK 50 | *Harrow blood x Okinawa peach* |
| Hansen | *P. dulcis x P. persica* |
| Brights 5 | *P. dulcis x P. persica* |
| BB 106 | *P. dulcis x P. persica* |
| Paramount (a.k.a. GF 677) | *P. dulcis x P. persica* |
| Flordaguard x Alnem a.k.a. Y119-109-98. | *P. persica x* Israeli bitter almond |
| PAC9908-02 | *(P. dulcis x P. persica) x P. persica* |
| Hansen x Monegro (HM2) | *(P. dulcis x P. persica) x (P. dulcis x P. persica)* |
| Viking | *P. Persica x (P. dulcis )x [(P. cerasifera x P. armeniaca)]* |
| Atlas | *P. Persica x (P. dulcis )x [(P. cerasifera x P. armeniaca)]* |
| Krymsk 86 | *P. cerasifera x P. persica* |
| Rootpac R | *P. cerasifera x P. dulcis* |

# Rootstock Effect on Chloride Accumulation in Leaf Tissue

Cl critical level = 0.3%

| | % Cl | |
|---|---|---|
| Krymsk 86 | 0.89 | a* |
| Lovell | 0.72 | b |
| Nemaguard | 0.57 | c |
| PAC9908-02 | 0.45 | d |
| Atlas | 0.42 | de |
| Cadaman | 0.38 | def |
| Empyrean 1 | 0.33 | ef |
| HBOK 50 | 0.31 | ef |
| Viking | 0.30 | f |
| F x A | 0.19 | g |
| BB 106 | 0.19 | g |
| Brights 5 | 0.18 | g |
| GF 677 | 0.18 | g |
| Rootpac R | 0.17 | g |
| HM2 | 0.16 | g |
| Hansen | 0.15 | g |

*P ≤ 0.05

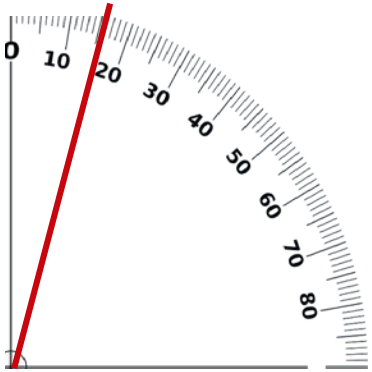
# Rootstock Effect on Boron Accumulation in Hull Tissue

B critical level = 300 ppm

| | B (ppm) |
|---|---|
| Lovell | 180 a* |
| Cadaman | 170 ab |
| Atlas | 158 ab |
| HBOK 50 | 158 ab |
| Nemaguard | 153 bc |
| Krymsk 86 | 152 bc |
| Empyrean 1 | 133 cd |
| Rootpac R | 132 cd |
| Hansen | 126 de |
| GF 677 | 120 de |
| HM2 | 116 de |
| Viking | 109 e |
| PAC9908-02 | 108 e |
| Brights 5 | 106 e |
| F x A | 104 e |
| BB 106 | 102 e |

*P ≤ 0.05

# Anchorage




| | Average Trunk Lean (degrees) | % of Trees > $15^0$ Lean |
|---|---|---|
| Krymsk 86 | 6.4 a | 3.3 |
| Hansen | 7.4 a | 20.0 |
| Flordaguard x Alnem | 8.1 a | 10.0 |
| Rootpac R | 9.8 a | 23.3 |
| Viking | 10.2 a | 6.7 |
| BB106 | 10.8 ab | 26.7 |
| Nemaguard | 11.0 ab | 17.2 |
| GF 677 | 11.0 ab | 37.9 |
| PAC 9908-02 | 11.1 ab | 26.7 |
| Lovell | 11.9 abc | 33.3 |
| Brights 5 | 12.1 abc | 20.0 |
| Atlas | 12.1 abc | 24.1 |
| HBOK 50 | 16.3 bcd | 53.3 |
| Empyrean 1 | 17.0 cd | 60.0 |
| Hansen x Monegro | 21.1 d | 70.0 |

