Understanding How Fruit Trees Work
“Reviewing the Fundamentals”

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The Fundamentals:

The overall objective of all cropping systems is **to maximize resource capture** and **optimize resource use** to achieve sustainable economic yields.

What resources are we mainly interested in?

- light energy
- carbon
- oxygen
- water
- nutrients

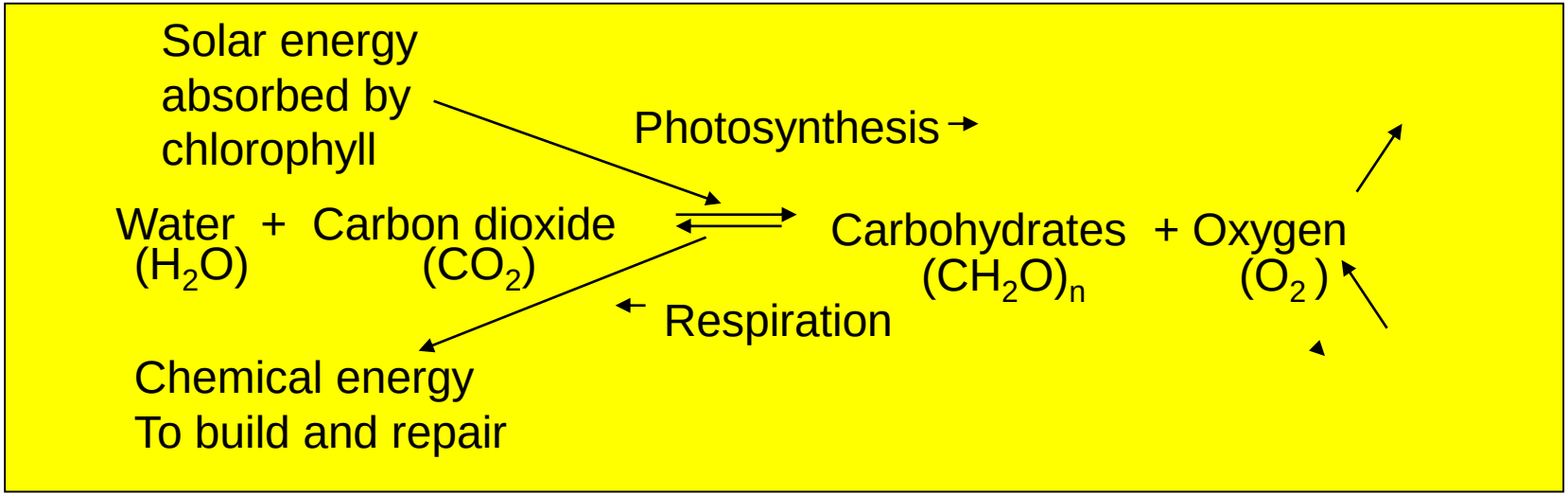
What are the three most prominent chemical elements in dry plant parts?

Carbon C
Hydrogen H
Oxygen O
(Roughly in a ratio of 40:7:53)

Where does all that C H O come from?

PHOTOSYNTHESIS!

The basic photosynthesis/respiration reactions
(the most important processes for supporting life on the planet)



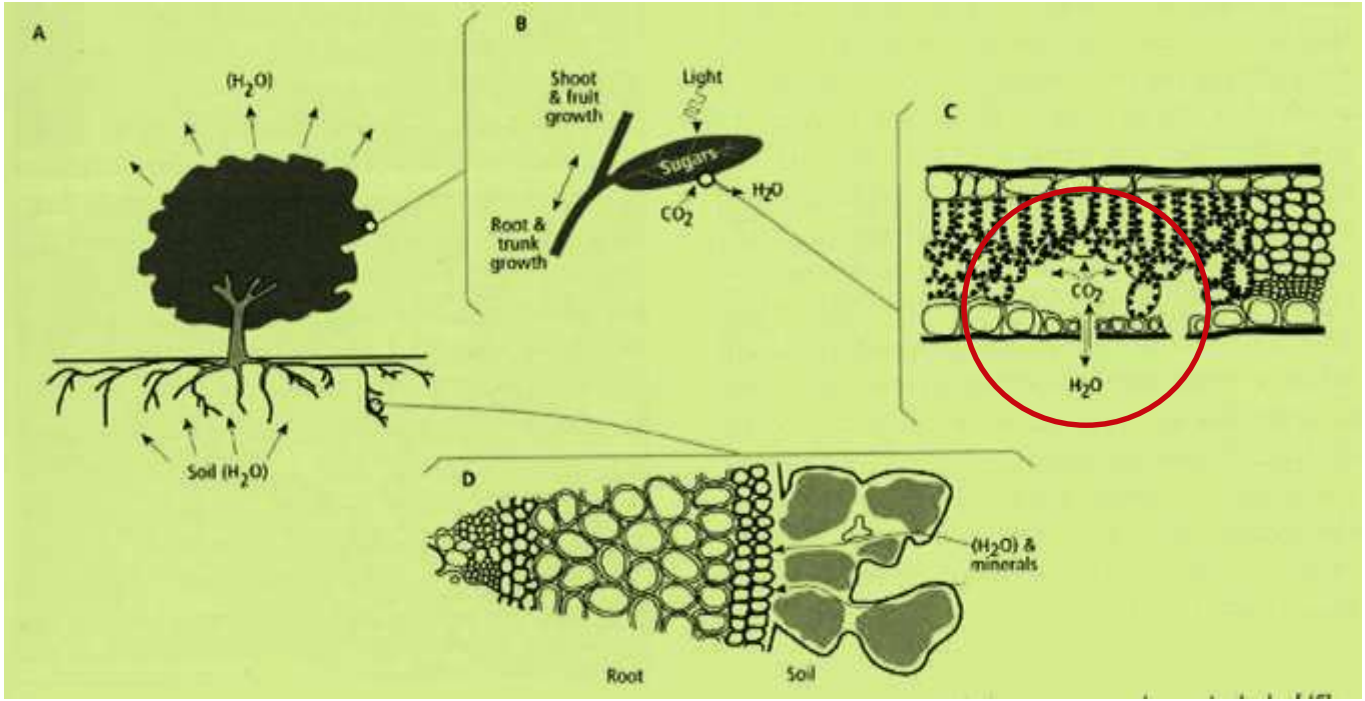
Plants, nature's original solar energy collectors

- What are nature's natural solar energy cells?
- Chloroplasts

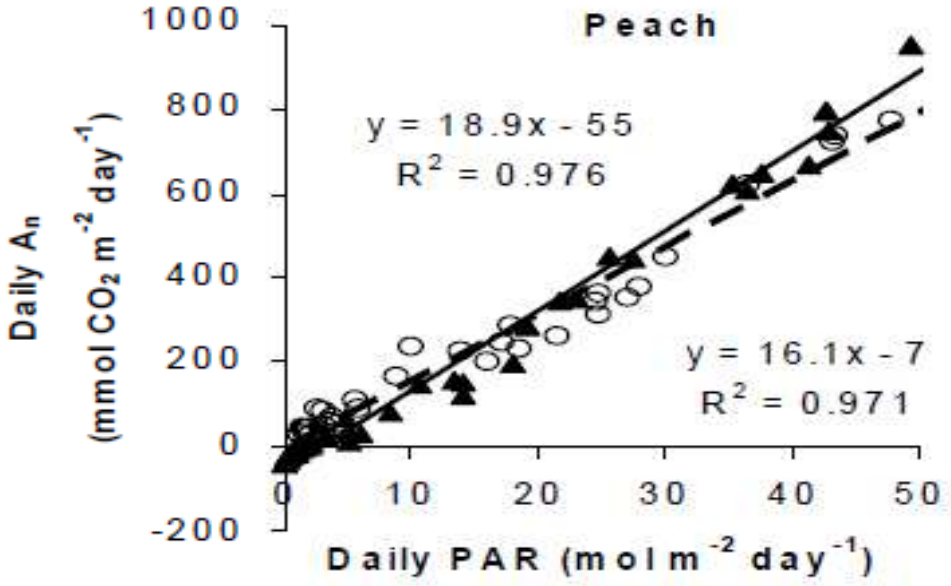
The primary function of tree structure is **to support and display leaves** and the sole function of leaves is **to house and display chloroplasts for solar energy collection**.

