# Literature Review of Canopy Management in oil olive orchards in high density and super-high intensive olive orchards

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# How muc enough?

South Side

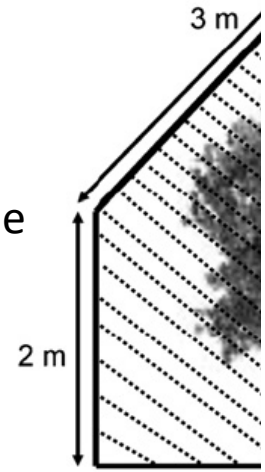
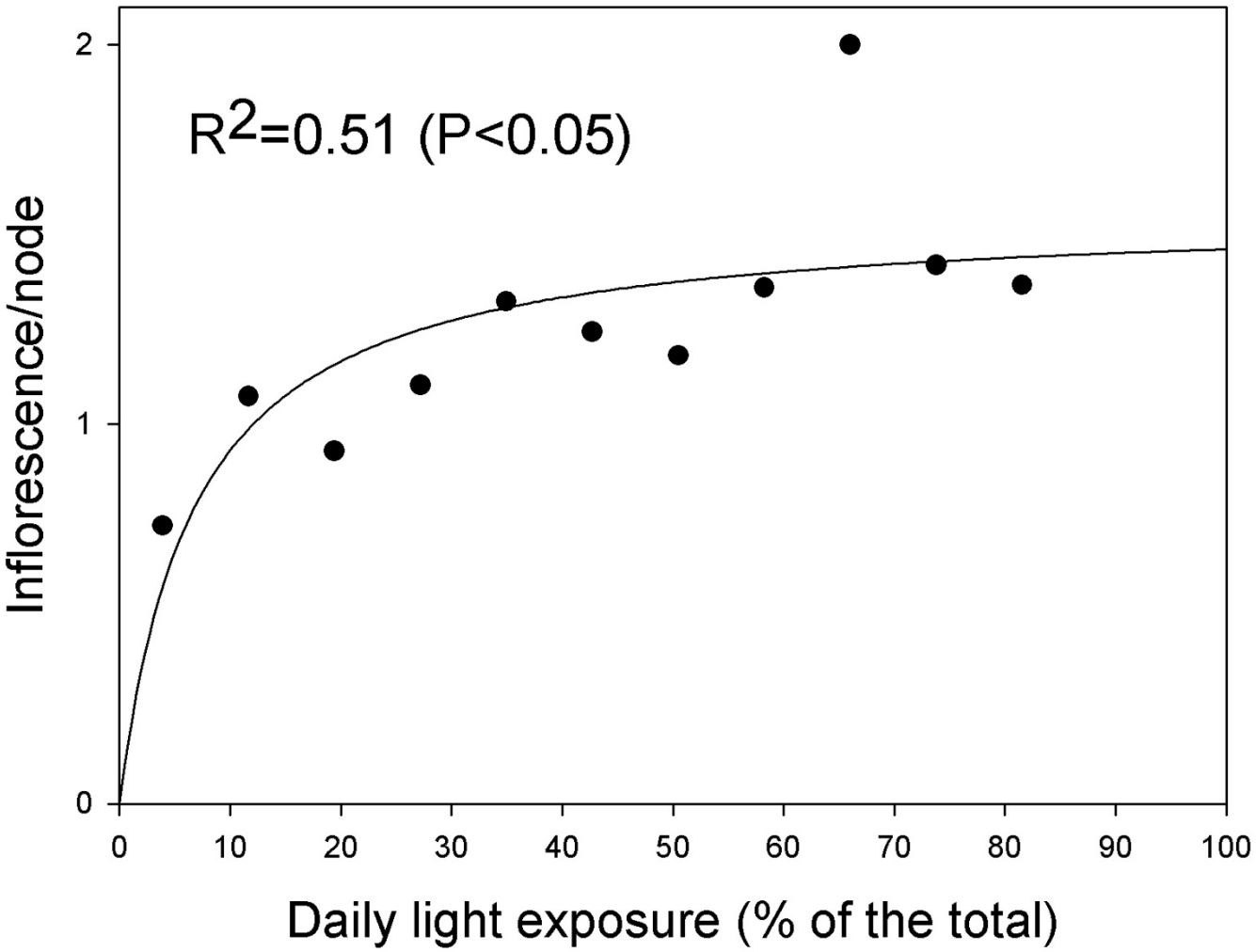
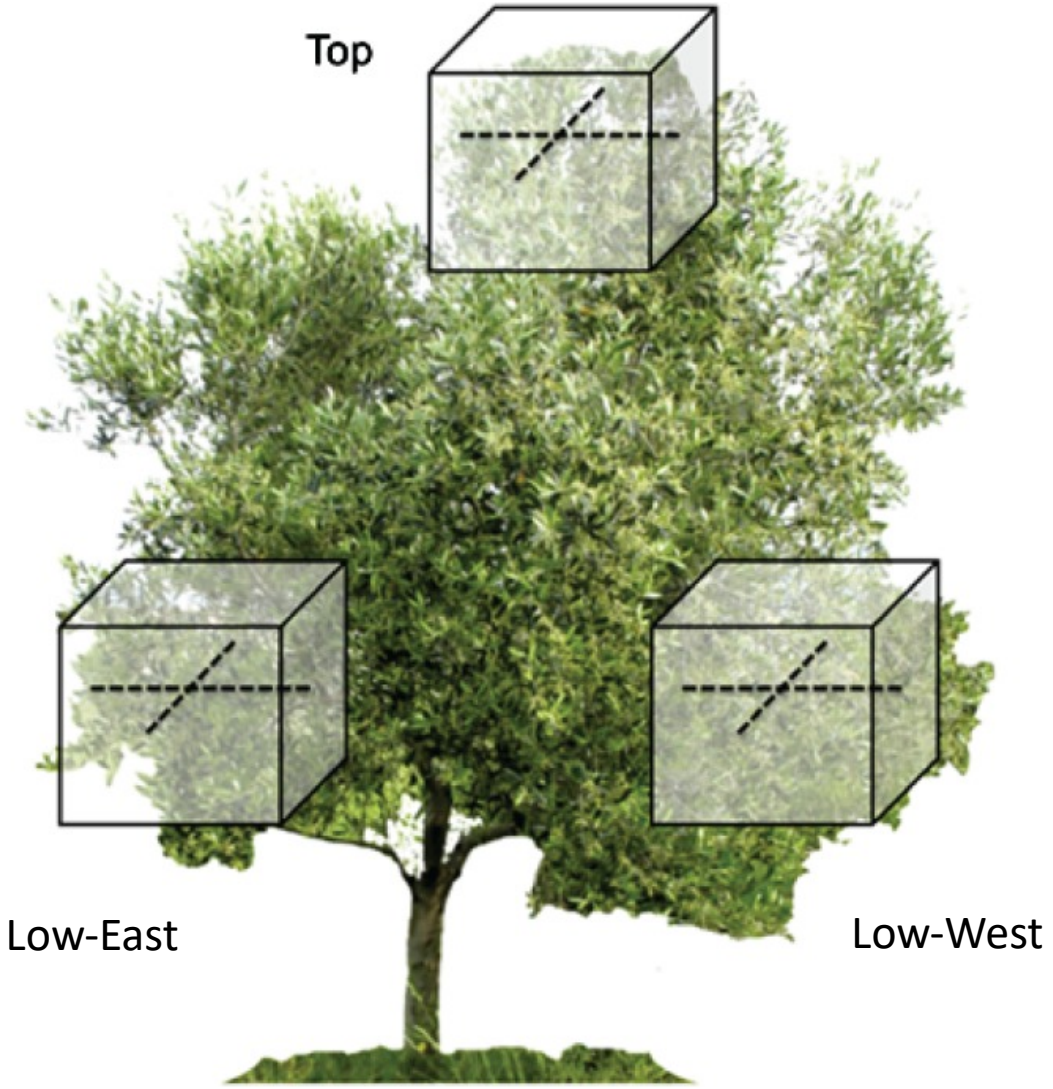