*P $\leq$ 0.05

# Rootstock Effect on Tree Size and Yield

| | Trunk Circumference | 2018 Yield | Cum Yield (4th – 7th) | Yield Efficiency |
|---|---|---|---|---|
| Flordaguard x Alnem | 66.0 a | 3965 a | 12,276 | 35.5 |
| BB 106 | 62.1 b | 3875 ab | 12,203 | 39.9 |
| Brights 5 | 54.6 de | 3701 abc | 11,564 | 48.8 |
| Empyrean 1 | 63.2 b | 3487 abcd | 11,461 | 36.2 |
| HM2 | 63.4 b | 3572 abc | 11,361 | 35.6 |
| Hansen | 62.8 b | 3665 abc | 11,355 | 36.3 |
| PAC9908-02 | 63.3 b | 3362 bcd | 10,916 | 34.3 |
| Rootpac R | 62.0 b | 3476 abcd | 10,587 | 34.7 |
| Atlas | 54.5 de | 3457 abcd | 10,506 | 44.5 |
| Viking | 54.3 de | 3085 cd | 9,704 | 41.5 |
| Paramount (GF 677) | 55.4 cd | 3194 cde | 9,579 | 39.3 |
| HBOK 50 | 57.5 c | 3060 de | 9,201 | 35.1 |
| Krymsk 86 | 51.4 f | 3004 de | 8,866 | 42.2 |
| Nemaguard | 55.3 cd | 2802 e | 8,833 | 36.3 |
| Lovell | 52.6 ef | 2752 e | 8,040 | 36.5 |

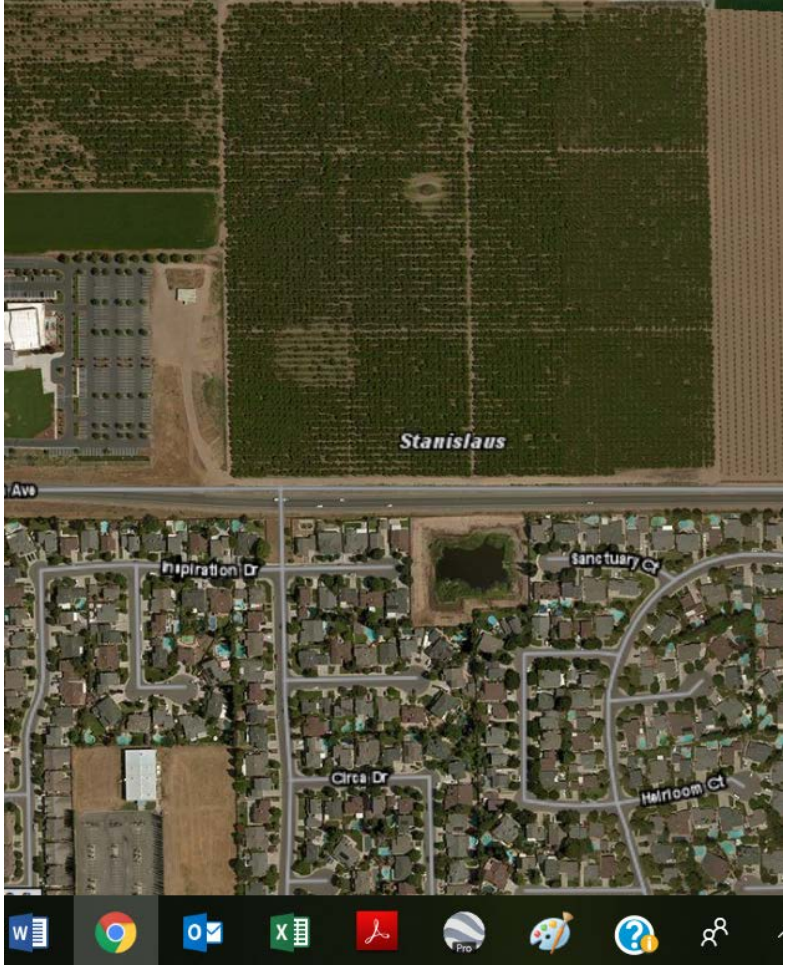
# Conclusions:

- Standard rootstocks Lovell, Krymsk 86 & Nemaguard are lowest performing rootstocks

