Carbohydrate assimialtion, translocation, storage and utilization in walnuts

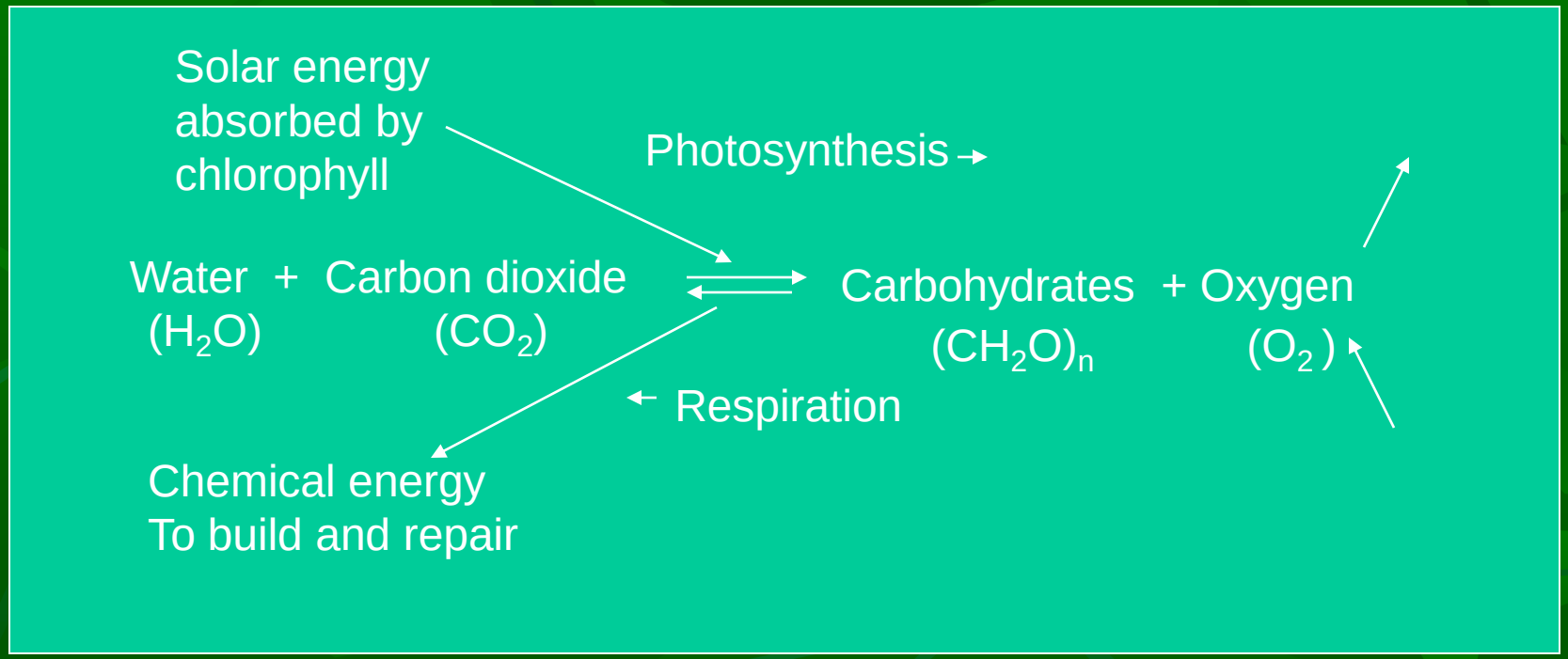
Ted DeJong
Department of Plant Sciences
UC Davis

Photosynthesis is the process by which plants capture the energy in sunlight and convert it to a biologically usable form.

- The energy is stored in carbon bonds created during photosynthesis and liberated during respiration

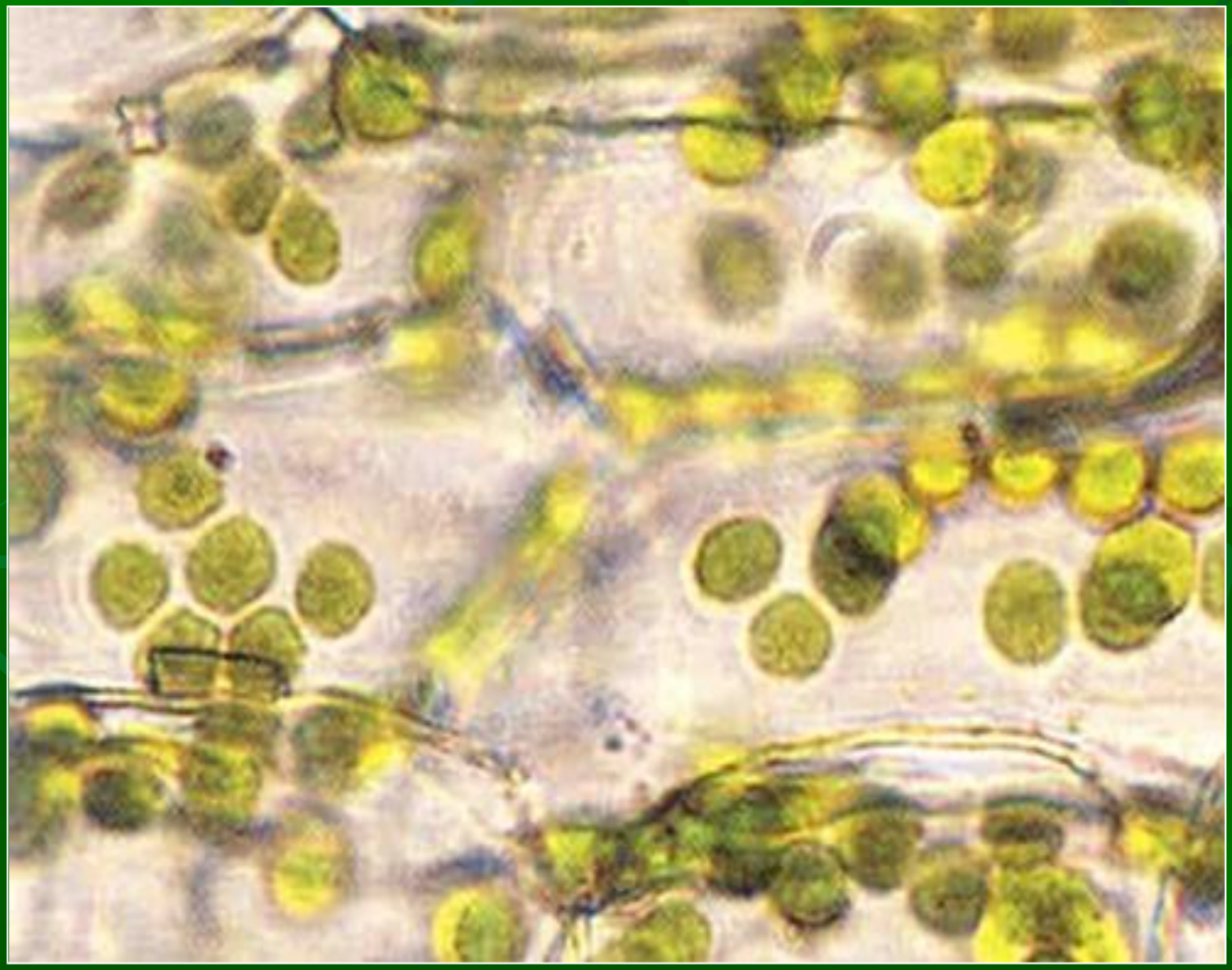
The basic photosynthesis/respiration reactions

(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.