Fig. 1. Diagrammatic sid

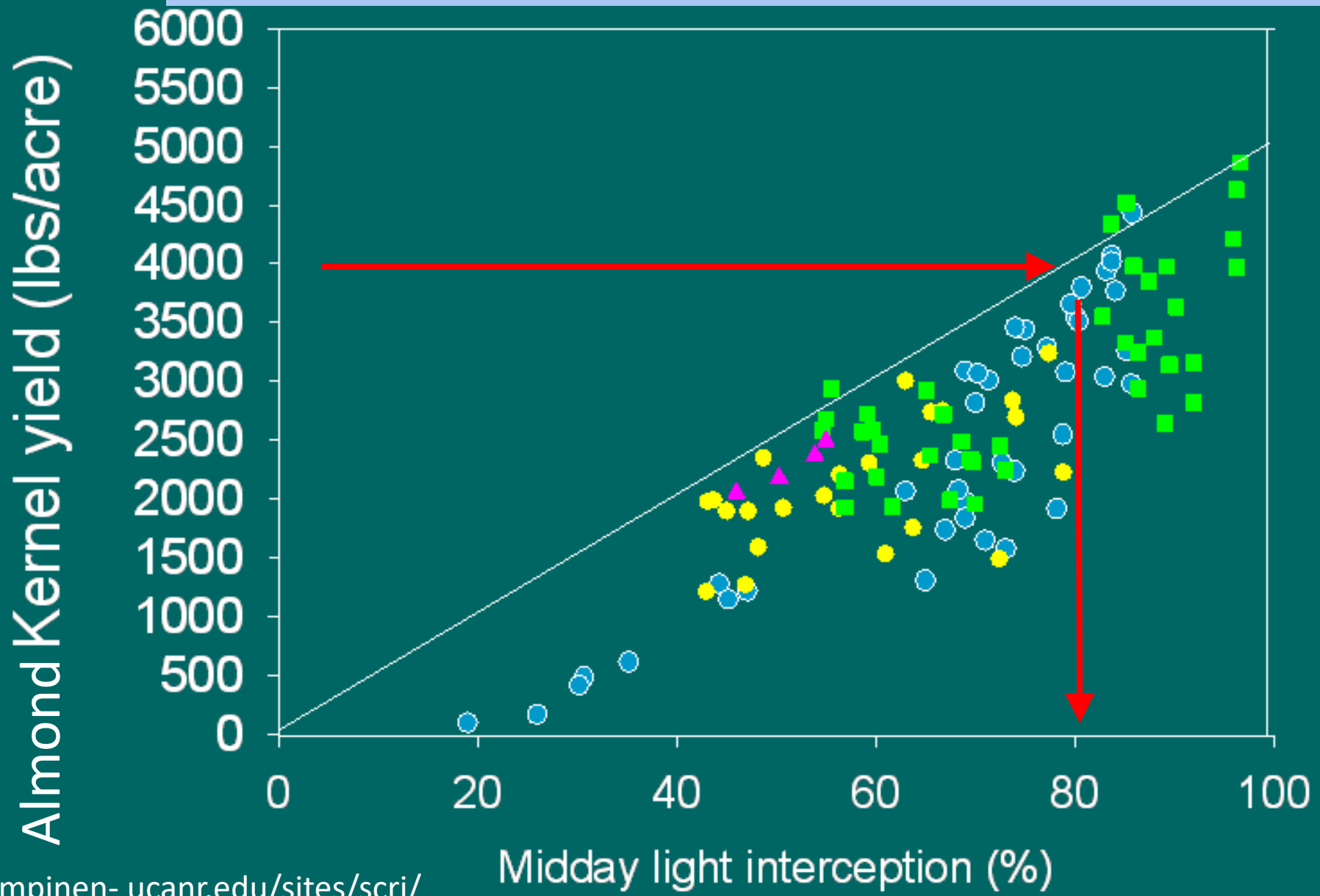



In Cherbiy-Hoffmann, et al., 2013.

- Typically fruit low in canopy compared to the top are:
  1. Smaller
  2. Lower in number
  3. Lower oil content
  4. Lower oil quality
  5. Less mature



potential production = % PAR intercepted x 50 kernel lbs/a

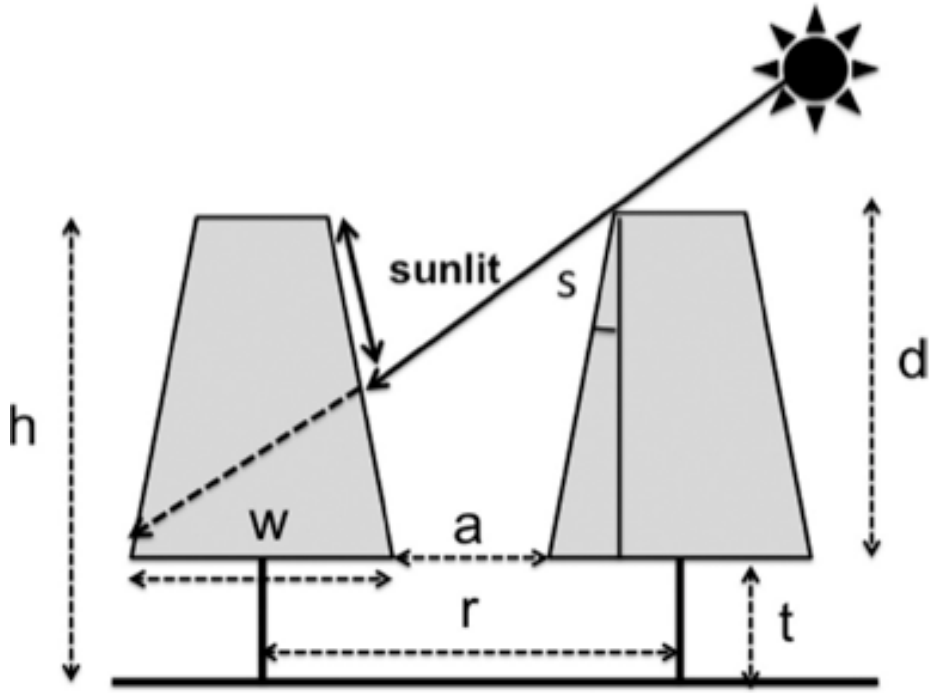



Lampinen- ucanr.edu/sites/scri/

At noon, light interception ~ 50 %. (~4-5 t/a fruit)

At noon, light interception ~74-84 %. (~10.7 t/a fruit)

# Production Model (Connor et al.,)




Simulation of yield and oil quality as affected by canopy depth, width, shape and d row spacing.

Uses a model of illumination of hedgerow orchards and associated data on yield and oil quality collected from a range of SHD orchards of the variety Arbequina in Spain,