- Cumulative yields ~ 2/3 of best performing rootstocks

# Can Alternative Rootstocks Compensate for No Fumigation

- In cooperation with Tony Rodin, Modesto



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Replanted orchard following peaches on Nemaguard

Rootstocks:

- Nemaguard
- Viking
- Hansen
- Empyrean 1
- Rootpac R

Fumigation Telone C35 vs. No Fumigation

| | 3rd Leaf | 4th Leaf | 5th Leaf | Cum |
|---|---|---|---|---|
| Empyrean 1 | 629 | 2407 a | 1136 a | 4172 a |
| Empyrean 1 + C35 | 672 | 2407 a | 1041 ab | 4120 a |
| Hansen | 551 | 2209 ab | 1044 ab | 3804 ab |
| Hansen + C35 | 511 | 1926 bc | 1081 a | 3518 b |
| Nemaguard + C35 | 454 | 1616 cd | 682 c | 2752 c |
| Viking + C35 | 511 | 1386 d | 859 bc | 2756 c |
| Viking | 438 | 1353 d | 846 bc | 2637 cd |
| Nemaguard | 345 | 1414 d | 680 c | 2439 d |
| Rootpac R + C35 | 443 | 785 e | 398 d | 1626 e |
| Rootpac R | 247 | 475 e | 343 d | 1065 e |

Comparative Yield (lbs per acre) for Five Rootstocks in Unfumigated Soil vs. Soil Fumigated with Telone C35

Orchard was clobbered by bacterial blast in 2019

Nemaguard

Rootpac R

# Conclusions:

- Unfumigated Empyrean 1 and Hansen rootstocks outperforming fumigated Nemaguard
- Ring nematodes building on Hansen but not Empyrean 1
- Rootpac R does not belong in sandy soils

# Does Compost Improve the Performance of Almond Orchards?

In cooperation with:

- Robert & Brandon Longstreth
- Brian Dugo

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# Amendments incorporated at planting time.  Additional ½ ton after planting.
- Two locations

Composts applied annually @ 10 tons / acre (5 tons in 2019)

# Leaf Nutrients in July-Sampled Leaves from Trees in Compost Amended and Non-Amended Soil

*Independence on Nemaguard (4th Leaf)*
*Loamy Sand, Replant*

| | N | P | K | Ca | Cl |
|---|---|---|---|---|---|
| Unamended | 2.58 b | 0.16 a | 2.89 b | 5.31 a | 0.39 c |
| Green Waste | 2.76 a | 0.16 a | 3.06 b | 4.73 b | 0.56 ab |
| Manure | 2.74 a | 0.17 a | 3.37 a | 4.44 b | 0.63 a |
| Additional N | 2.58 b | 0.15 a | 3.12 b | 5.33 a | 0.39 bc |

Higher nitrogen and chloride; lower calcium; higher potassium in manure.

# Yield Comparison of Almonds in Compost-Amended or Non-Amended Soil

First generation orchard on Sandy Loam. Nonpareil on Nemaguard

| | 3rd leaf 2017 | 4th leaf 2018 | 5th leaf 2019 | Total Yield |
|---|---|---|---|---|
| Unamended | 568 a | 2148 a | 3154 a | 5870 a |
| Composted Green Waste | 559 a | 1992 a | 2898 a | 5449 a |
| Composted Manure | 602 a | 1977 a | 2909 a | 5488 a |
| Additional 0.2 lb N / tree | 600 a | 2121 a | 3015 a | 5736 a |

# Yield Comparison of Almonds in Compost-Amended or Non-Amended Soil

Replant Orchard on Loamy Sand.  Independence on Nemaguard

| | 3rd leaf 2017 | 4th leaf 2018 | 5th leaf 2019 | Total Yield |
|---|---|---|---|---|
| Check | -- | 1988 a | 1779 a | 3766 a |
| Composted Green Waste | -- | 2256 a | 1788 a | 4044 a |
| Composted Manure | -- | 1991 a | 1859 a | 3849 a |
| Additional 0.2 lb N / tree | -- | 2018 a | 1554 a | 3572 a |

# Cost of Compost Application

- $10 / ton composted green waste
- Freight costs = $275 / 25 ton load
  - = $21 / ton delivered
  - Roughly $5.50 / ton application cost

Total cost = $26.50 / ton composted green waste applied

= $265 / acre for 10 tons applied

# Conclusions

- Spent about $1300 / acre over 5 years
- Increased cation exchange capacity (top few inches)
- Increased in organic matter in top few inches
- Increased soil carbon
- Increased microbiological activity
- Increasing trend for higher K, N in soil & leaves
- Improved water penetration at soil surface
- Increase in leaf chloride
- Decrease in leaf calcium
- More negative stem water potential??
- No difference in tree size or yield after 5 years… YET!