- Problem: chloroplasts need an aqueous environment to function, air is dry and CO_2 from air is required for photosynthesis.
- Solution: leaves with waxy cuticle to prevent dehydration and air control vents called stomates.

Carrying out photosynthesis is always a compromise between taking up CO_2 and losing H_20.

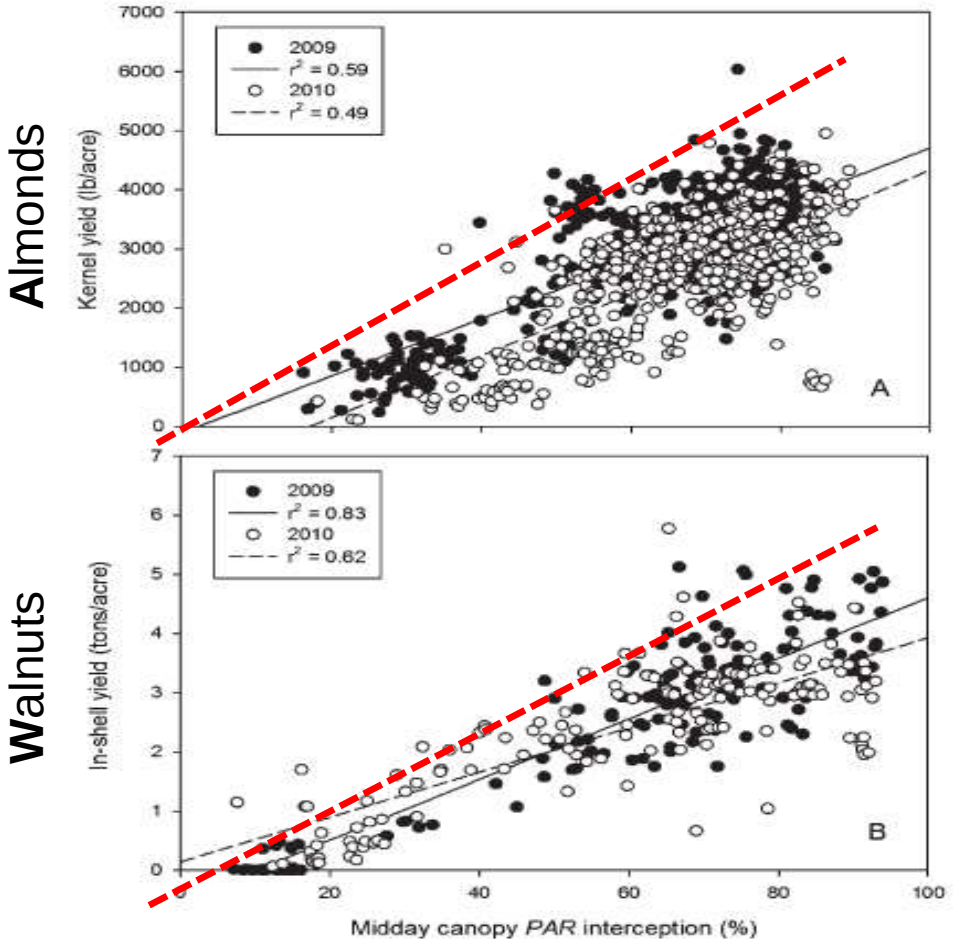


direct function of the light intercepted by the canopy during a day.



Rosati, et al. 2002. Acta Hort. 584: 89-94

Light interception (that drives photosynthesis) is related to crop yield but why then is there so much scatter in all of these points?

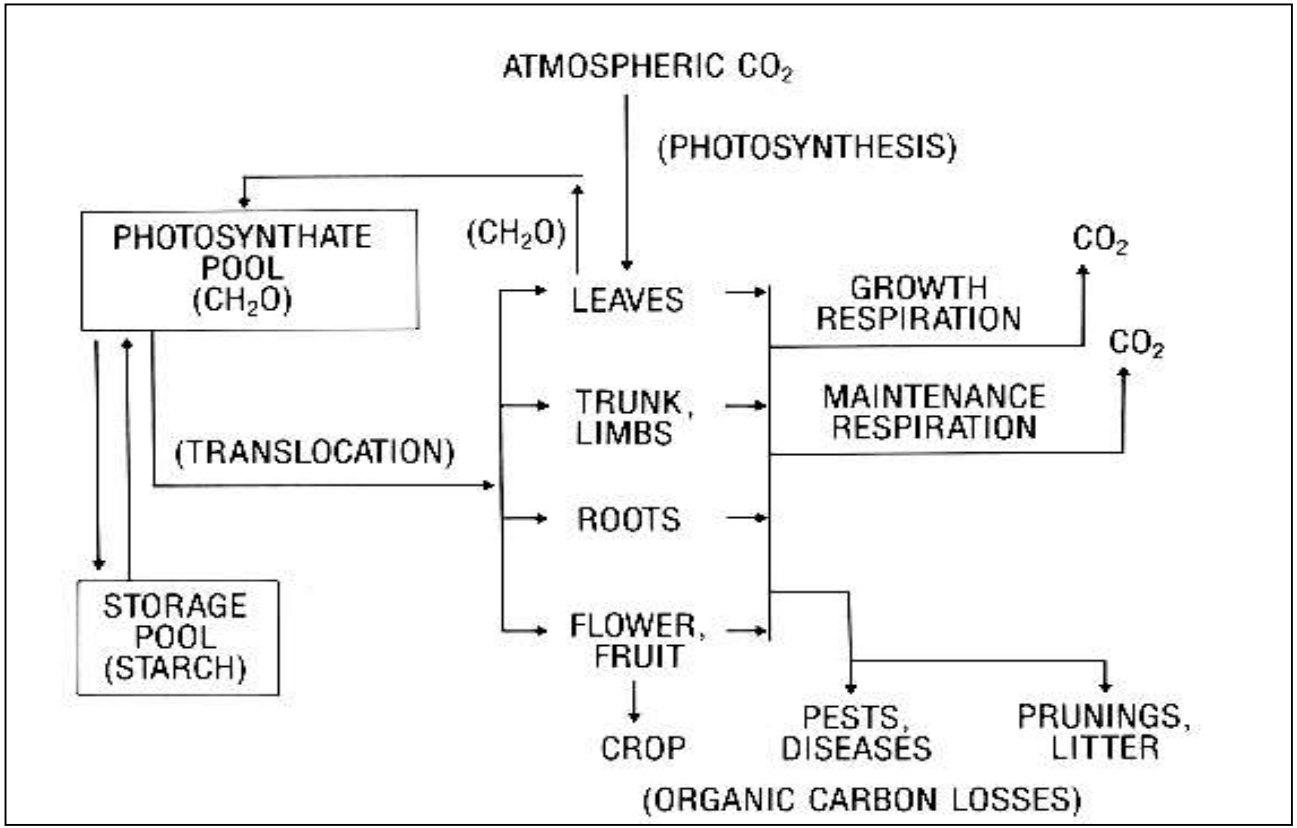


Lampinen, et al.,2012

Carbon distribution within the tree

The translocated CH_2O's are mainly sorbitol, sucrose and glucose in almond trees.