Predict optimum yield and quality when d/a=1

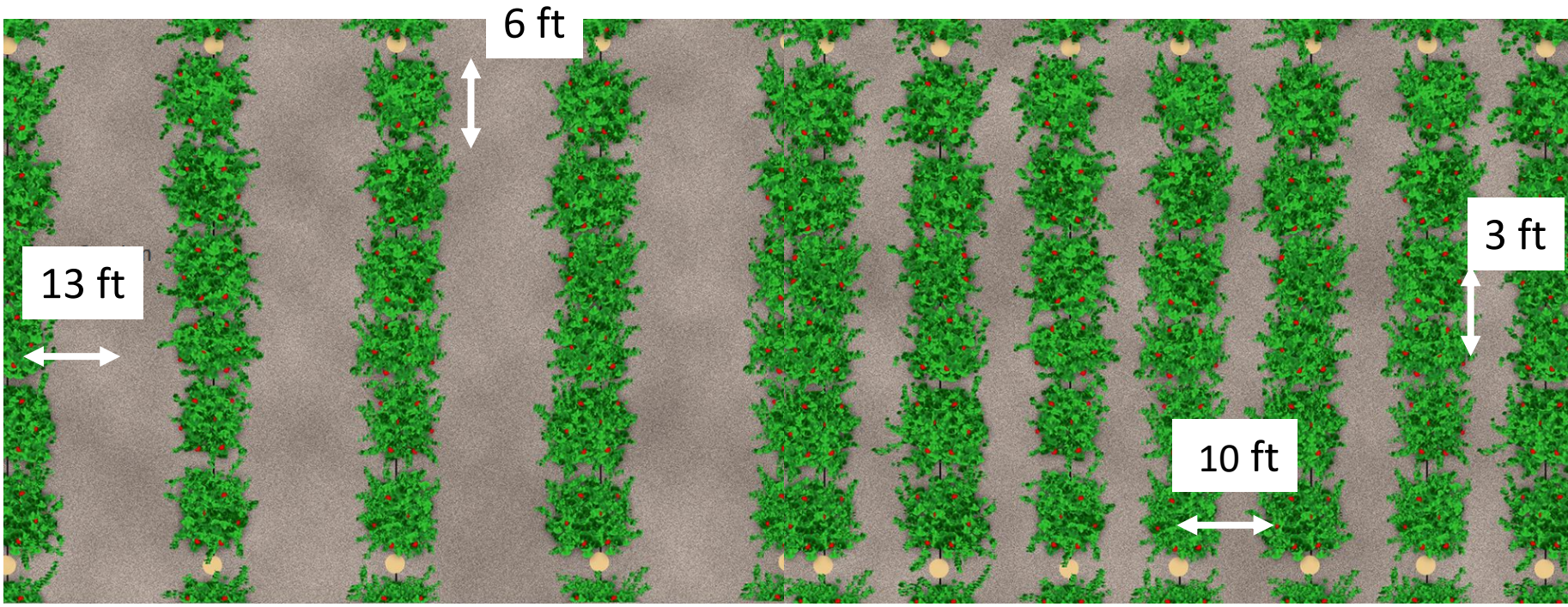
Not applicable to east west plantings

# Row Orientation for Hedgerow Plantings

- North South recommended, results in symmetrical light interception (east side in am and west side in pm) vs asymmetrical interception for East West plantings
- Literature review of orchard crops revealed 20% yield advantage to North-South planting (Trentecoste et al. 2015).
- If North-South plantings are impractical due to land constraints, good yields and quality can be achieved with East-West planting
- More research is needed to better define to plantings for better application and management of these systems

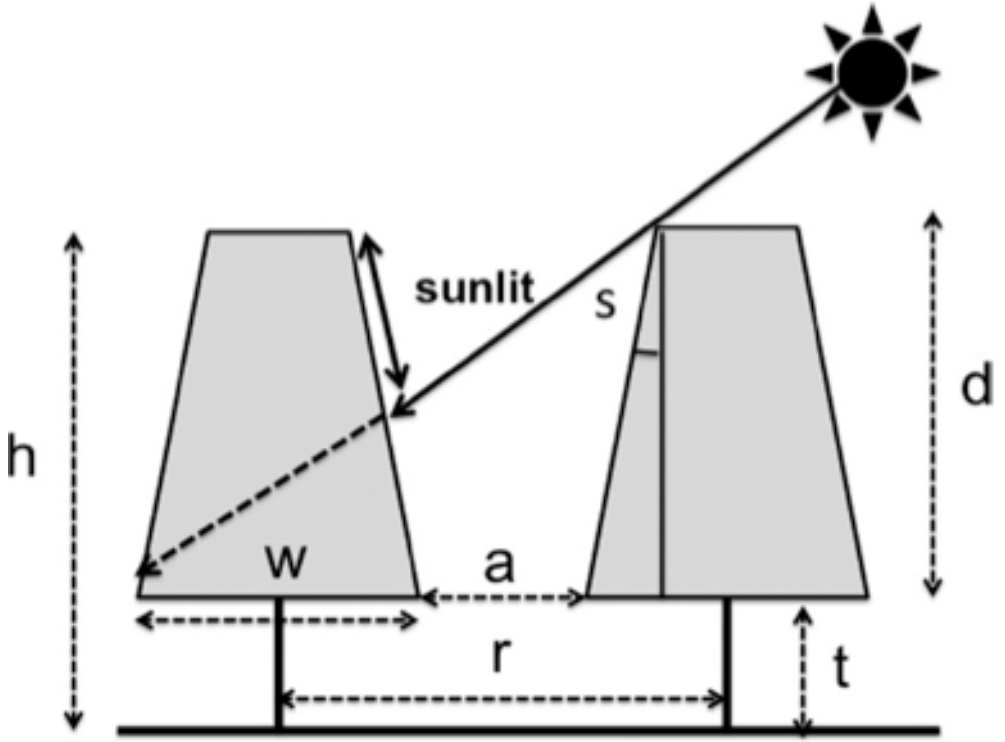
# Increase light interception (production) by:

- Decrease in-row spacing- effects early production until canopies close in row
- Decrease between-row spacing (alley width) increases row length/area
- Increase tree height



# Model

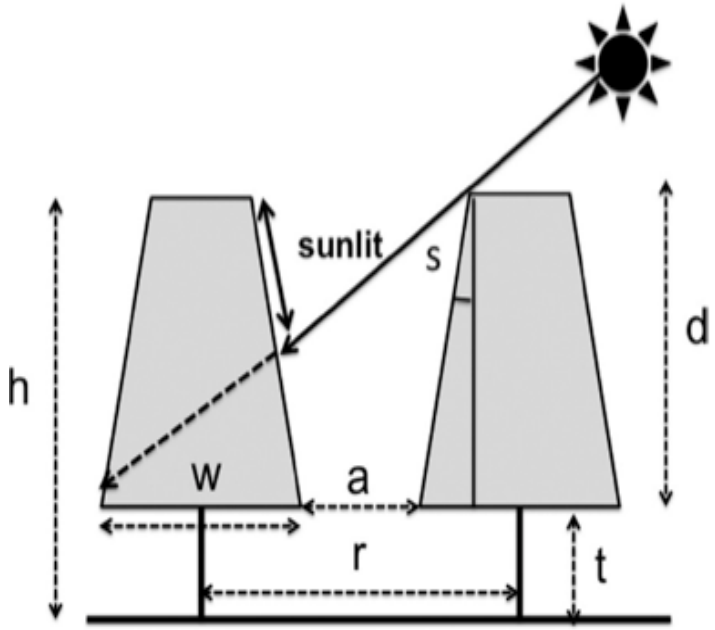
- Model assumes most of fruit on the outer canopy, which may not be true for some varieties (Trentacoste, 2018)
- Recent studies have indicated a d a ratio of 2 to 1 as being most productive
- Regardless, provides a useful framework to evaluate the effects of orchard design on fruit yield and quality