Chloroplasts

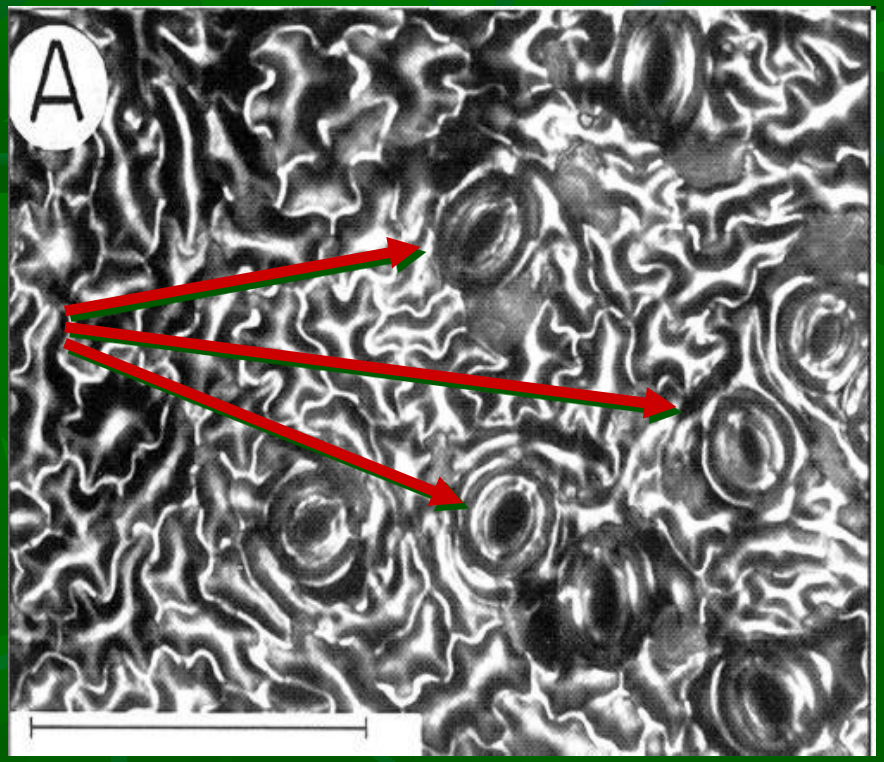


Chlorophyll

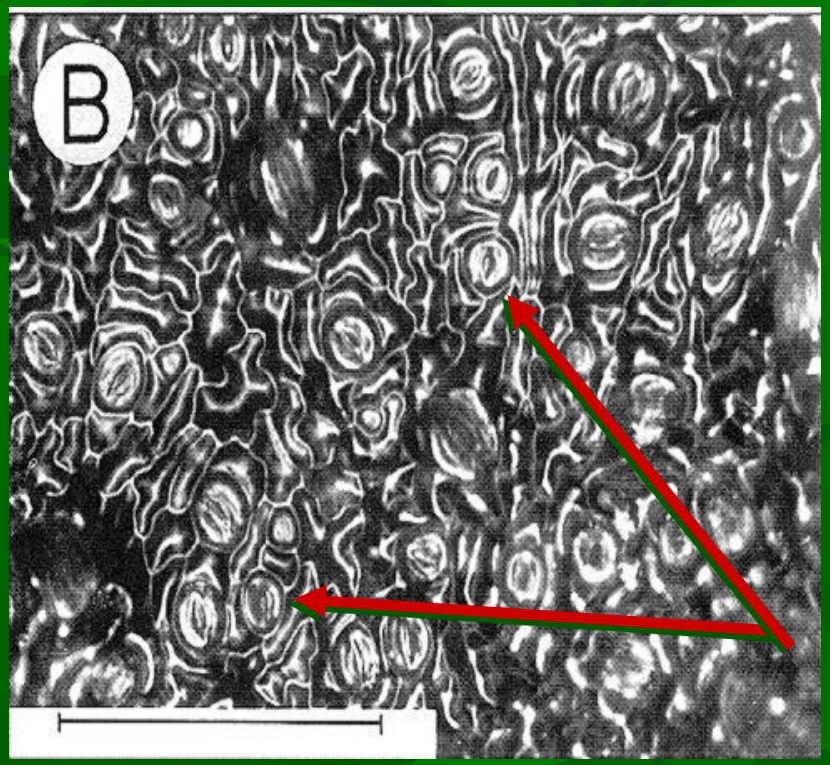
- Light energy is captured by the green pigment chlorophyll.
- Chlorophyll is found in all green tissues of plants.
- It is located in chloroplasts, specialized structures in the plant cells designed to be solar energy cells.

- The primary functions of leaves are to house and display the chloroplasts for solar energy collection.
- Problem: choroplasts need an aqueous environment to function, air is dry and CO2 from air is required for photosynthesis.
- Solution: leaves with waxy cuticle to prevent dehydration and air control vents called stomates.

Carbon dioxide in the leaf tissue is readily consumed by photosynthesis. CO2 enters the leaf through pore that can be opened or closed.

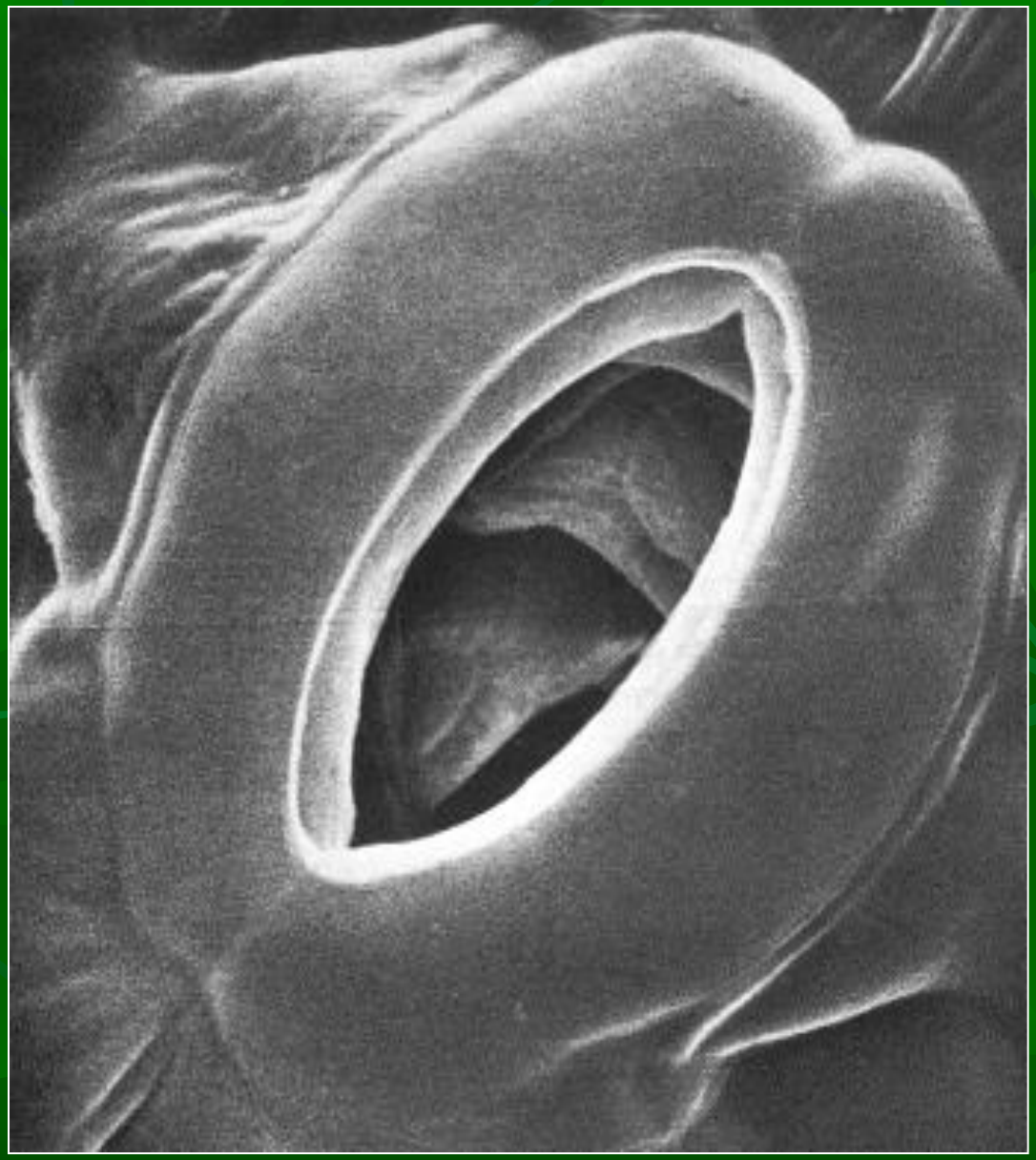


When the pores are open to admit CO2, water escapes.