(This is a conceptual diagram of where the CH_2O's go but how does that happen?)



What determines how and where CHO’s are used within the tree?

This is a question that has received much attention over the past 50 years and scientists still disagree about it.

However, I believe it is relatively simple.

Carbon distribution is mainly controlled by the development and growth patterns of individual organs and their ability to compete for CH_2O's.

- A tree is a collection of semi-autonomous organs and each organ type has an organ- specific developmental pattern and growth potential.
- Organ growth is activated by endogenous and/or environmental signals.
- Once activated, environmental conditions and genetics determine conditional organ growth capacity.
- Realized organ growth for a given time interval is a consequence of organ growth capacity, resource availability and inter-organ competition for resources.
- Inter-organ competition for CH_2Os is a function of location relative to sources and sinks of CH_2Os, transport resistances, organ sink efficiency and organ microenvironment.

Bottom line: ***The tree does not allocate CH_2Os to organs, organ growth and respiration takes it from the tree.***

examples of this concept at work is this type of tree.

Five cultivars on one tree

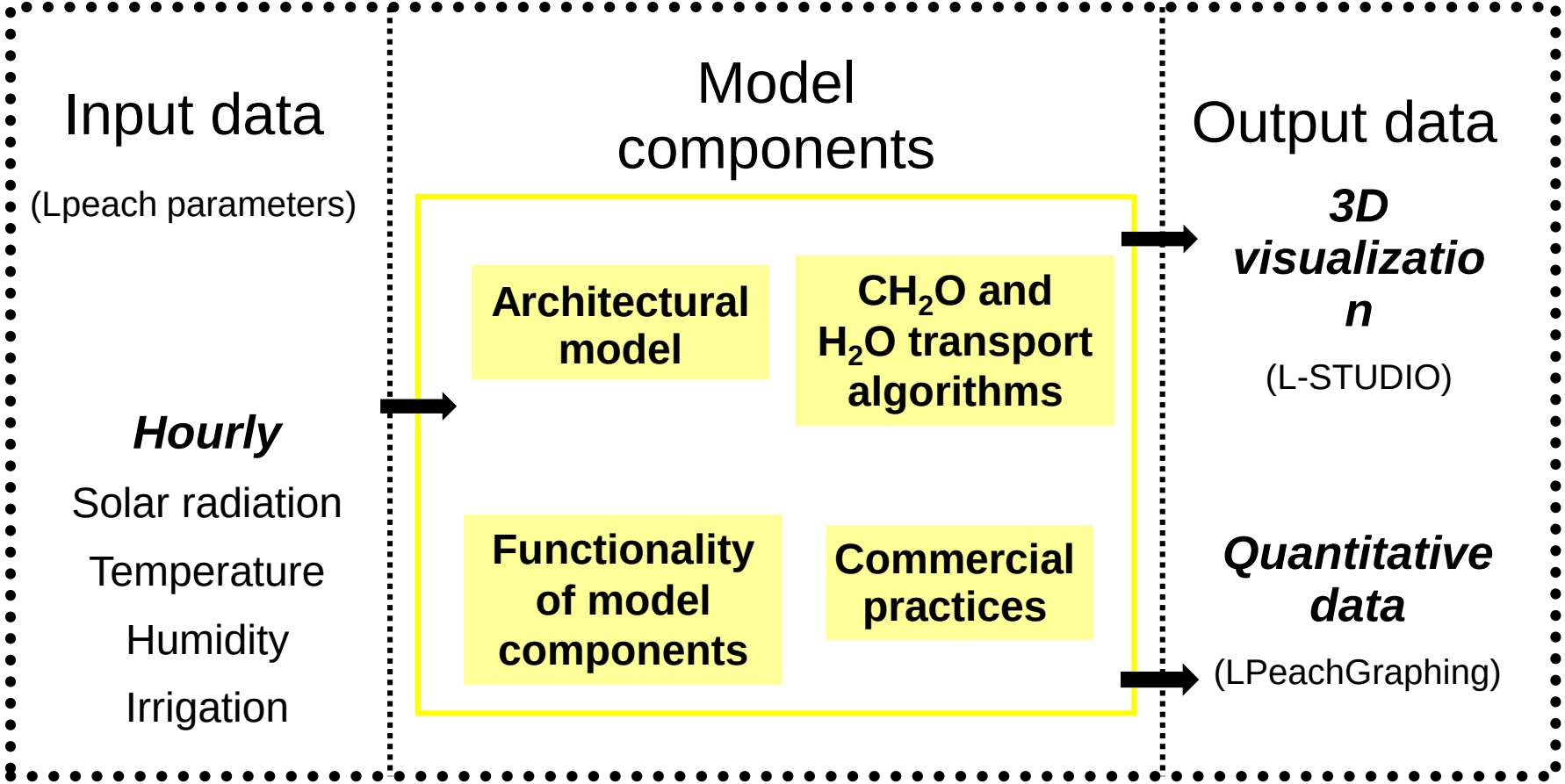
Five cultivars on one tree.

What does this carbon distribution look like through time as the plant grows?

Results from a new, 3-dimensional computer graphics based simulation model called

L-PEACH

L-Peach Model

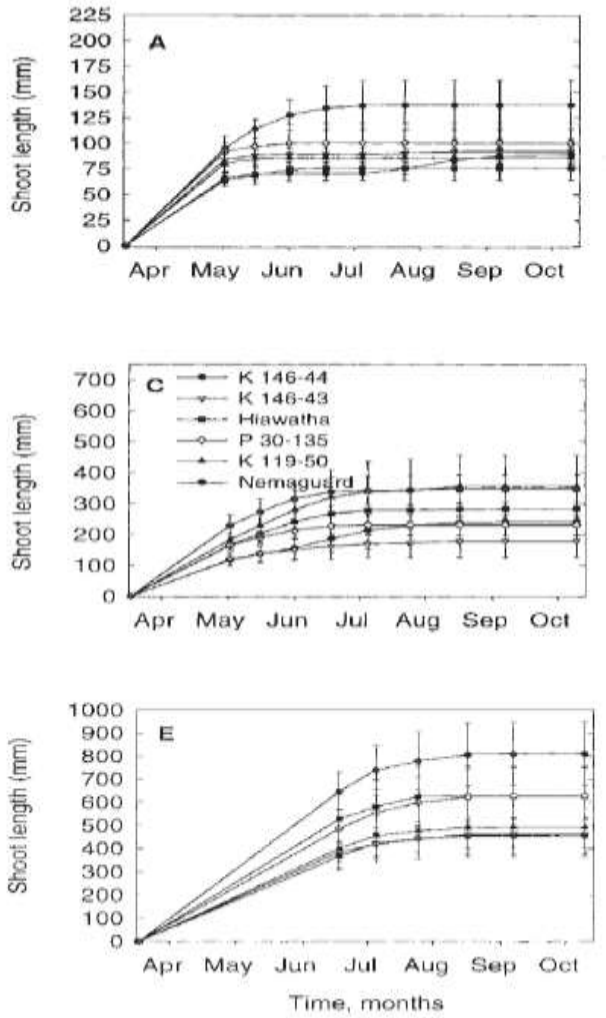


If we think of the tree as a collection of semi-autonomous parts, what are the main parts of a tree that we need to worry about from a CHO sink point of view?