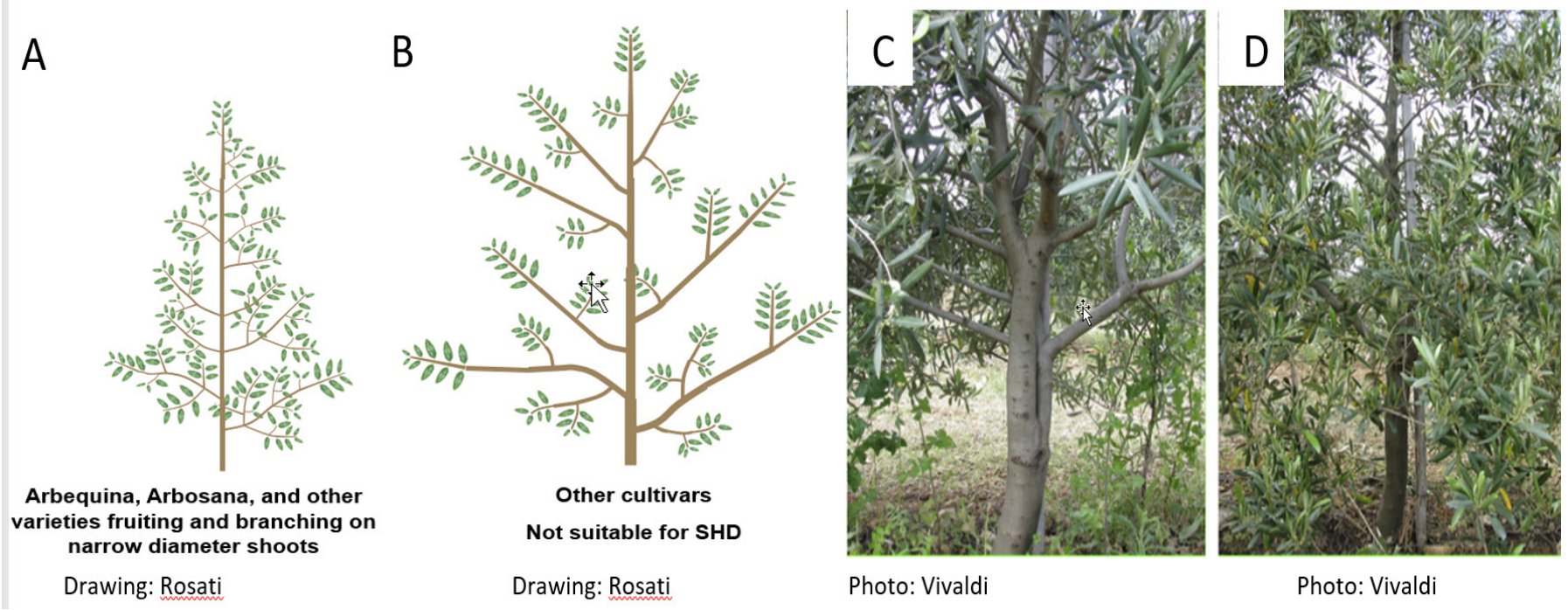

Connor et al. 2012

# Model Extended to Wider Canopies (High Density)

- Slope on canopy increases sunlit area on canopy wall
- Improved illumination allows for closer row spacing allowing for greater row length per area
- More applicable to HD than SHD
- i.e. a 10 degree slope on a 12 ft deep canopy with a 9 ft with increases yield by approximately 25%

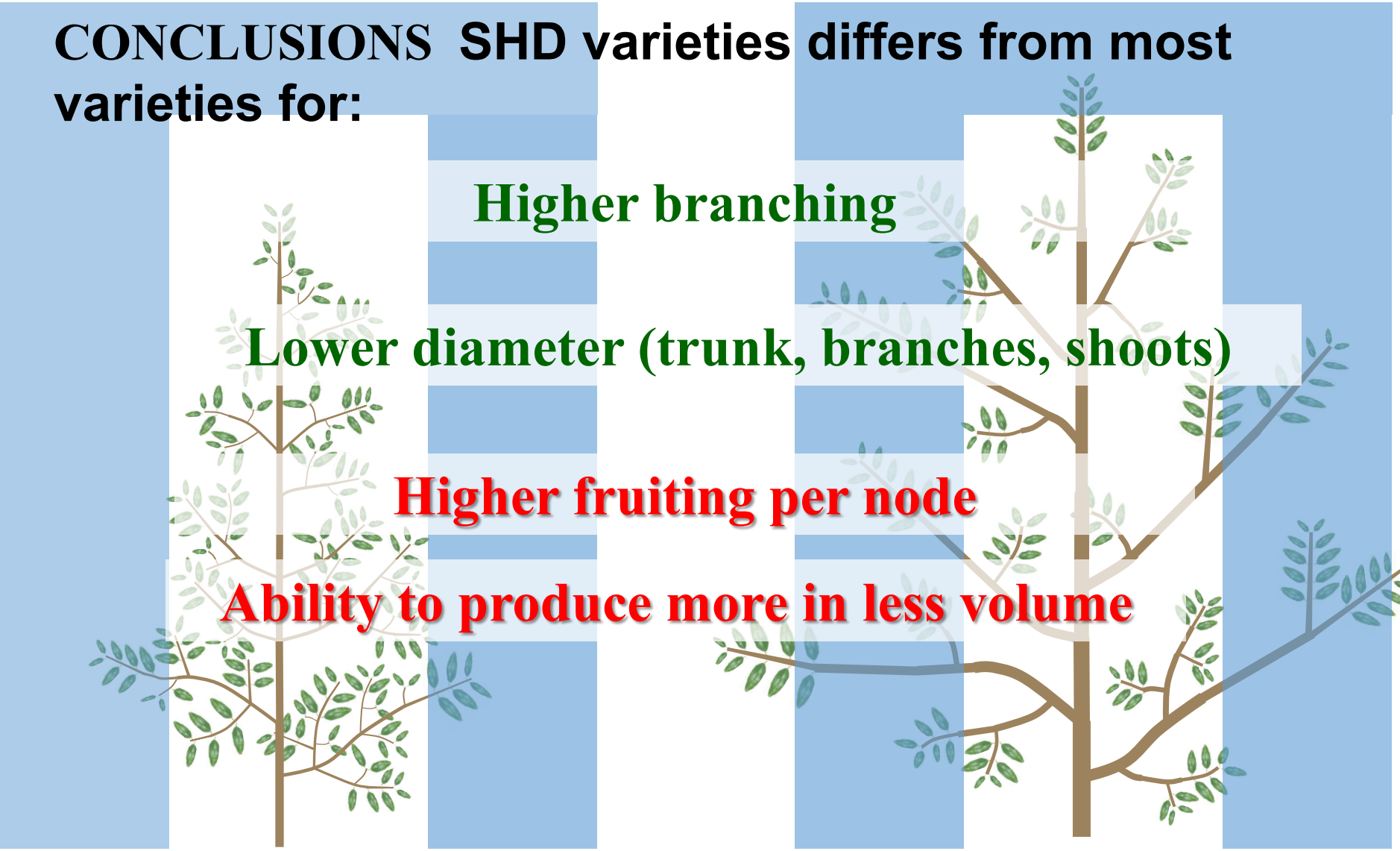



# Variety Characteristics Related to HD and SHD Planting




Schematic of trees fruiting on small diameter branches conducive to SHD orchards (A), i.e. ‘Koronieki’ (D) and not suitable for SHD (B) i.e.‘Coratina’ (C)

**CONCLUSIONS** SHD varieties differs from most varieties for:



Higher branching

Lower diameter (trunk, branches, shoots)

Higher fruiting per node

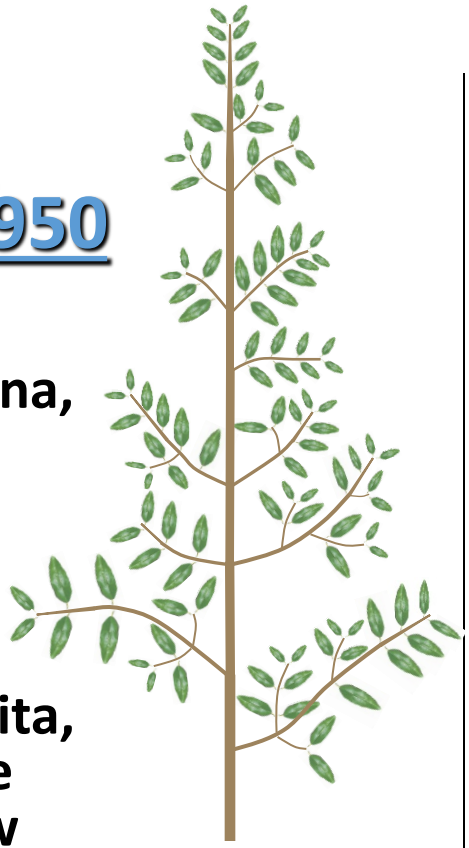
Ability to produce more in less volume

**Useful for variety choice and breeding**

# Varieties Based on System

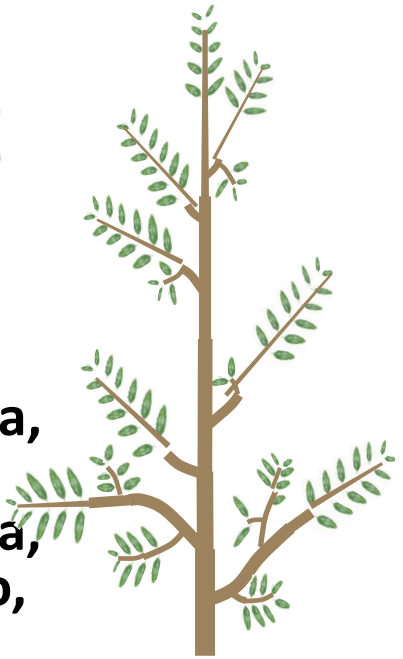
## Super-High Density (600-950 trees/a)