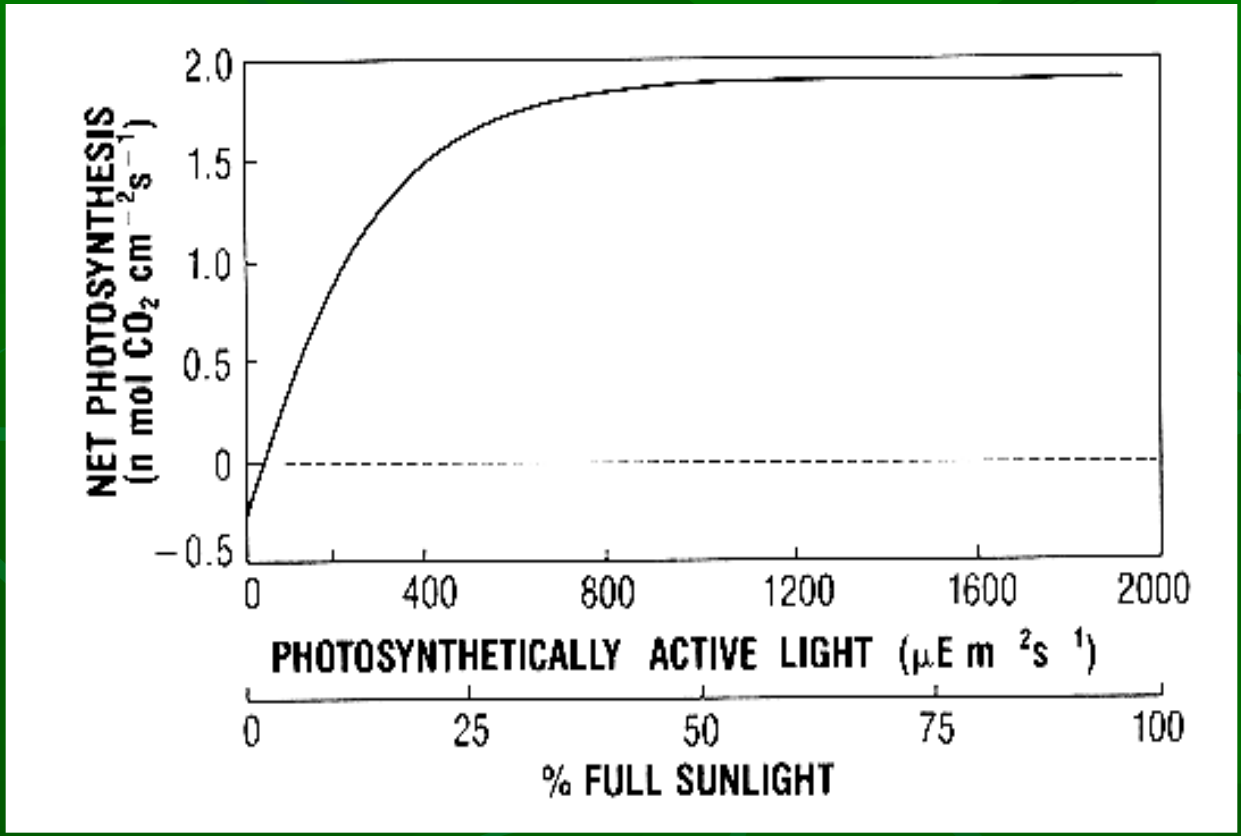


Under conditions of water stress, the pores close, shutting down photosynthesis.

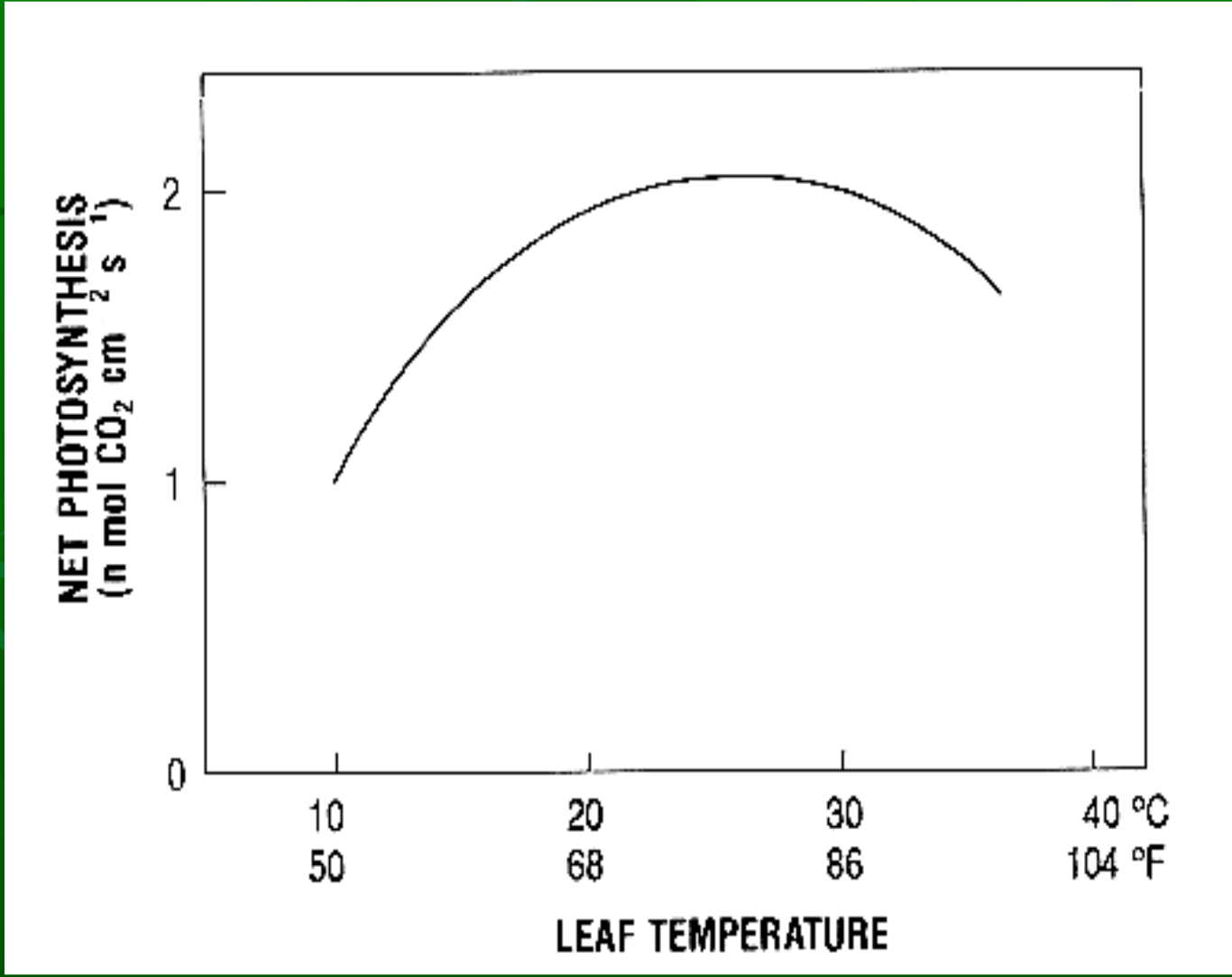
Stomate



Photosynthesis of individual leaves is light-saturated at 40-50% full sunlight. Below that, it falls off rapidly.



Photosynthesis Response to Temperature



Daily pattern of light and photosynthesis in August.