# What does this mean?

- Building soil “health” may take many years using compost
- Will it be economically feasible?
- May see most difference in problem soils or where inputs are limited
  - Poor infiltration
  - Organic
  - Replant or sandy sites??

# Long-term Pruning Study

- In cooperation with Robert Longstreth

1) Standard trained, standard annual pruning

- 3 scaffolds
- medium annual pruning to maintain open centers

2) Standard trained, unpruned after 2nd dormant

- 3 scaffolds
- unpruned after second dormant season

3) Minimally trained, “minimally” pruned

- 4-6 scaffolds
- 3 pruning cuts annually

4) Untrained & “unpruned" forever

- Limbs interfering with machinery removed

# Standard trained & pruned vs. Untrained & unpruned.

## End of 3rd Season.

Untrained, unpruned Nonpareil
22’ x 22’

Year 19

# The Effect of Long-term Pruning on 2018 (19th Leaf) & Cumulative Yield

| | Nonpareil | | Carmel | |
|---|---|---|---|---|
| | 2018 Yield (lb. / a) | Cumulative | 2018 Yield (lb. / a) | Cumulative |
| Training & Pruning Strategy | | | | |
| Trained to 3 scaffolds; Annual, moderate pruning | 2998 a | 41,326 | 2461 b | 38,851 |
| Trained to 3 scaffolds; Unpruned after 2nd year | 3080 a | 42,237 | 2784 ab | 41,732 |
| Trained to multiple scaffolds; Three annual pruning cuts | 2901 a | 39,739 | 2591 ab | 40,780 |
| No scaffold selection; No annual pruning | 3004 a | 42,278 | 2801 a | 43,274 |

| The Effect of Pruning on 2018 (19th Leaf) Nonpareil Yield in High Density Trees (10’ x 22’) on Hansen Rootstock | |
|---|---|
| | Nonpareil |
| | 2018 Yield (lb. / a) |
| Training & Pruning Strategy | |
| Trained to 3 scaffolds; Annual, moderate pruning | 3099 b |
| Trained to 3 scaffolds; Unpruned after 2nd year | 3733 ab |
| Trained to multiple scaffolds; Three annual pruning cuts | 3329 ab |
| No scaffold selection; No annual pruning | 3873 a |

# Effect of Pruning on Yield to Date

- Pruning has not increased yield in the short or long term.  Pruning has either had no significant effect or has reduced yield.
- 19 years x $275 pruning / shredding costs = $5225
- Decrease in cumulative yield by about 1000 to 3500 pounds = loss of ~$2500 - $9000 / acre
  - Cumulative loss from annual pruning likely $7,500 - $14,000 / acre

# Remarks on Pruning

- Sometimes pruning is needed for safety, equipment access, removing broken and dead branches, limb cankers, etc.
- Best to train trees for good structure and then abandon pruning
- Reason to prune should justify expense, potential yield loss and your fengshui

# Mechanical Topping of Nonbearing Almond Trees

In cooperation with:

- Dr. Vikram Mahal
- Chris Bettencourt

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# Why mechanically top young trees?  The assumptions are:

- Reduce training costs
- Create a shorter, bushier, higher (earlier?) yielding tree
- Reduce tree leaning

# Comparison of Training Strategies


Untrained


long pruned


short pruned


topped

no scaffold selection

# After topping, November 2014




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# Effect of Mechanical Topping 1rst-Leaf Trees on Future Yield - Nonpareil

| | 2016 | 2017 | 2018 | 2019 | Total |
|---|---|---|---|---|---|
| Untrained | 649 a | 2687 a | 2924 a | 3583 a | 9,843 a |
| Topped no scaffold selection | 561 ab | 2223 bc | 2915 a | 3684 a | 9,383 b |
| Medium trained by hand | 538 abc | 2397 ab | 2626 ab | 3294 a | 8,855 c |
| Topped + scaffold selection | 608 ab | 2231 bc | 2403 b | 3525 a | 8,767 c |
| Short pruned by hand | 402 c | 1981 c | 2779 ab | 3513 a | 8,675 c |