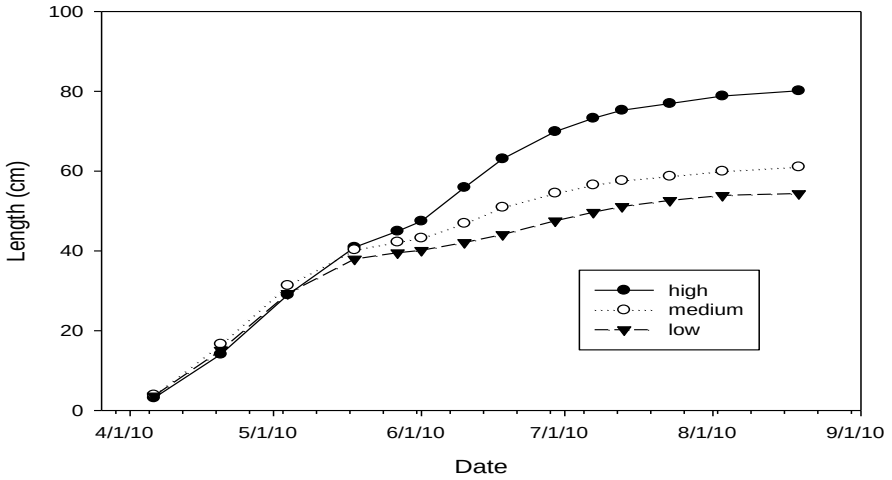
- Shoot growth
  - both annual and daily
- Trunk growth
- Root growth
- Carbohydrate storage
- Fruit growth

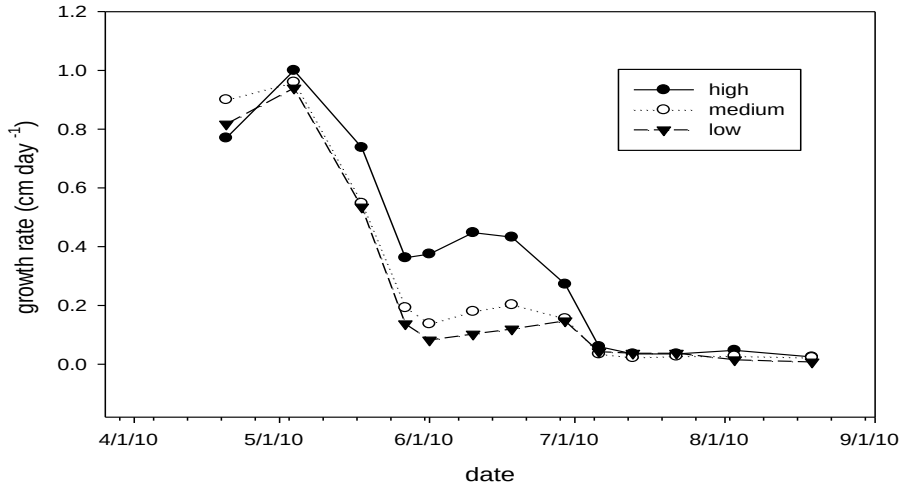
In peach, length growth of most shoots except water sprouts (epicormic shoots) is finished by June.

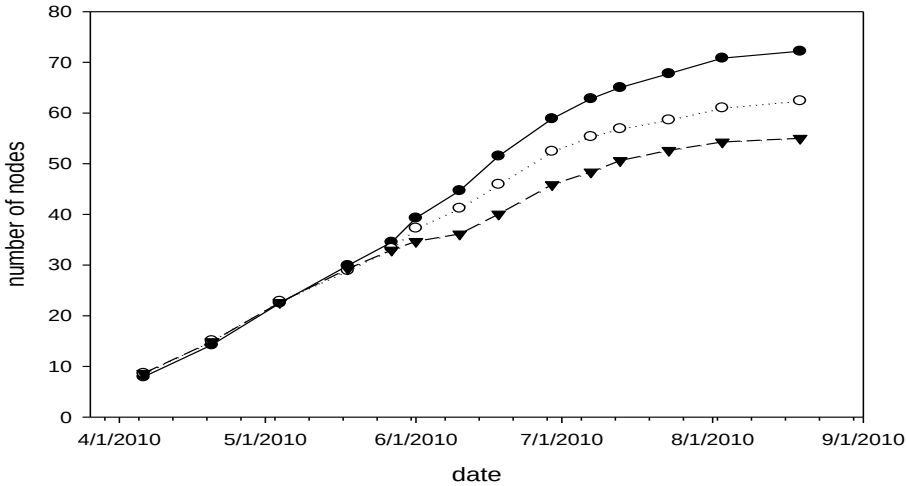
This is different in almonds.



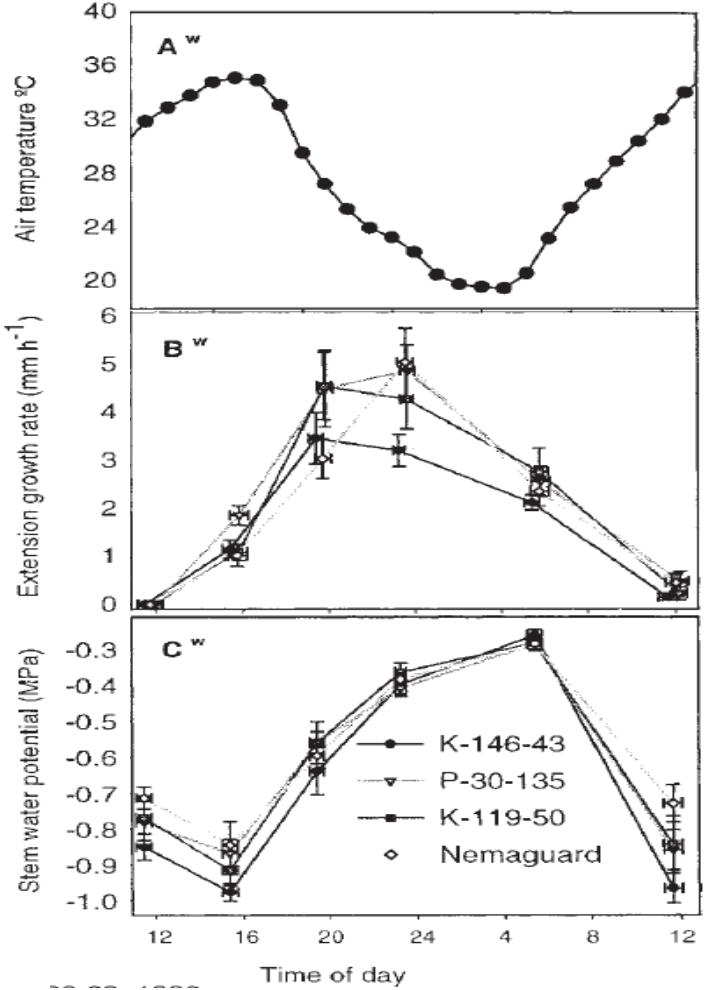
Seasonal patterns of proleptic almond shoot growth at three rates of irrigation.
Note that shoot growth slowed down by June but then there was a second flush but addition of nodes was more continuous.