Sunlight in the open

Light at the surface of outer, southerly exposed leaves

Leaf temperature

Leaf photosynthesis

Stomatal opening

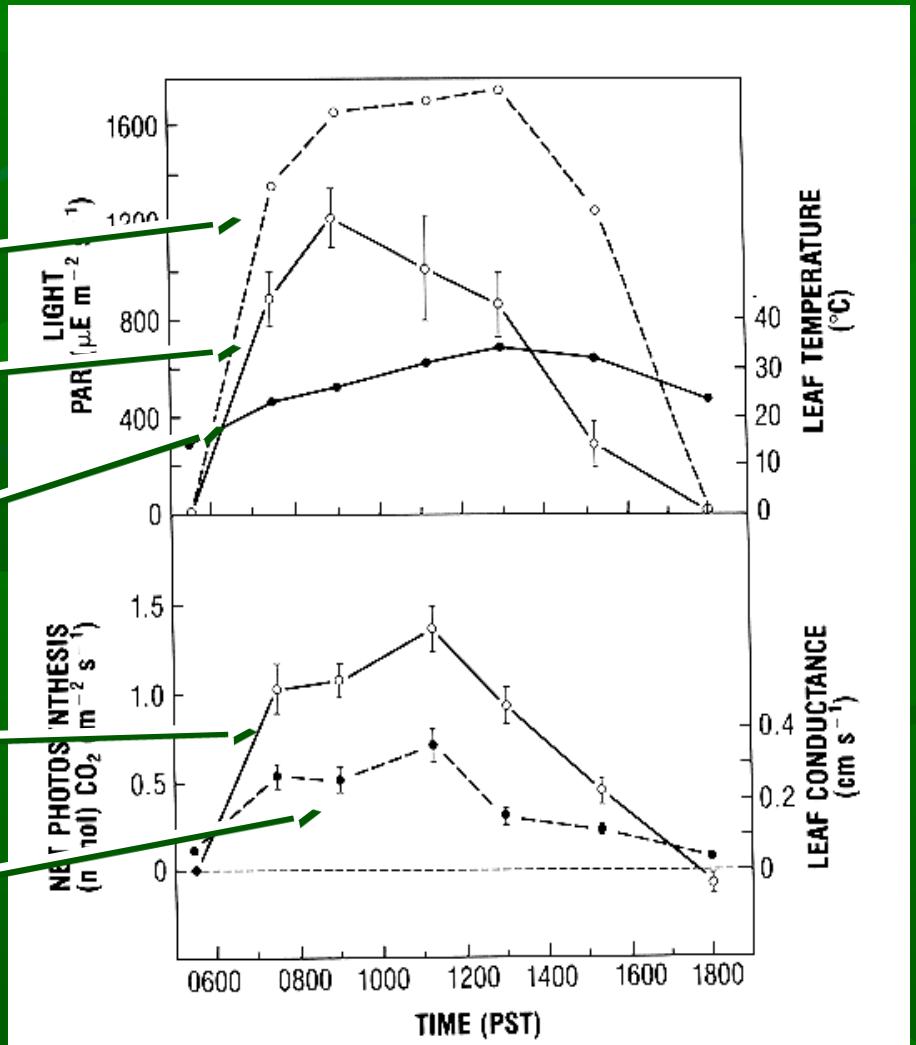
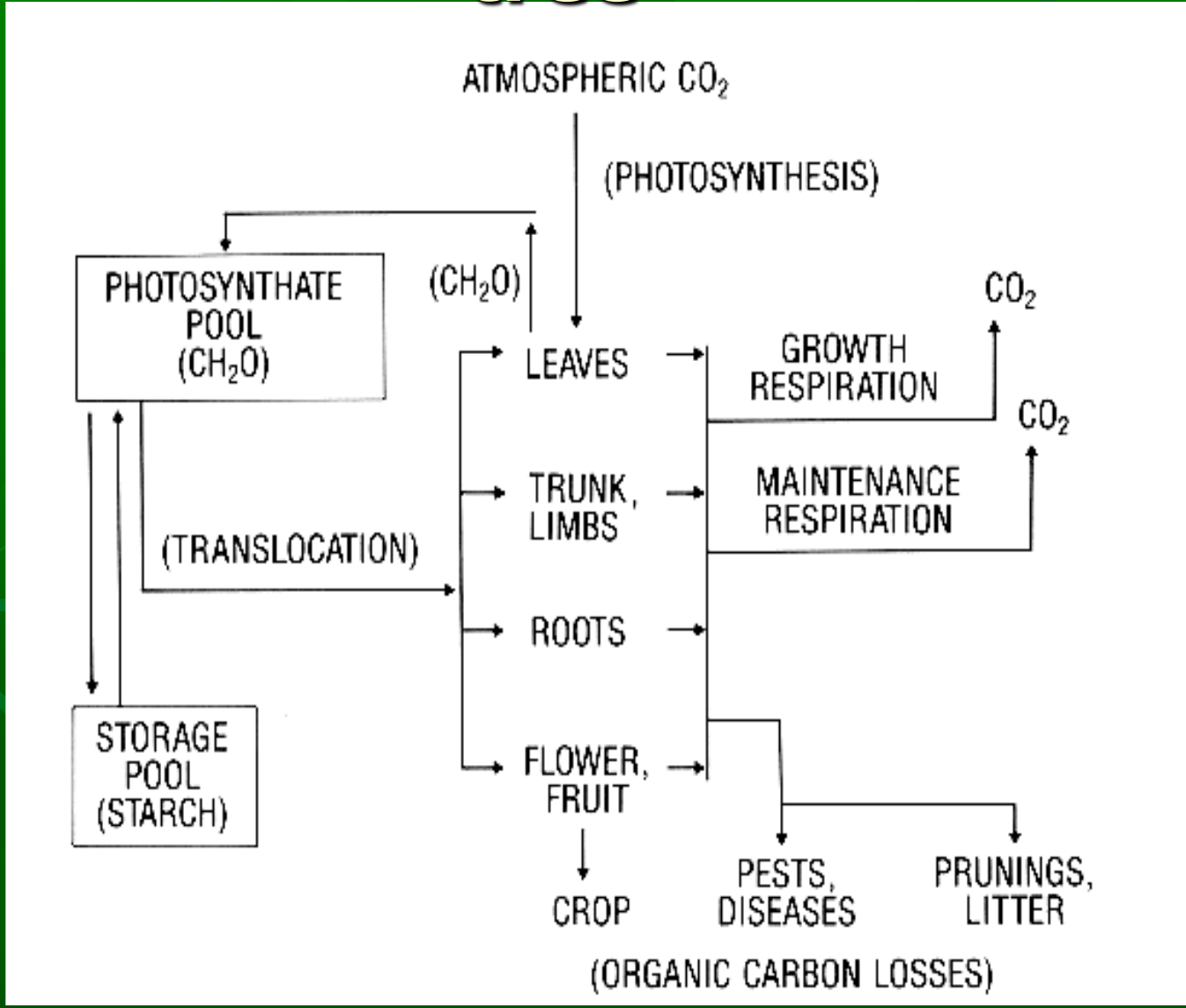
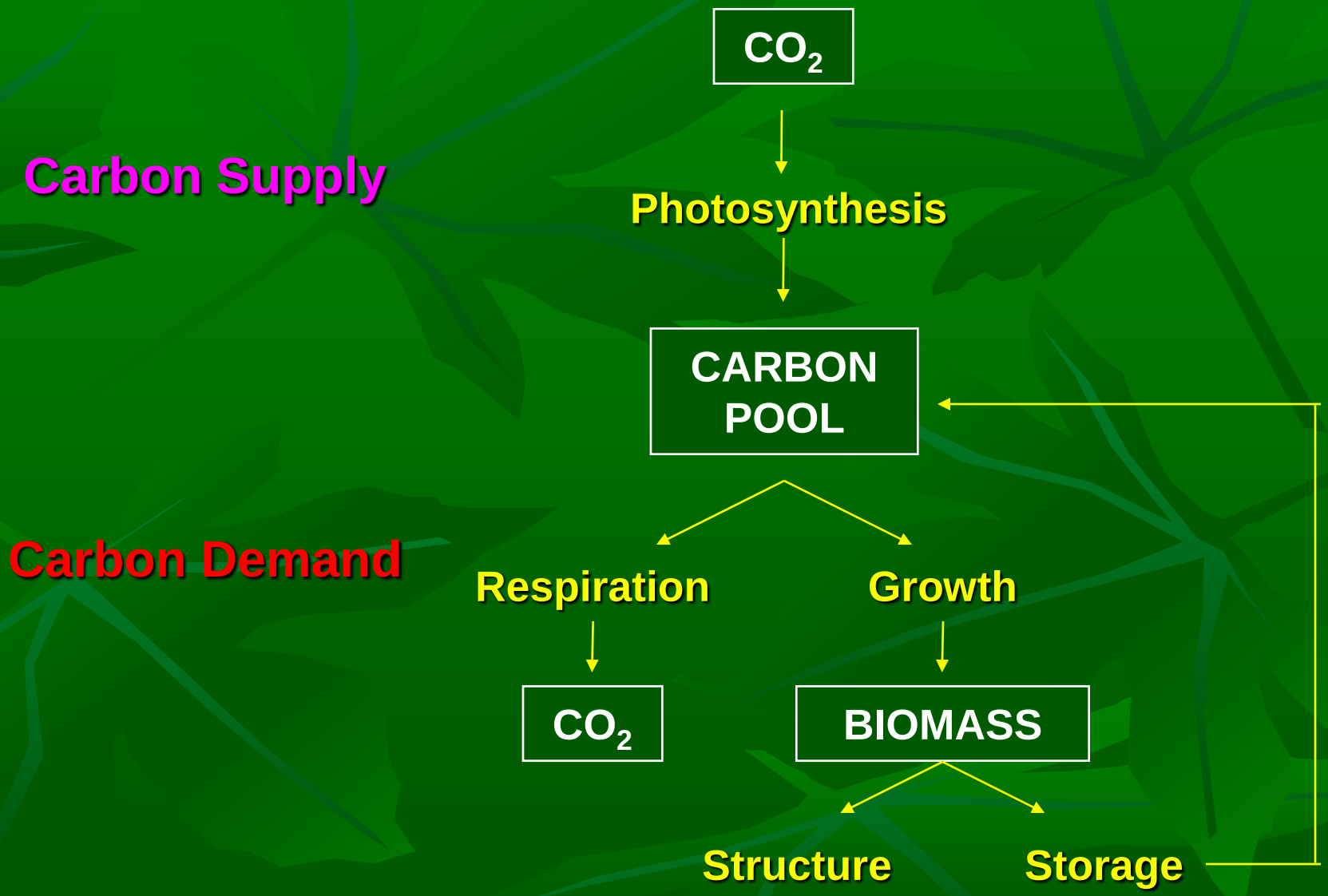


Fig. 7.4. Daily pattern of light in open (*top*, dashed line, open circles); light at leaf surface (*top*, solid line, open circles); leaf temperature (*top*, solid line, solid circles); leaf photosynthesis (*bottom*, solid line, open circles); and stomatal opening (*bottom*, dashed line, closed circles), measured on outer southerly exposed leaves in August.