- **Arbequina, Arbosana, Koroneiki**
- **I-77, Don Carlo, Favolosa, Diana, Urano, Askal, Sikitita, Maurino, Charmille and AJ-17, and new varieties**
- **Did poorly on trials- FS-17, Tosca**



## High Density (100-350 trees/a)

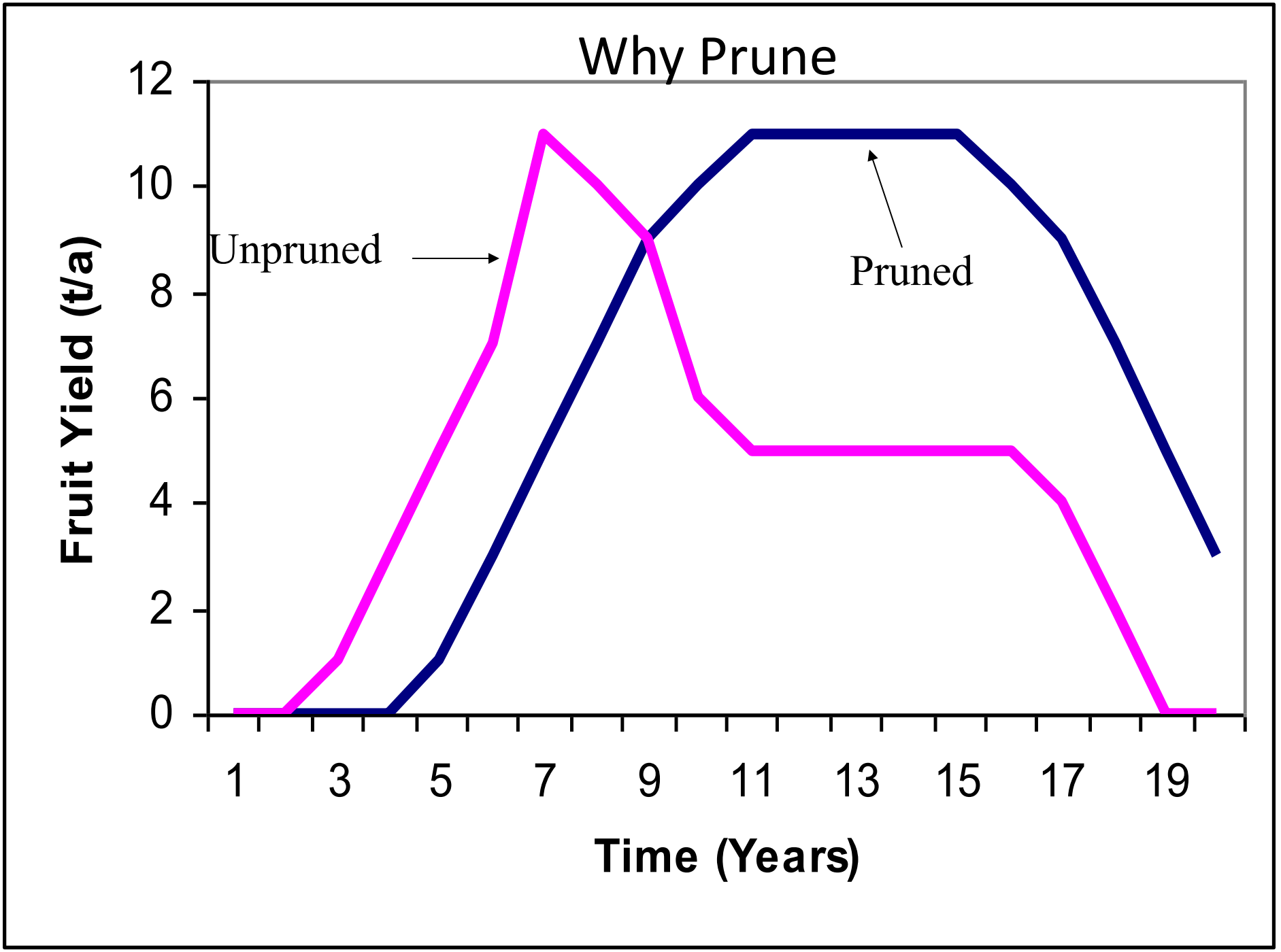
- **Arbequina,Arauco, Manzanillo, Coratina, Picual, Barnea, Frantoio, Hojiblanca, Correggiola, Leccino, Nevadillo, etc.**



Marino et al., 2017

Rosati et al., 2013

Gómez-del-Campo etal.,2010

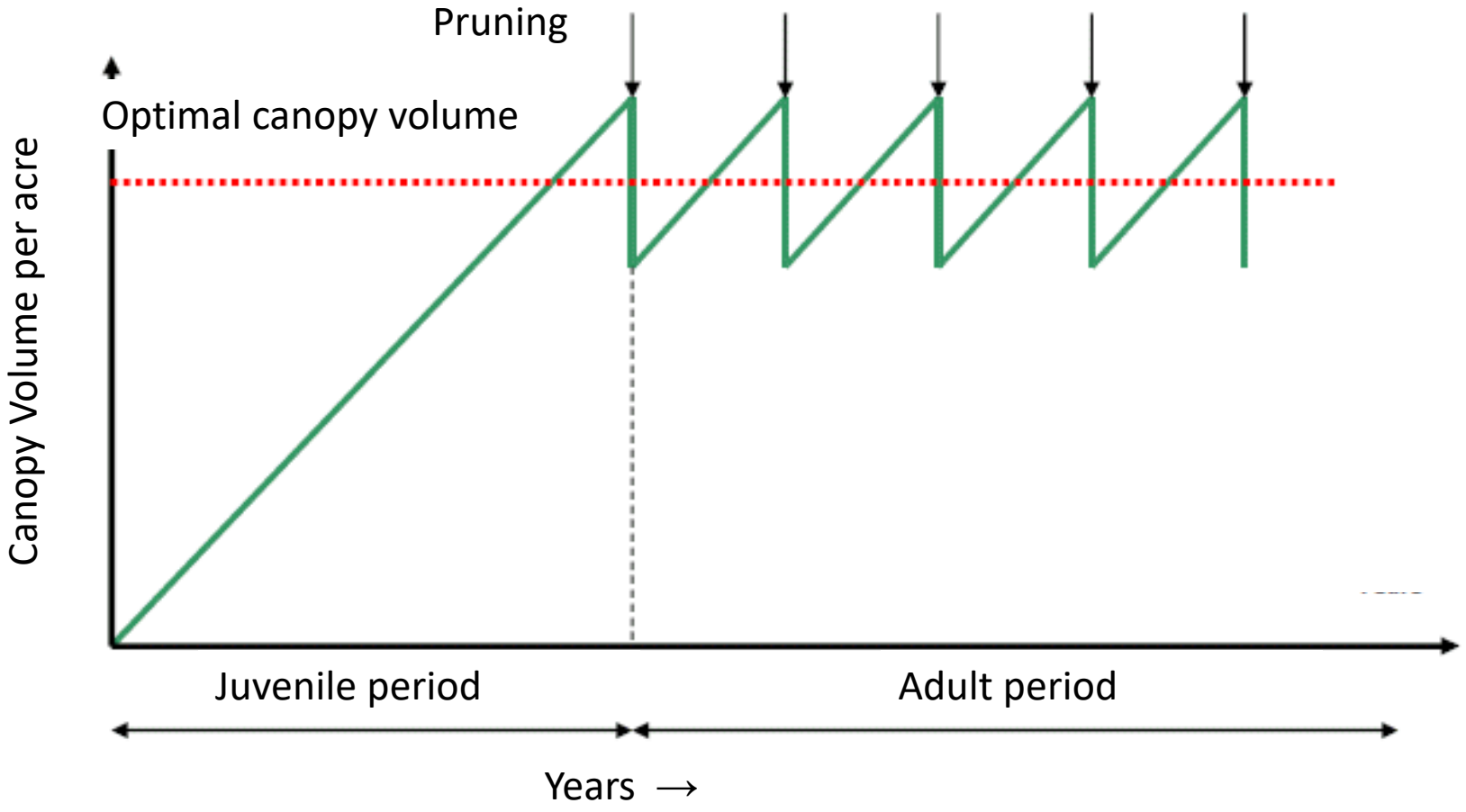

Why Prune
12
10
8
6
4
2
0
Fruit Yield (t/a)
Unpruned
Pruned
1
3
5
7
9
11
13
15
17
19
Time (Years)