# Conclusions:

- Mechanically topped trees were not shorter than standard hand trained or unpruned trees at the end of one year.
- Mechanical topping plus follow up scaffold selection was the most expensive treatment.
- Did not appear to be a yield advantage
- No difference in tree leaning

# In-Row Tree Spacing Effects on Orchard Performance

- In cooperation with Robert Longstreth

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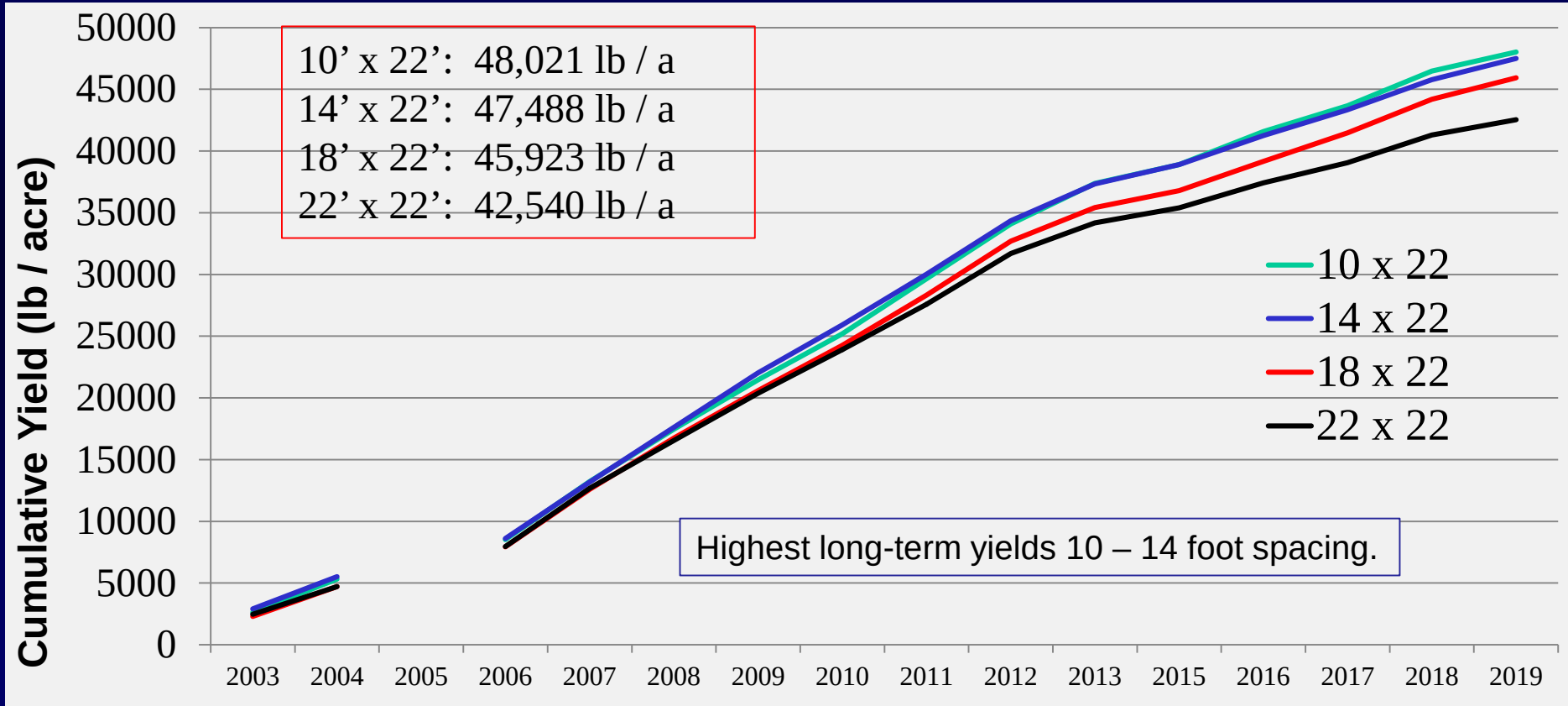
10’ x 22’ hedgerow
22’ x 22’ offset