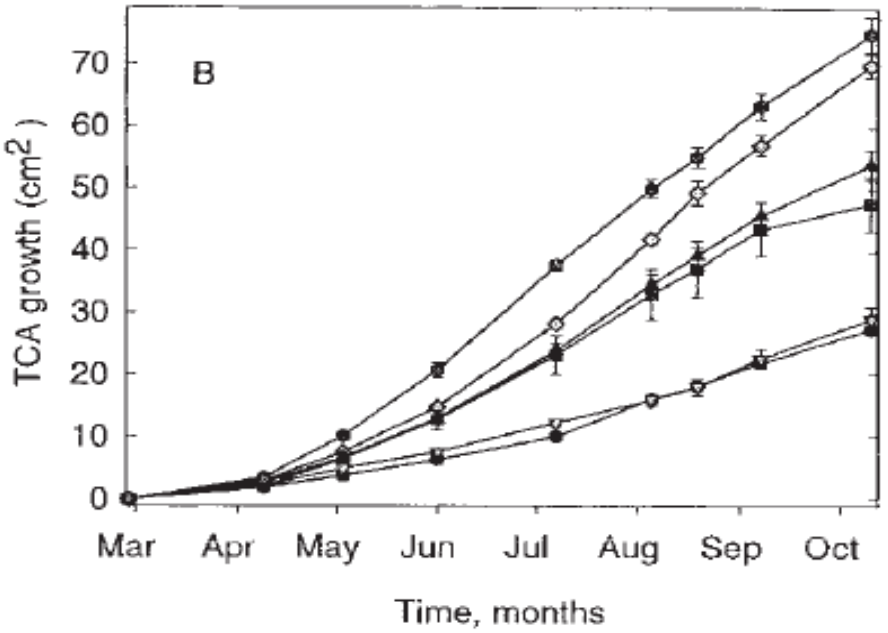




Contrary to popular opinion, shoots grow most rapidly in the afternoon when temperatures are high and stem water potential is recovering form a daily minimum.

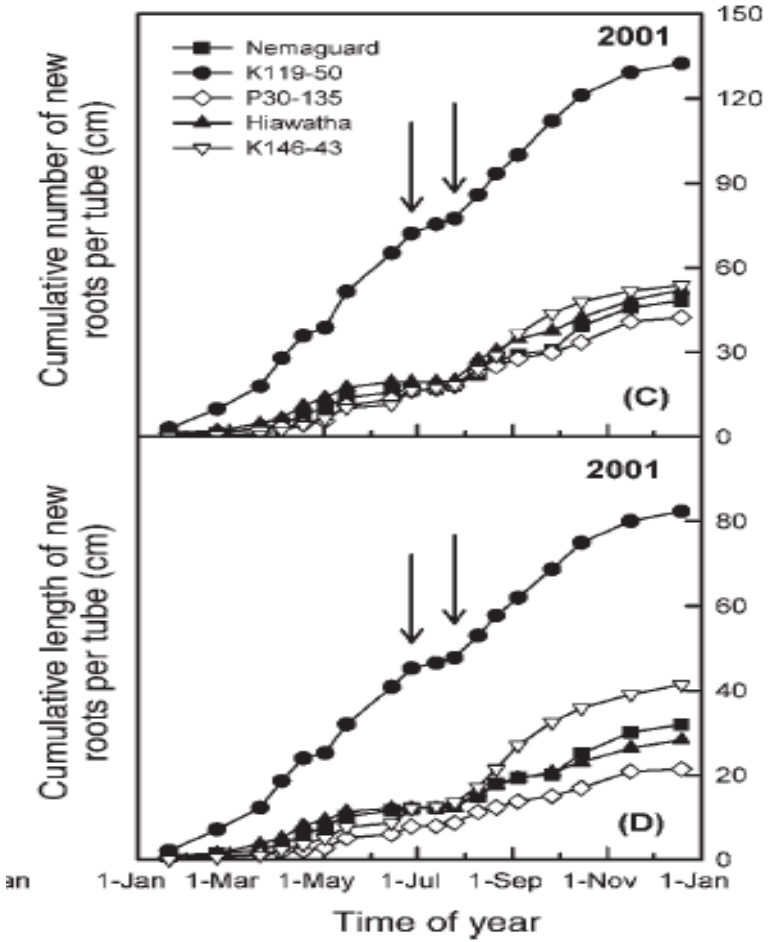


Trunk diameter growth continues through most of the growing season.



Root growth tends to be episodic in many species. There is usually a burst of activity in spring, a lull in mid-summer and a second burst in fall.

Peach example.
(mini-rhizotron data)