Carbon distribution within the tree

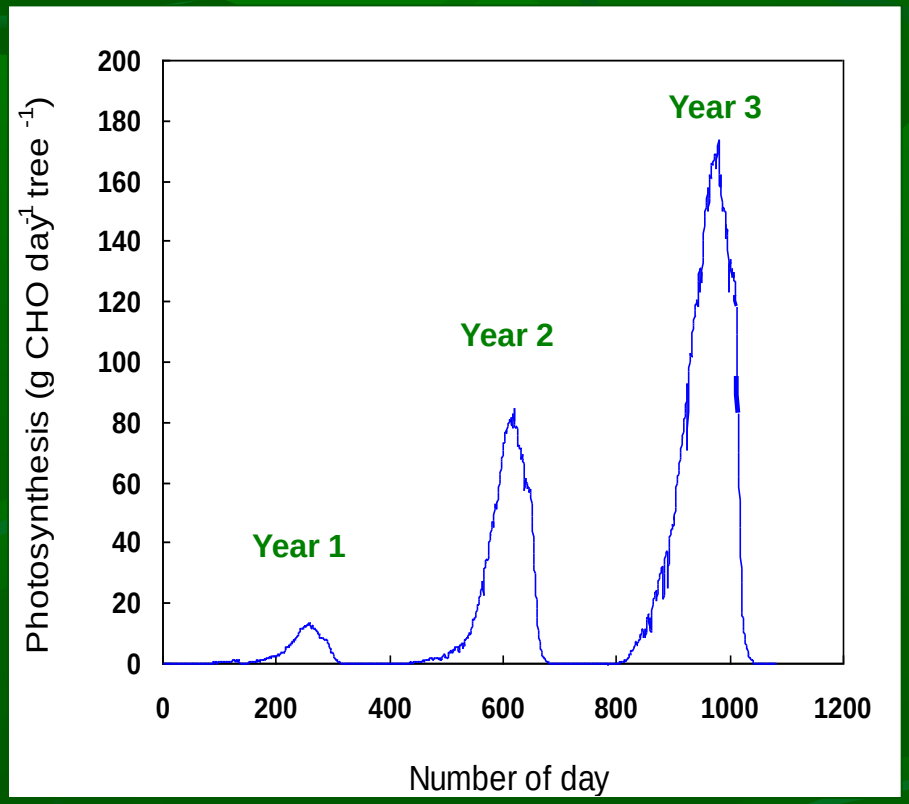


Carbon Budget

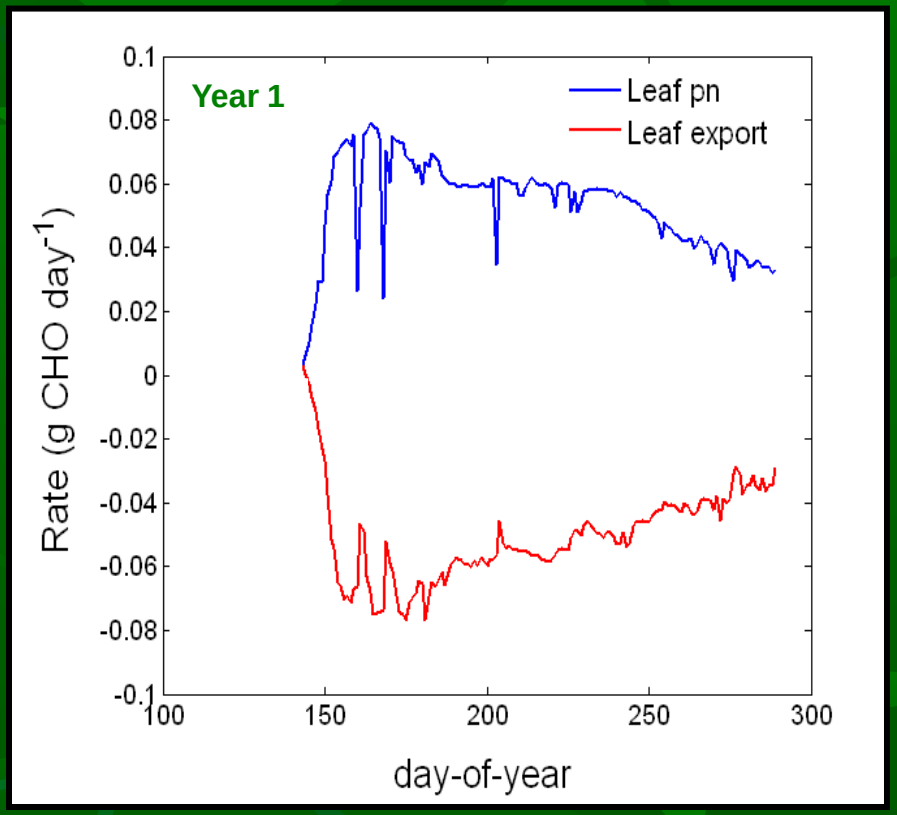


Carbohydrate assimilation

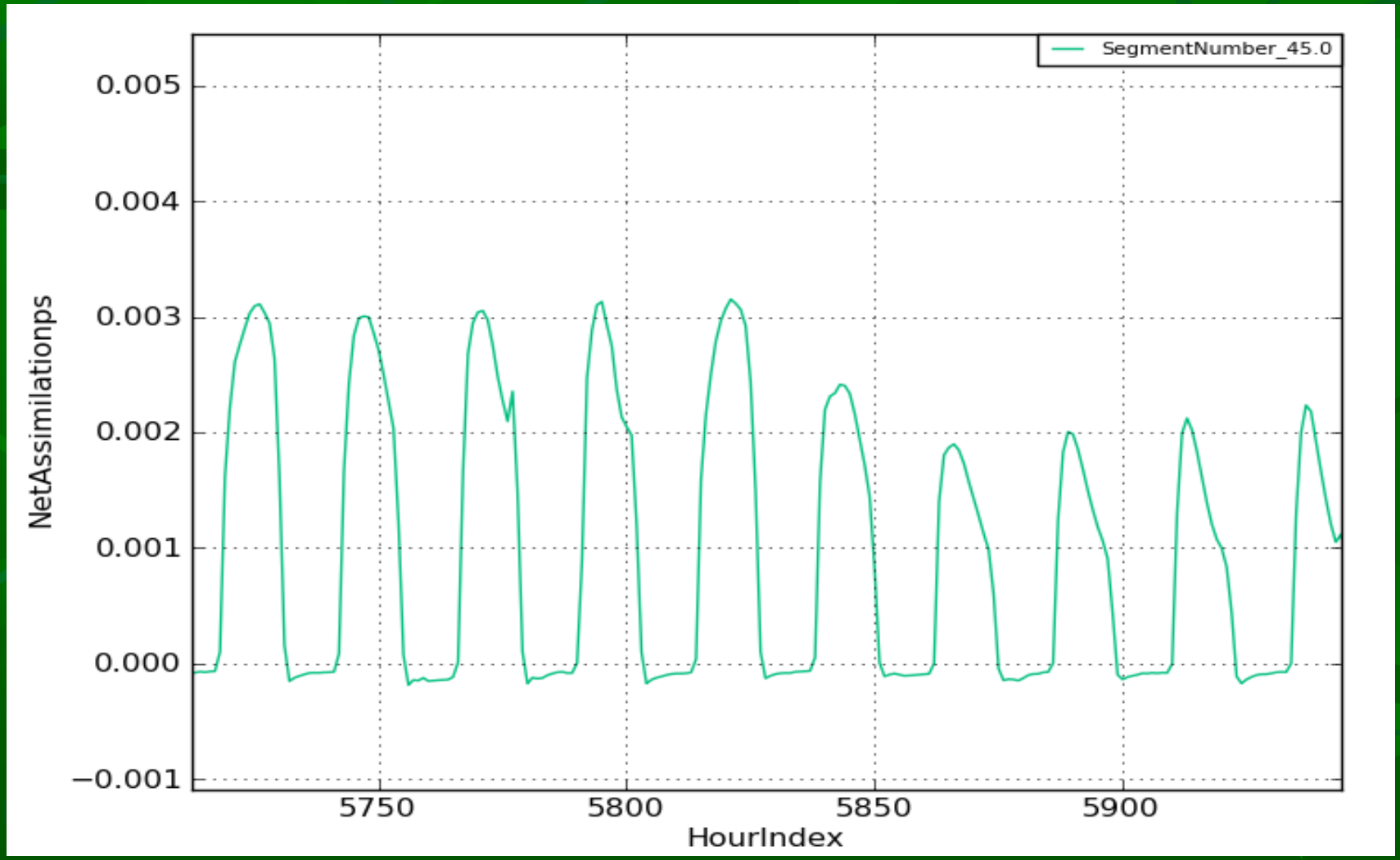
Whole tree



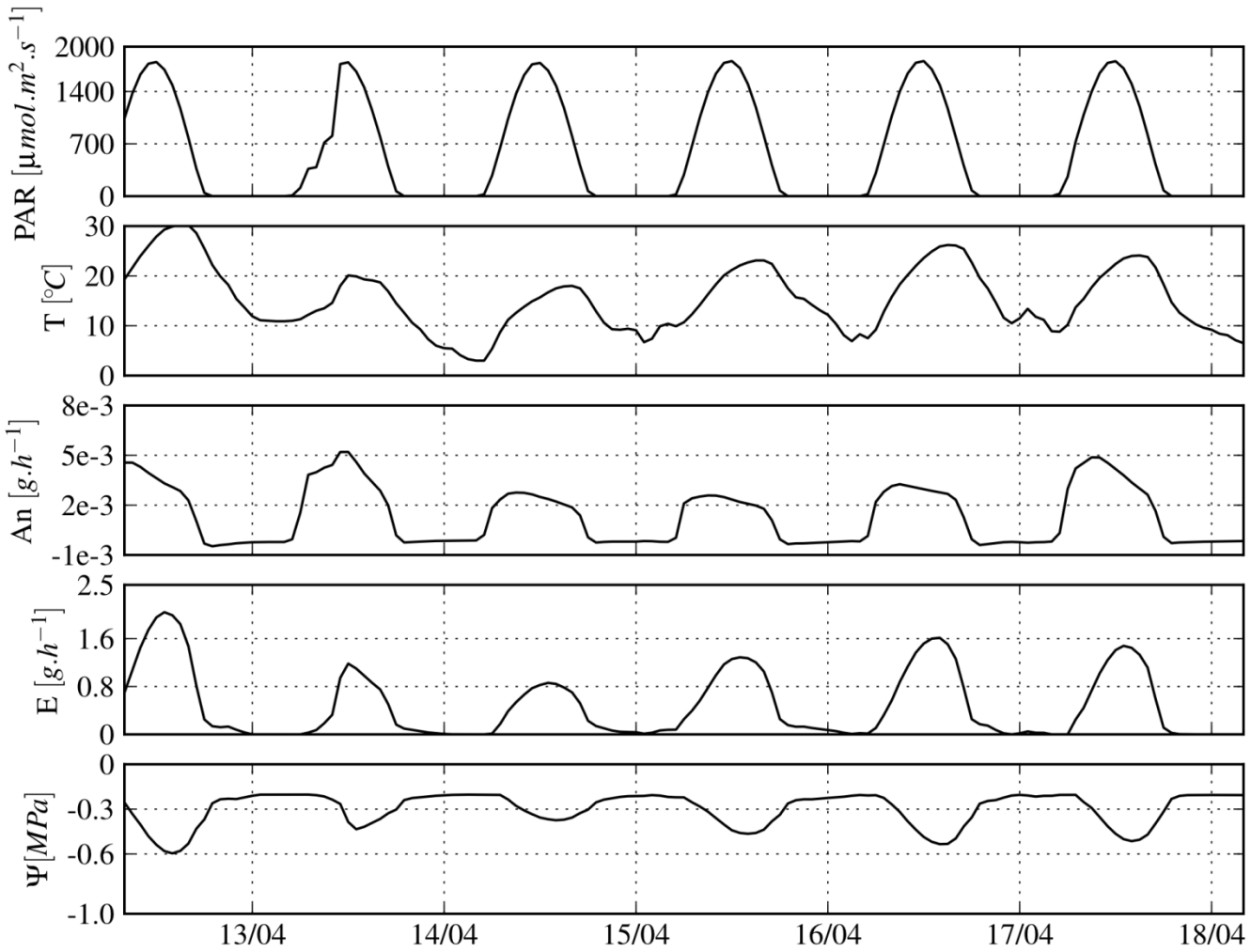
Individual leaf



Hourly leaf assimilation