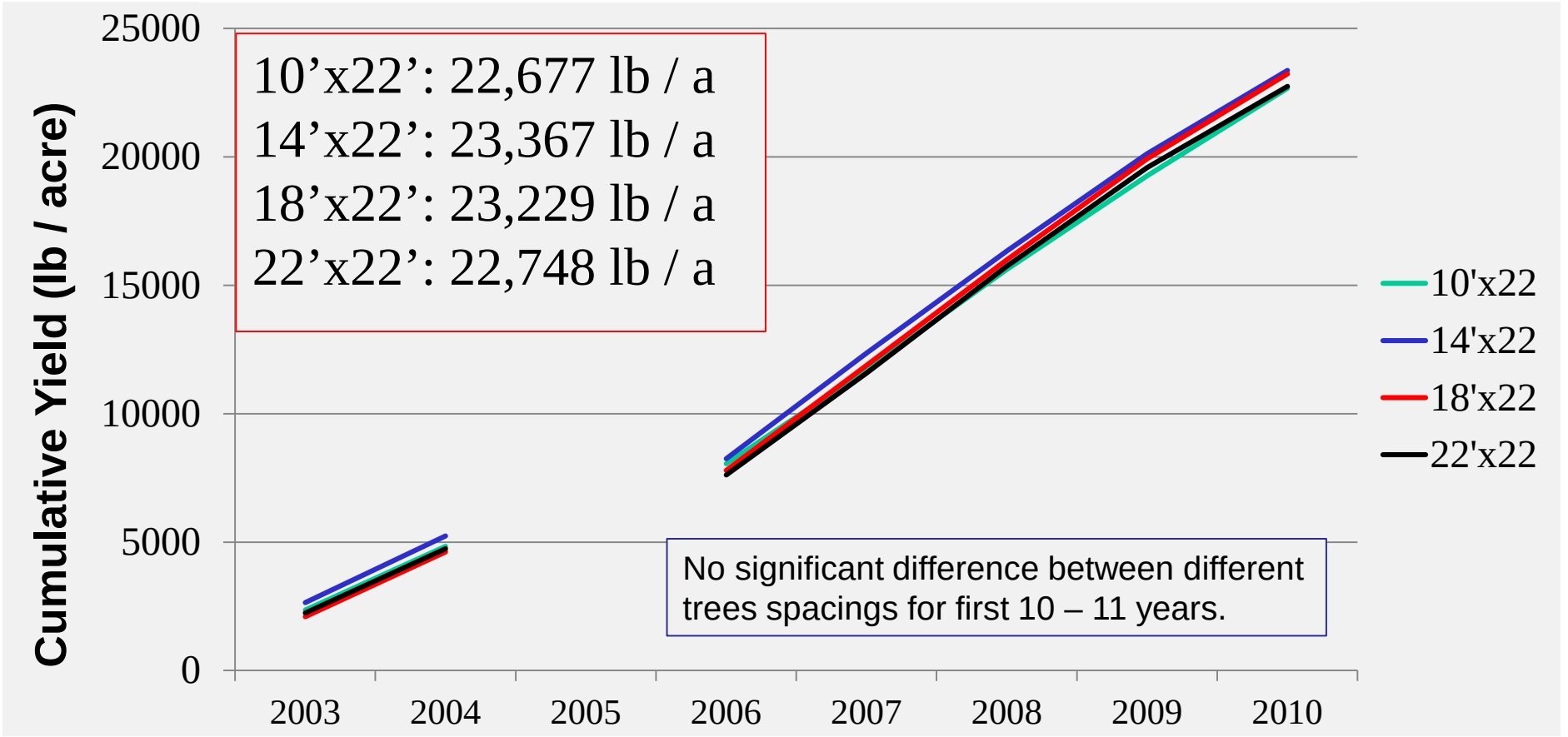
# The Effect of In-row Tree Spacing on Cumulative Yield Through 20th Season