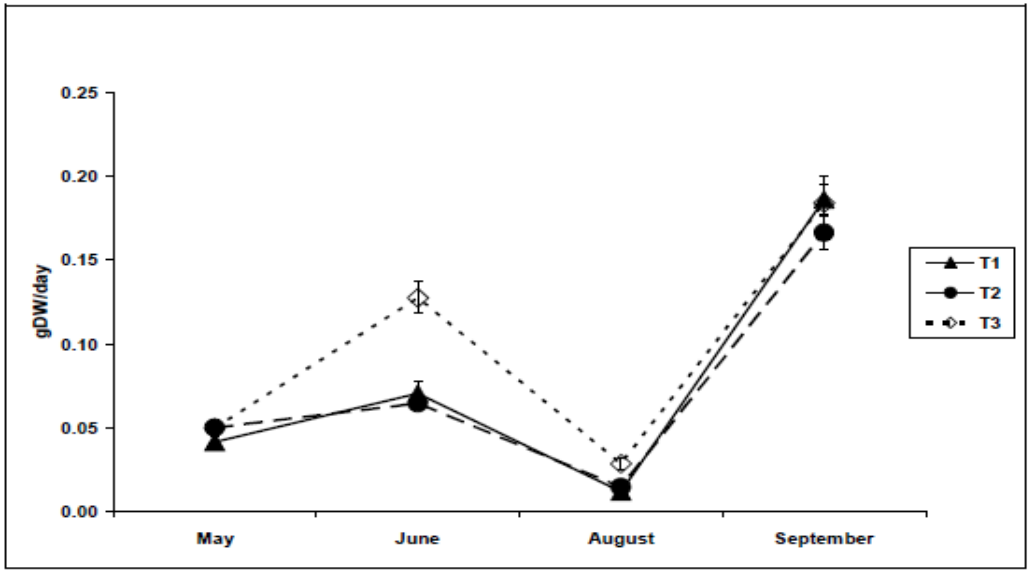
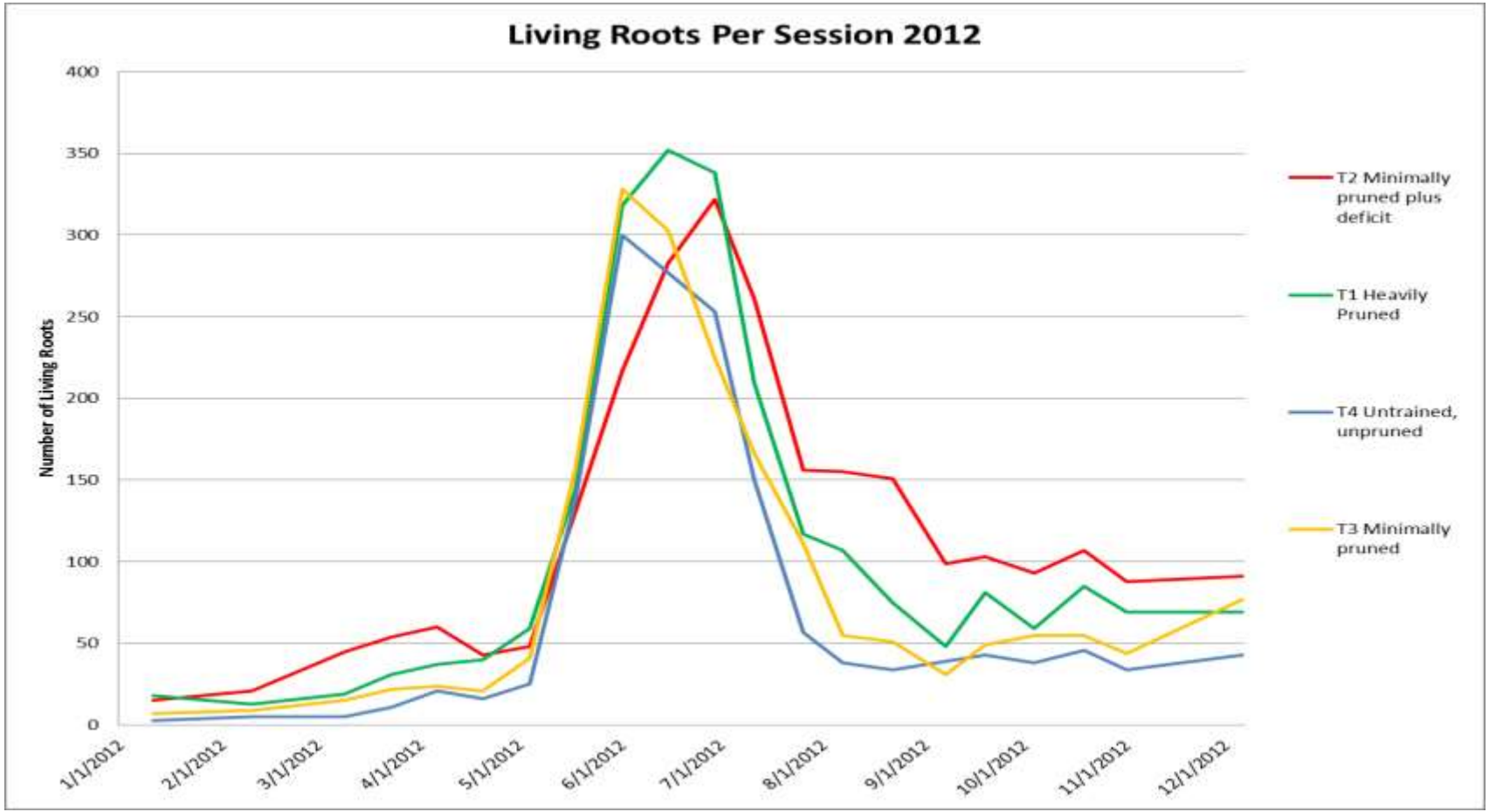
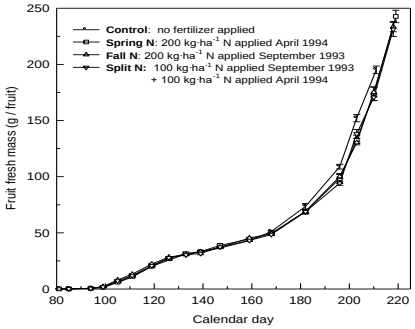


Fig. 6. The seasonal patterns of mean (± SE) root growth rates (g DW/day) measured in ingrowth root bags during four periods (Table 1) in 'O'Henry' peach trees subjected to three different thinning treatments; defruited (T1), commercially thinned (T2), and unthinned (T3).