# Canopy Management for Mechanical Harvest

- Harvesting is the key issue in olive production
- Primary requirement of hedgerow design is that the distance between adjacent hedgerows (i.e. alley width) is wide enough for entry of all equipment, (hedgerow dimensions should match harvesting machinery)

photo: Boundary Bend

# Goal: Maintain optimal canopy volume to maximize yield while maintaining mechanical access

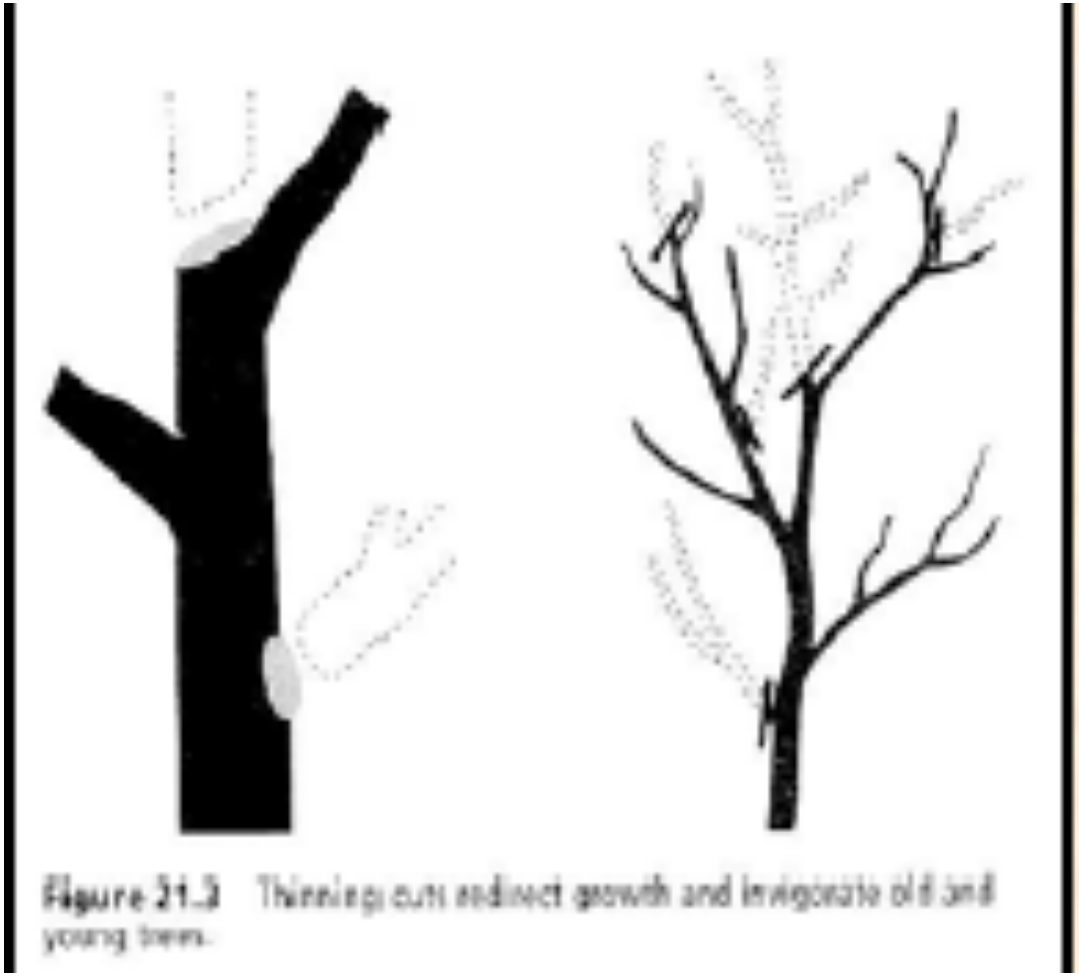



Adopted from Ravetti, 2011

# How to Prune:

**Thinning Cuts**

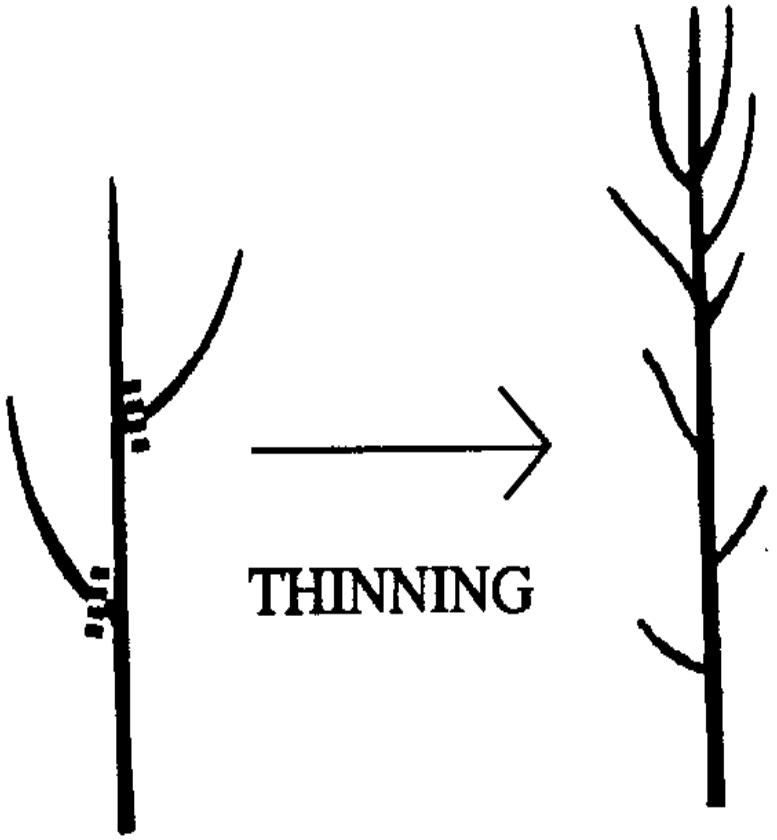
Thinning is the complete removal, at the point of origin, of a branch or limb.