## Nonpareil on Nemaguard



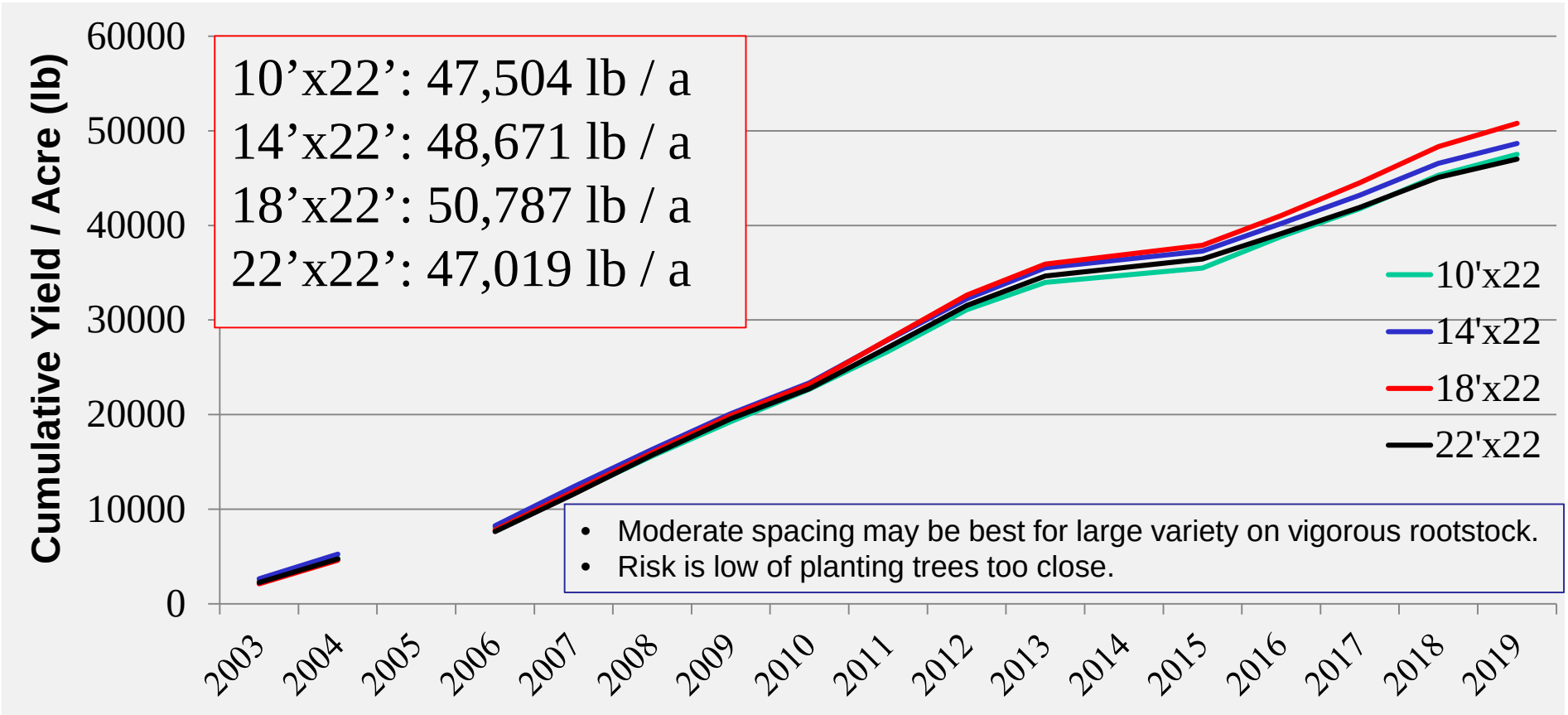
# The Effect of Tree Spacing on Cumulative Yield Through 11th Leaf