Photosynthesis varies greatly from day to day depending on ambient conditions of especially light and temperature.

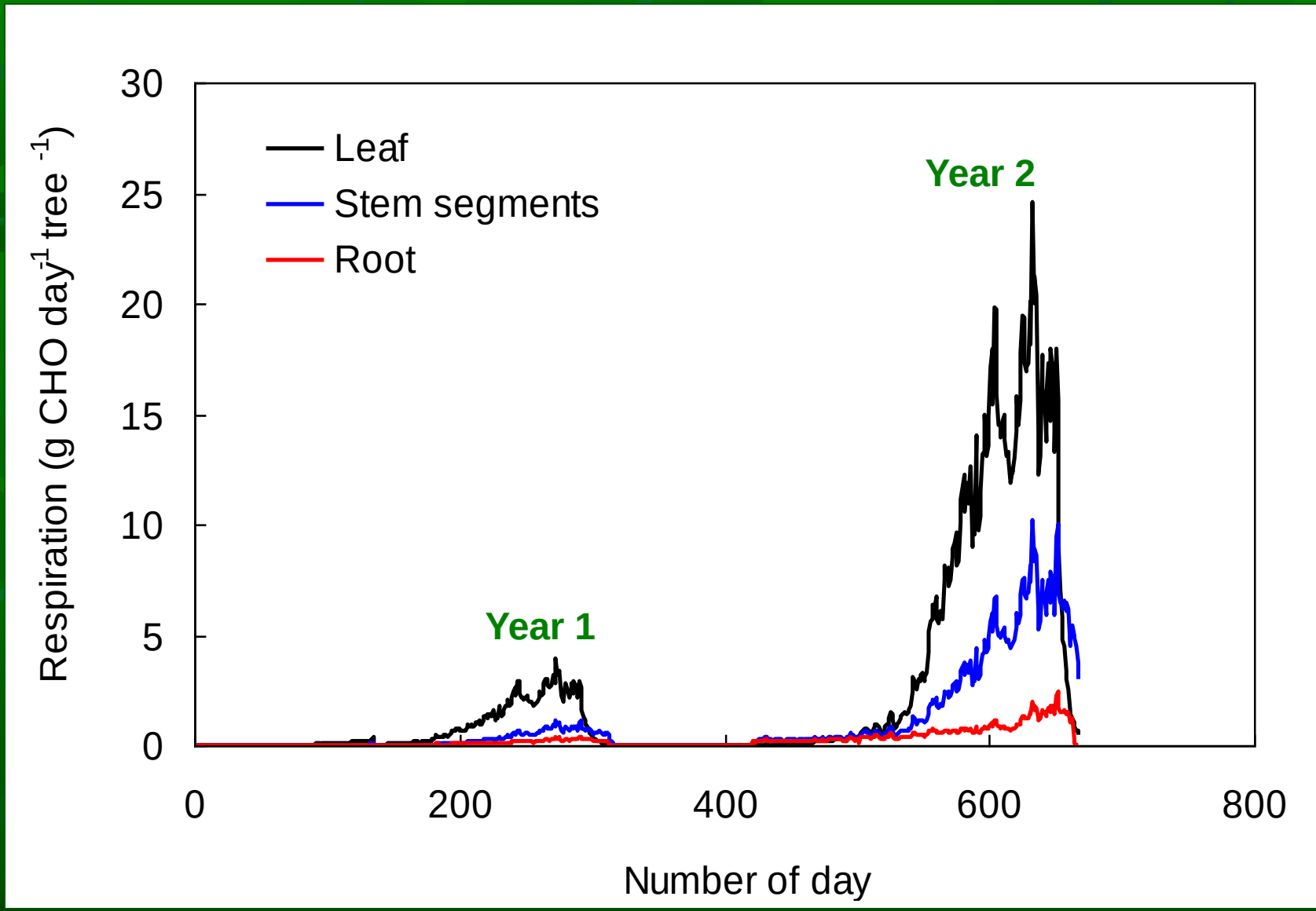


Guiding premise for understanding carbon partitioning:
Carbon distribution is mainly controlled by the development and growth patterns of individual organs and their ability to compete for CH_2O's