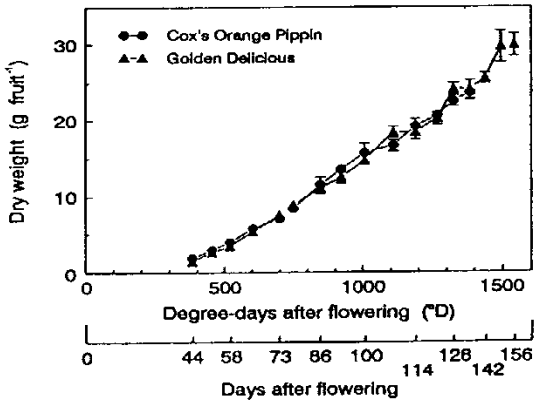
Mini-rhizotron data for walnut roots



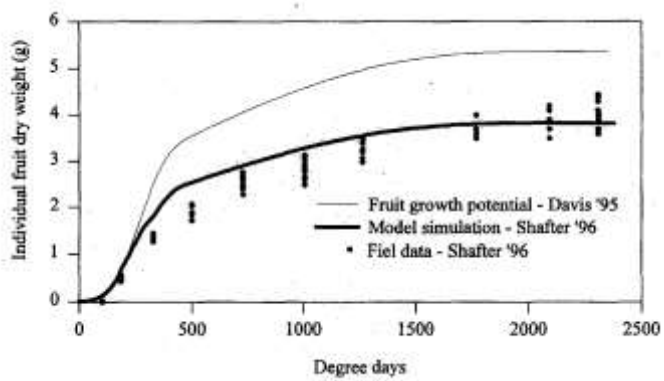
Describing fruit growth potentials



Peach

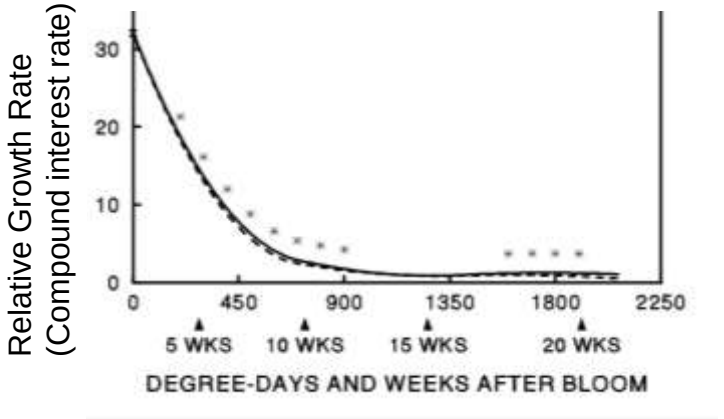


Apple



Almond

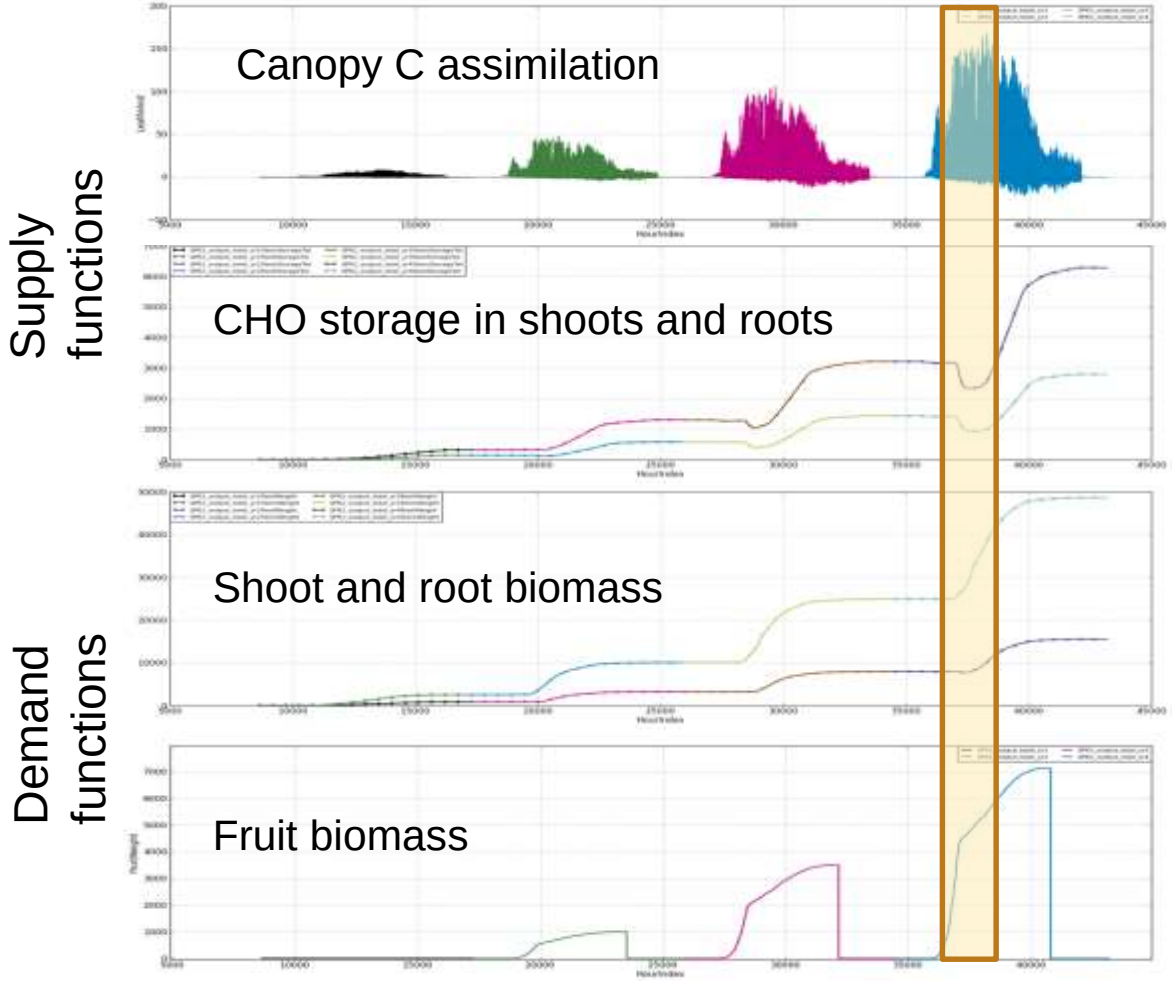
The potential growth rate of all of these fruit types can be predicted with a relative growth rate (decreasing compound interest rate) function.

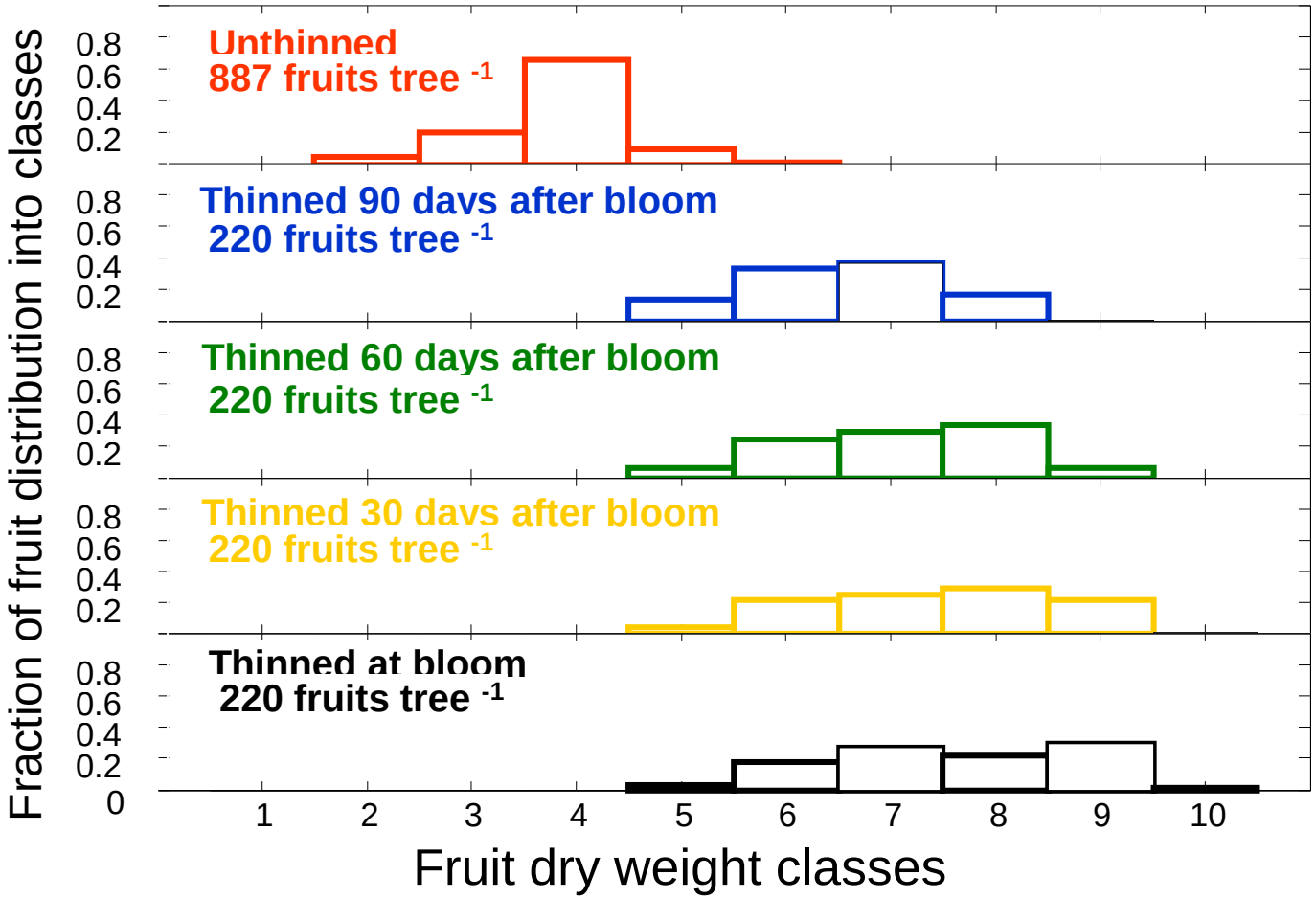


The L-Almond model calculates all the carbohydrate supply and demand functions for each hour of a day.