# Pruning Remove the Source of Auxin

## Thinning cut

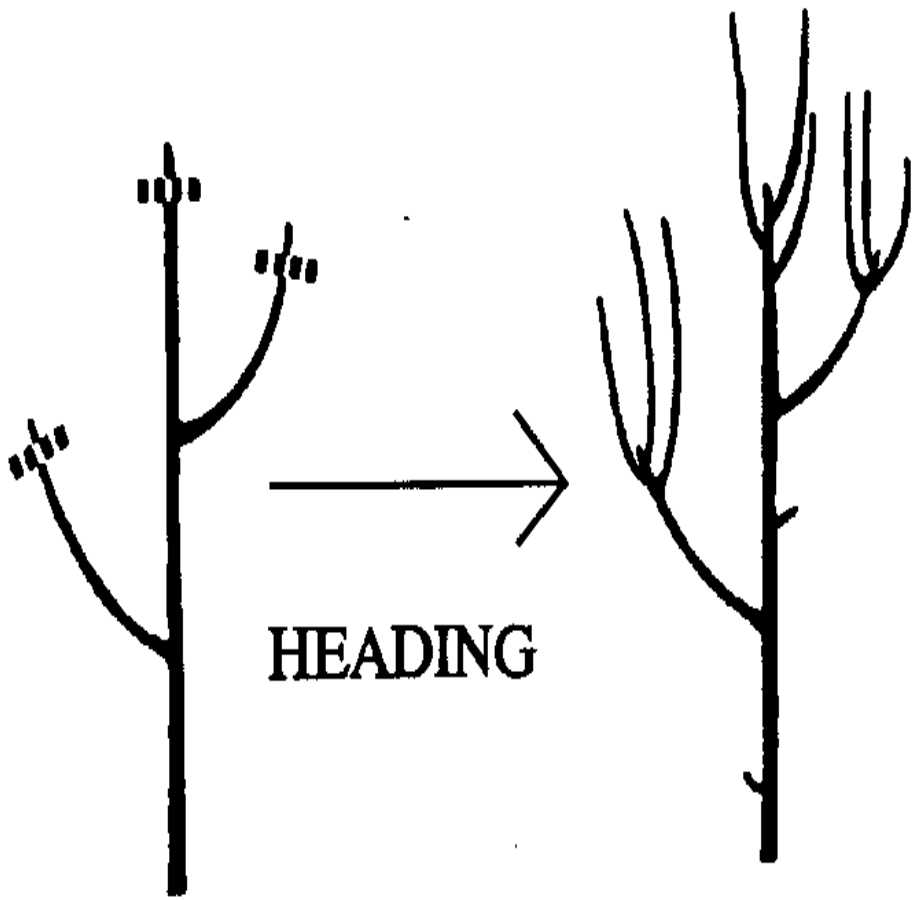
- ***Remove branch at point of origin***
- ***Least invigorating cut***
- ***Promote light penetration canopy***
- ***Maintenance pruning***



# Pruning - Remove the Source of Auxin

## Heading Cut

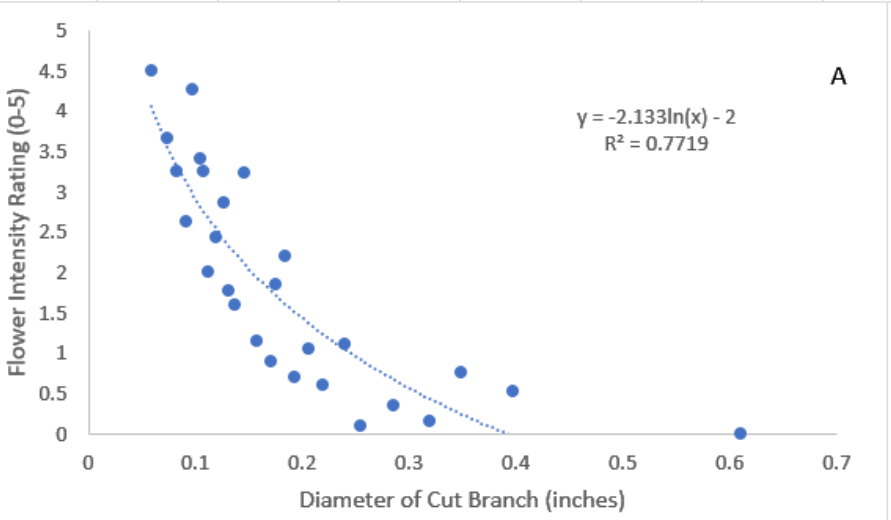
- ***Remove part of the branch***
- ***Stimulate bud break near cut***
- ***Stimulate localized branching***
- ***Mechanical cuts are heading cuts***

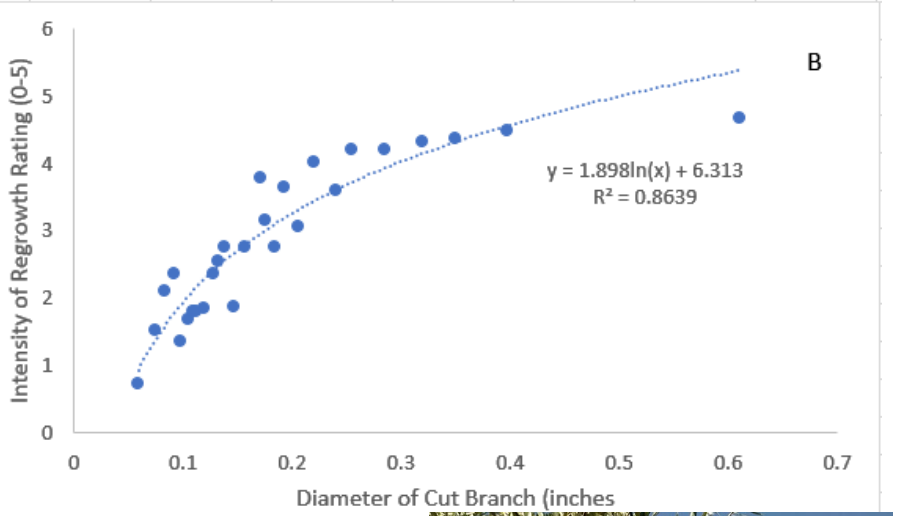


# Timing of Pruning

- Winter pruning by hand or mechanically results in more vigorous regrowth compared to summer pruning
- Winter pruning in opens tree canopies and can result in freeze injury in colder climates
- Limited research suggests preferred timing for hedging spring to early summer and mid summer for topping