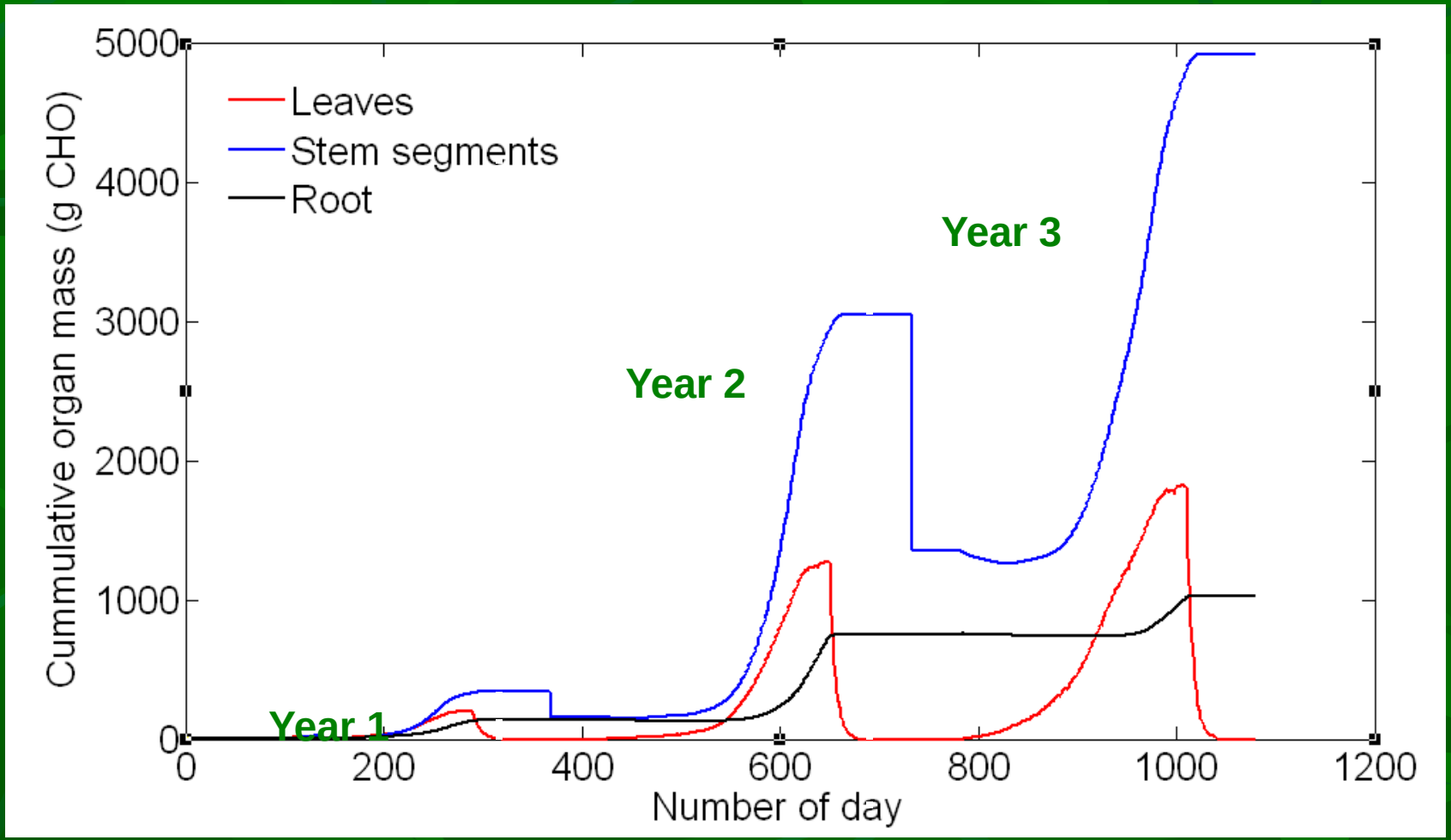
- A tree is a collection of semi-autonomous organs and each organ type has an organ- specific developmental pattern and growth potential.
- Organ growth is activated by endogenous and/or environmental signals.
- Once activated, environmental conditions and genetics determine conditional organ growth 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 CHOs is a function of location relative to sources and sinks of CHOs, transport resistances, organ sink efficiency and organ microenvironment.