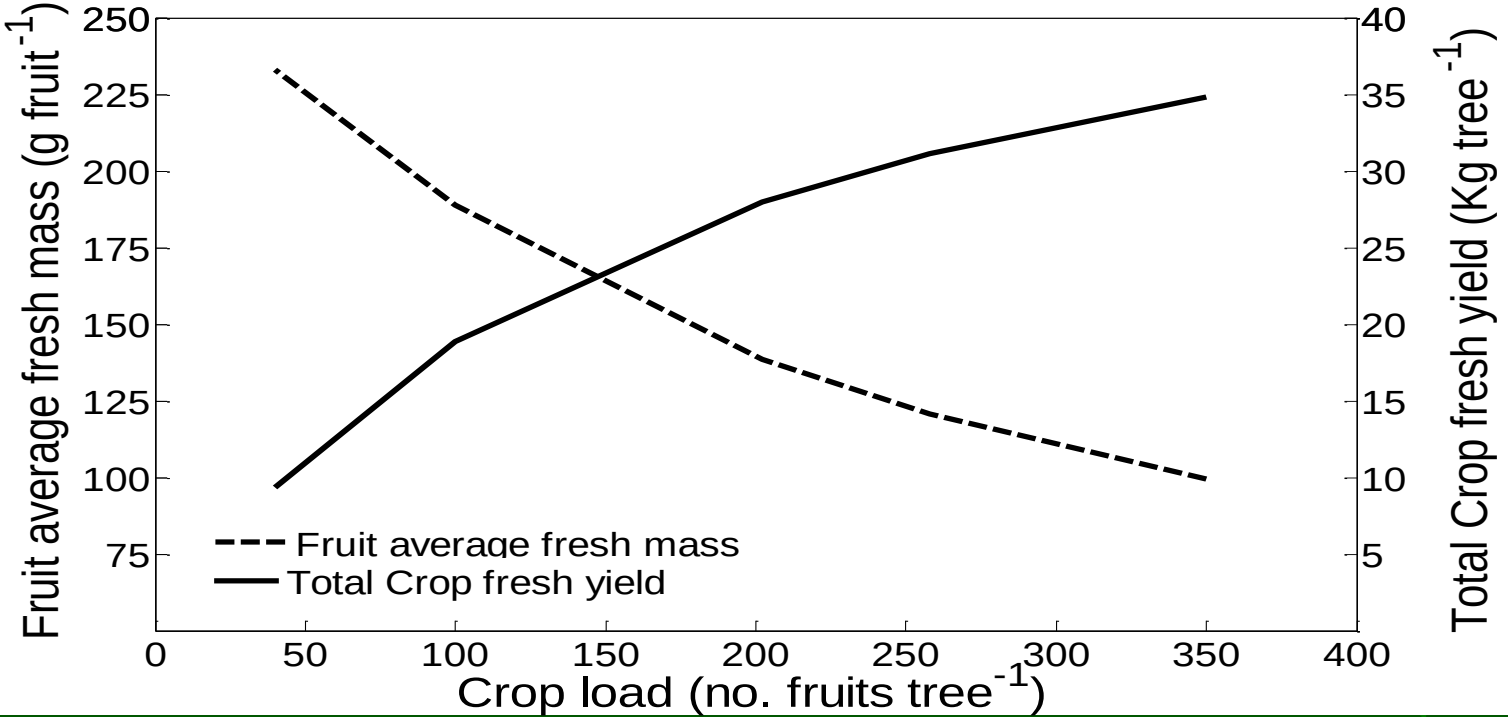
The model indicates that the period corresponding to early fruitlet growth is a time when carbohydrate availability may be particularly limiting.

This explains why there is a fruit drop/abortion period in late April/May/or early June in many fruit species.




Unthinned
887 fruits tree -1
Thinned 90 days after bloom
220 fruits tree -1
Thinned 60 days after bloom
220 fruits tree -1
Thinned 30 days after bloom
220 fruits tree -1
Thinned at bloom
220 fruits tree -1
Fraction of fruit distribution into classes
0
0.2
0.4
0.6
0.8
1
2
3
4
5
6
7
8
9
10
Fruit dry weight classes

Effect of crop load on fruit growth and crop yield



Classes (g)

1 = < 30

2 = 30 - 60

3 = 60 - 90

4 = 90 - 120

5 = 120 - 150

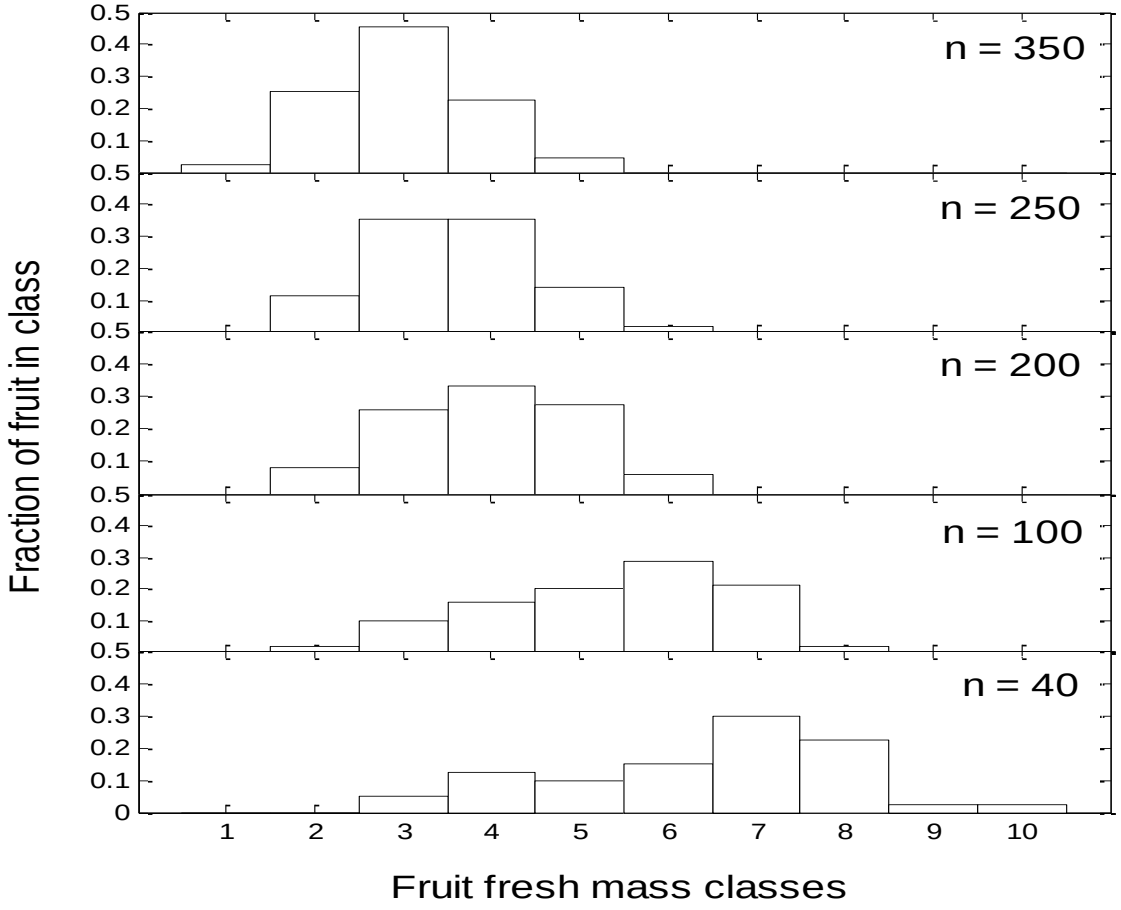
6 = 150 - 180

7 = 180 - 210

8 = 210 - 240

9 = 240 - 270

10 = > 270



Thanks for your attention!

Questions?