# Severity of Pruning



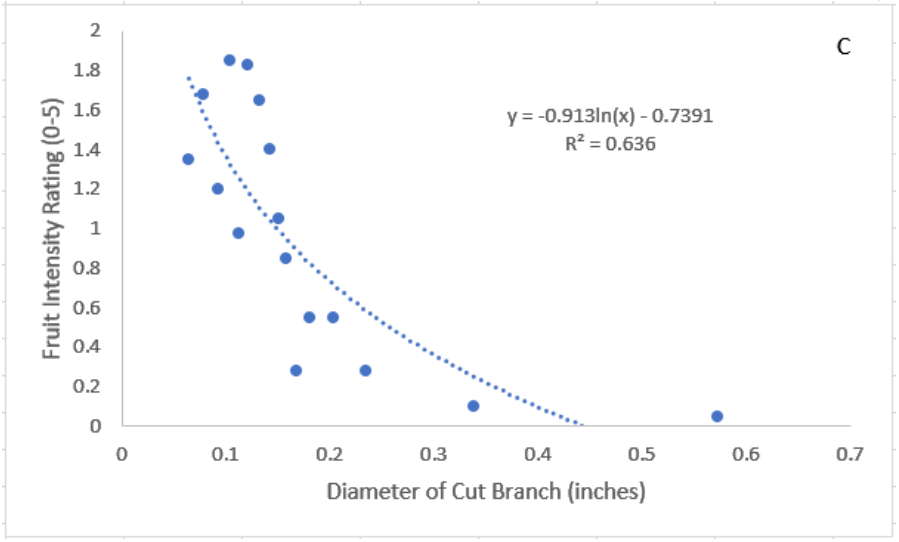
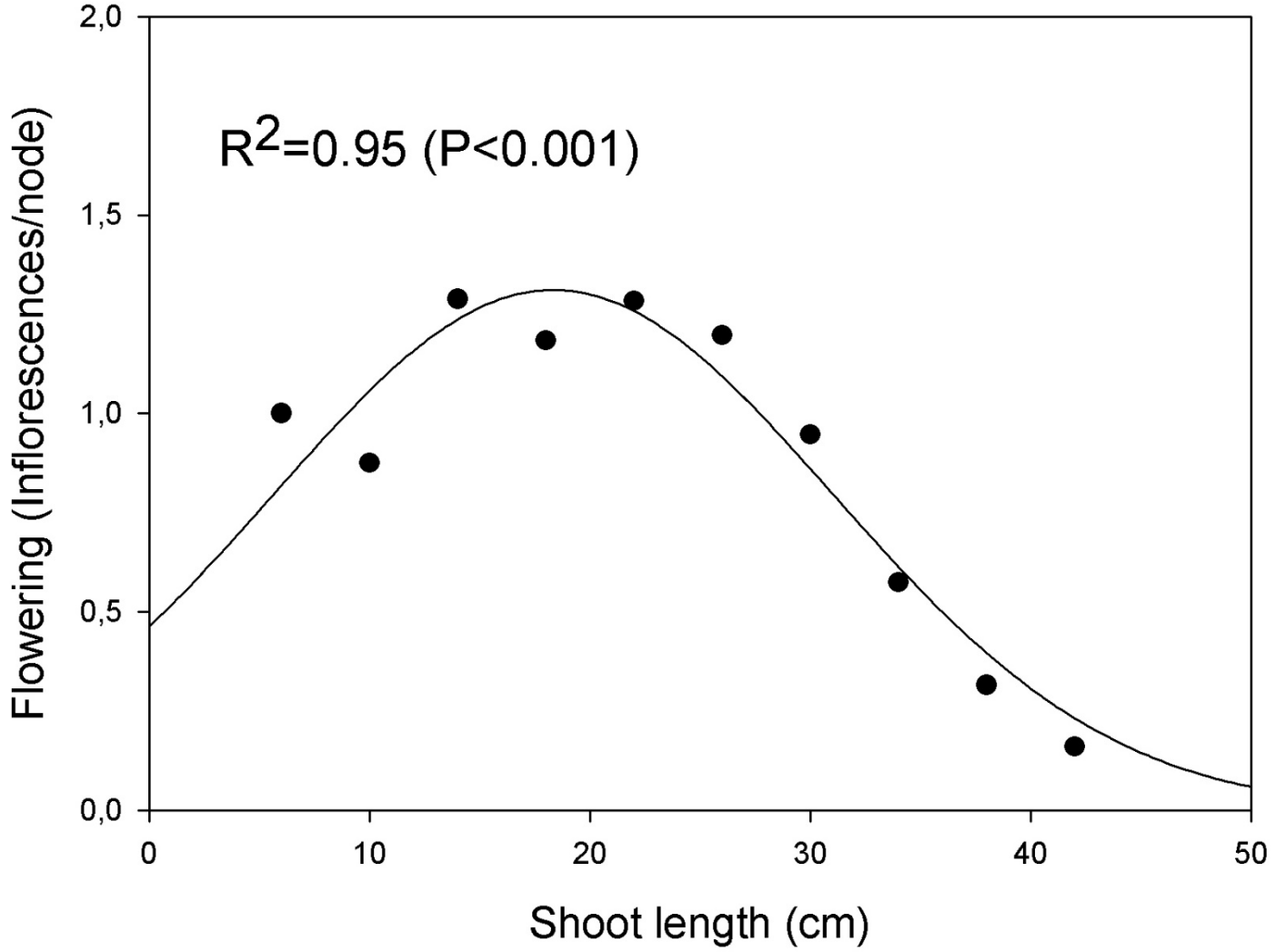




Figure. Effects of previous season's branch cut diameter on current season's flower (A), vegetative regrowth (B), and fruiting (C) intensity rating (0 = no flowers, fruits or no growth; 5=excessive flowering, fruiting, or growth) in 'Arbequina'

# Maurino




Tombesi and Farinelli, 2011

# Alternate side vs alternate row hedging

- In walnuts alternate side hedging was more productive than both side hedging in alternate rows (Ramos et al. 1991).
- In Olives, two studies have recorded the effect of simultaneous mechanical hedging of both sides of olive hedgerows (Albarracín et al., 2017; Vivaldi et al., 2015).

- 1. Oil yield ↓ in the current season recovered the following season. Over three years cumulative oil yields were equal for hedged and unhedged.

- 2. Hedging and topping ↓ oil yield for 3 years in high- but not in low-vigor cultivars (e.g. Arbequina and Arbosana), low vigor varieties with fruiting near the trunk.
- Alternate year hedging maintained hedge row dimensions and oil production in two successive growing seasons. (Trentacoste et al 2018).

# Frequency of hedging

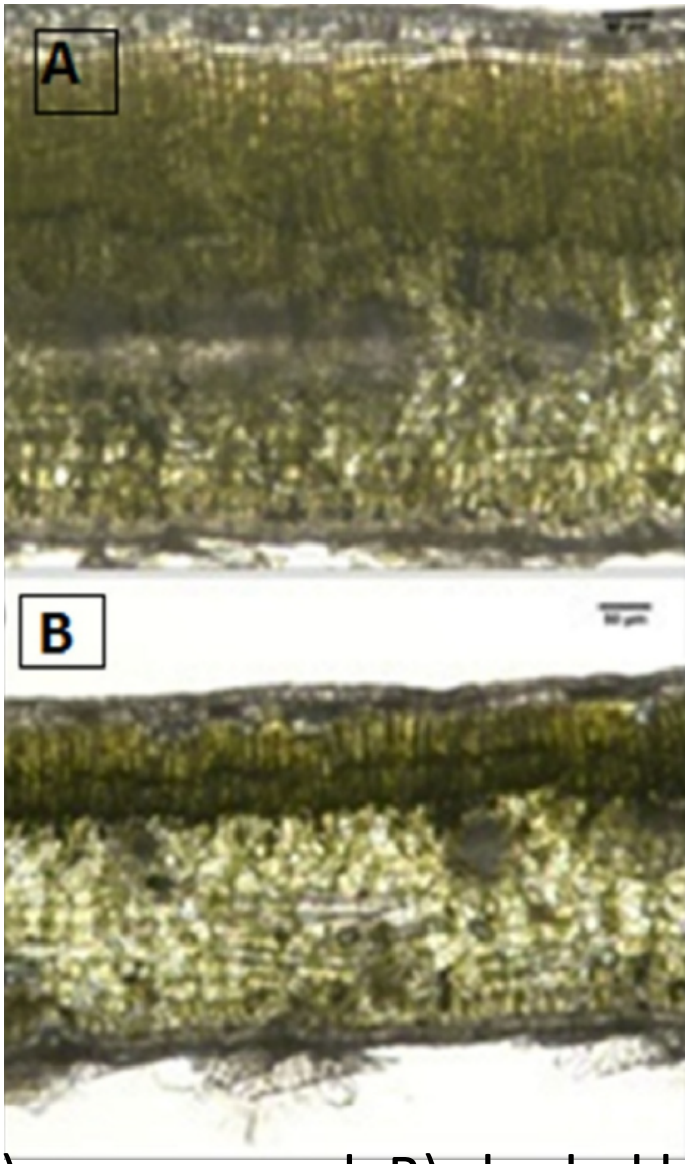
- Walnuts are typically hedged on alternate side on a 3 or 4 year rotation
- Some olive growers have adopted a 3 year cycle of alternate side hedging.
- Tree vigor and growth will likely be a determining factor
- Longer intervals may result in heavy pruning which can delay return to production
- More research is necessary

# Canopy Management Summary

1. Light Levels
   - Maximize leaf area exposed to at least 50% full sun
2. Light Models on Canopy Mgt
   - D/A ~ 2 for max yield
3. Hedging and topping timing
   - Hedging - spring
   - Topping – mid summer
4. Hedging severity and frequency
   - Avoid hedging branches > ¼ " in diameter (stay vegetative)
   - avoid severe topping & hedging
5. Varietal effects on Canopy Mgt
   - SHD varieties ↓ shoot diameter, ↑ branching, ↑ flowers per node.
6. Light effects on fruit and shoot growth
   - fruit & shoot growth needed 30-40% light
7. Mechanical pruning timing, severity, frequency
   a. Alternate year hedging, avoid severe topping & hedging

Specific Leaf Weight = leaf area/weight

Directly correlated to sun exposure




A) sun exposed, B) shaded leaves

Photo: Ajmi et al., 2018

# Additional Research Needs

- Must be able to maintain tree shape and size suitable for mechanical harvest without excessive shading or pruning resulting in vigorous non productive growth.
- Timing of mechanical pruning - optimum use of summer pruning especially topping to reduce vigor without loss of yield
- Effect of time of pruning on return bloom
- Frequency of pruning- alternate year, or a 3 or 4 year cycle etc.
- Varietal response to hedging and topping