DeJong 1999 *Hortscience 34:1037*

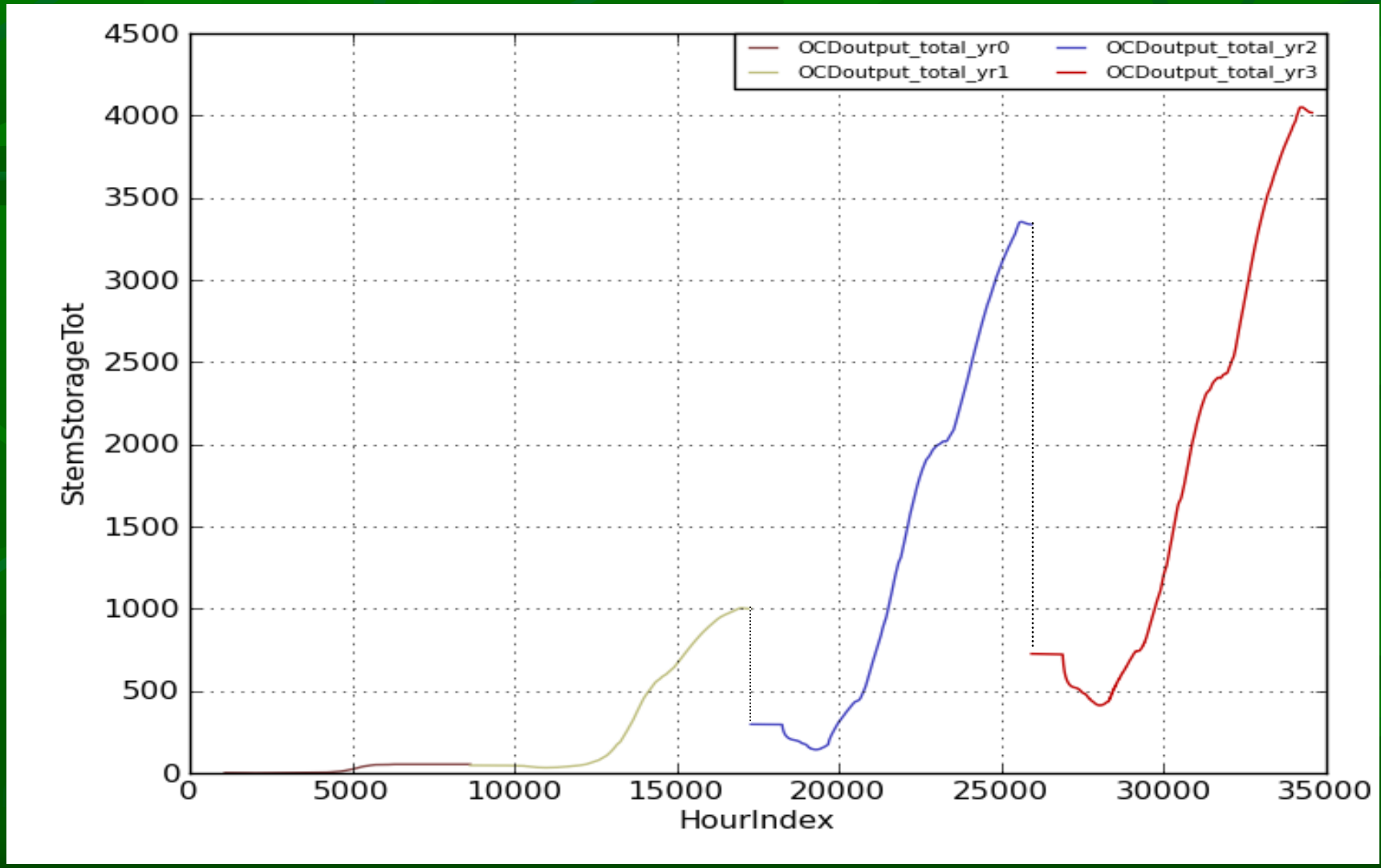
Maintenance respiration



Collective organ growth

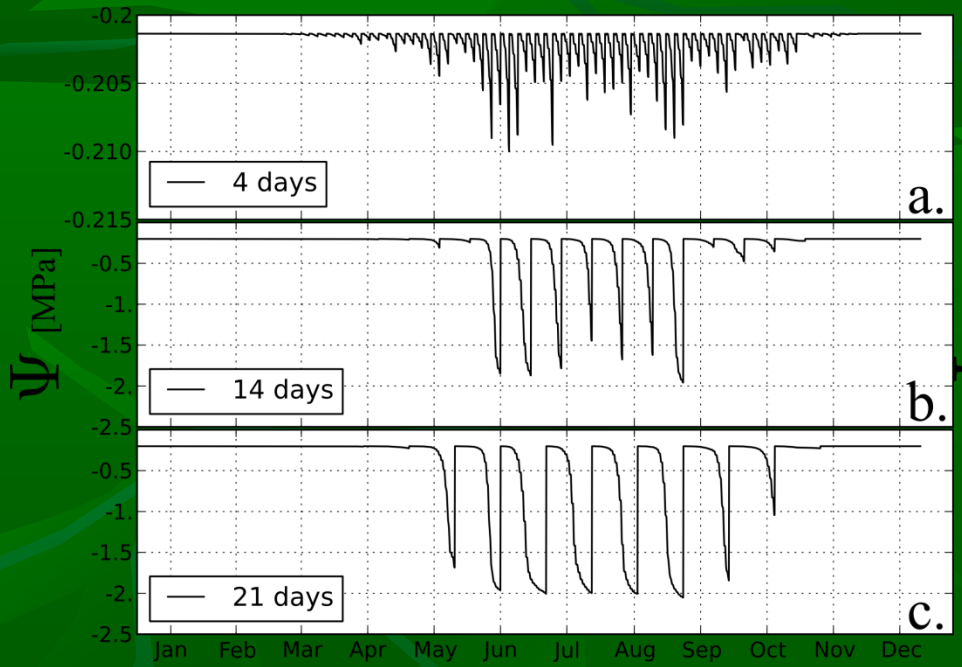


CHO storage and mobilization

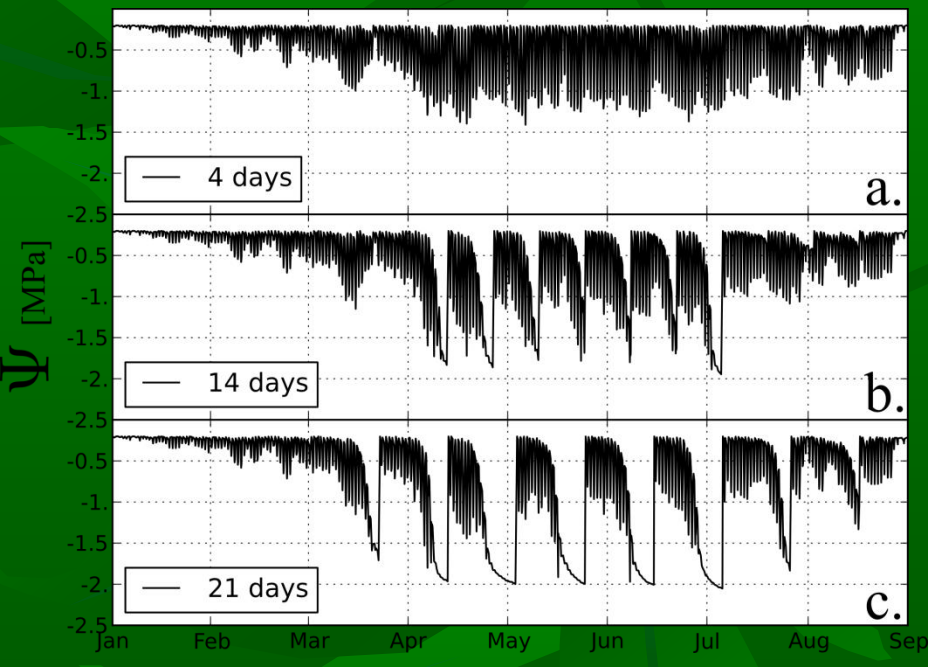


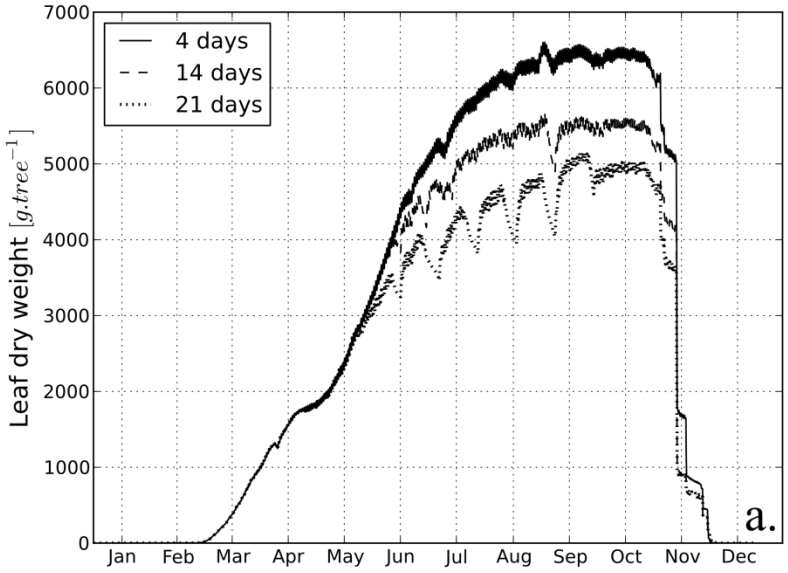
Irrigation scheduling can have large effect on photosynthesis and organ growth.

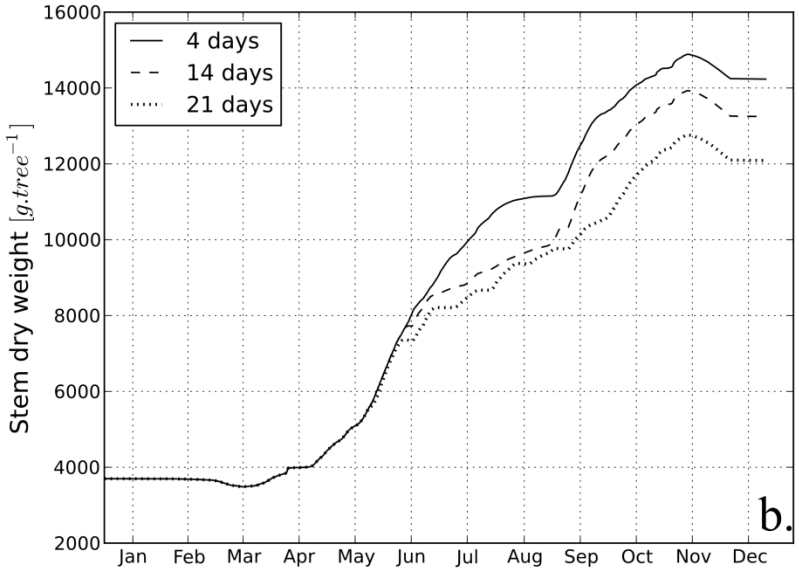
Soil water potential

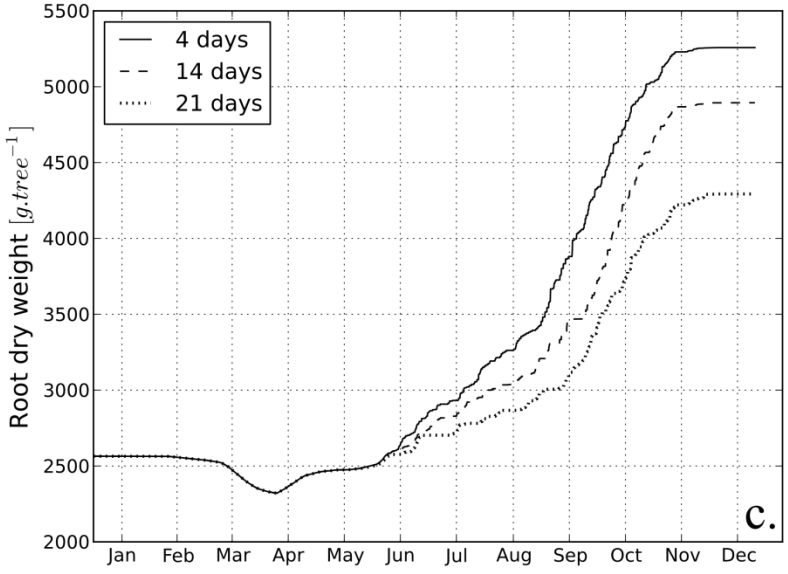


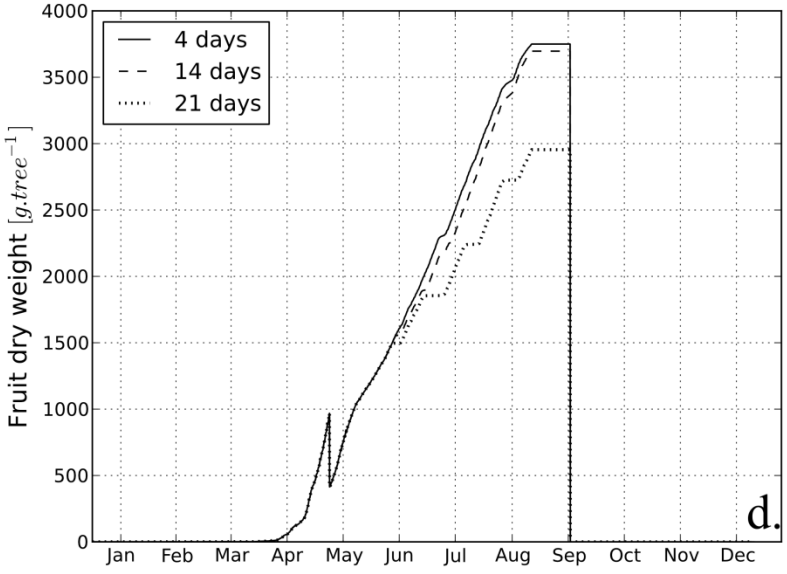
Stem water potential




4 days
14 days
21 days
Leaf dry weight $[g.tree^{-1}]$
7000
6000
5000
4000
3000
2000
1000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
a.


4 days
14 days
21 days
Stem dry weight $[g.tree^{-1}]$
16000
14000
12000
10000
8000
6000
4000
2000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
b.


4 days
14 days
21 days
Root dry weight $[g.tree^{-1}]$
5500
5000
4500
4000
3500
3000
2500
2000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
c.


4 days
14 days
21 days
Fruit dry weight $[g.tree^{-1}]$
4000
3500
3000
2500
2000
1500
1000
500
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
d.

Thanks for the support from:

California
PEACHES · PLUMS · NECTARINES

UCDAVIS
PLANT SCIENCES

CALIFORNIA
CLING PEACH
BOARD

Thanks for your attention!