## Nonpareil on Hansen



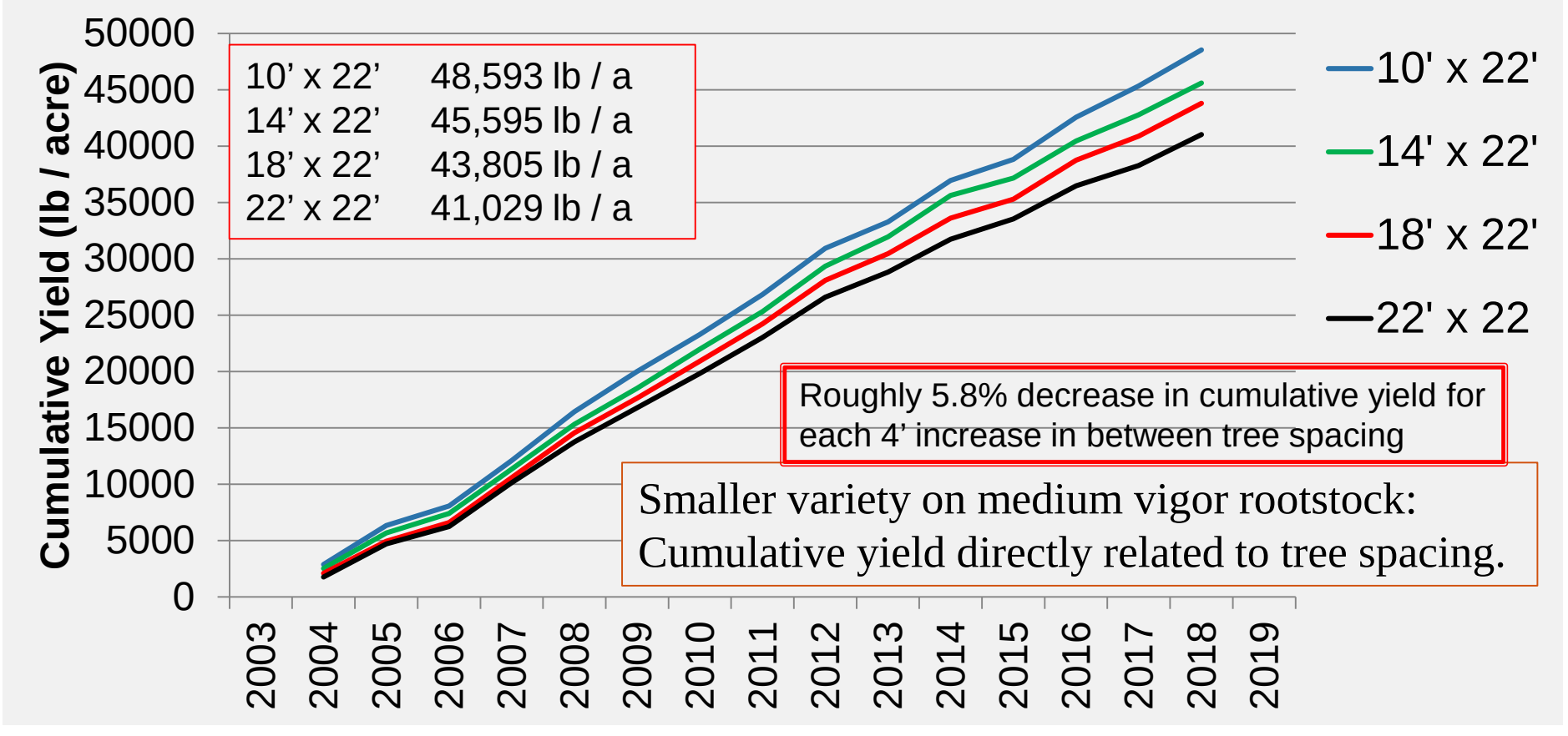
# The Effect of Tree Spacing on Cumulative Yield Through 20th Leaf

## Nonpareil on Hansen



# The Effect of Tree Spacing on Cumulative Yield Through 19th Season

## Carmel on Nemaguard



# Conclusions:

- We probably have worried too much about trees shading each other out with close spacing (see pruning story)
- Don’t expect a big yield bump from close spacing if trees are really fast growing
- Probably a greater risk of yield loss from planting too far apart than too close together

# Costs of Higher Density

- For every one foot reduction in row width (e.g., 22’ to 21’), many costs are increased by 5%
  - Strip fumigation, mowing, spraying, herbicides, irrigation hoses, sprinklers, etc.
  - Planting trees closer down the rows does not increase most on-going costs

# Thank you for your Attention

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