Why is water essential to the tree?

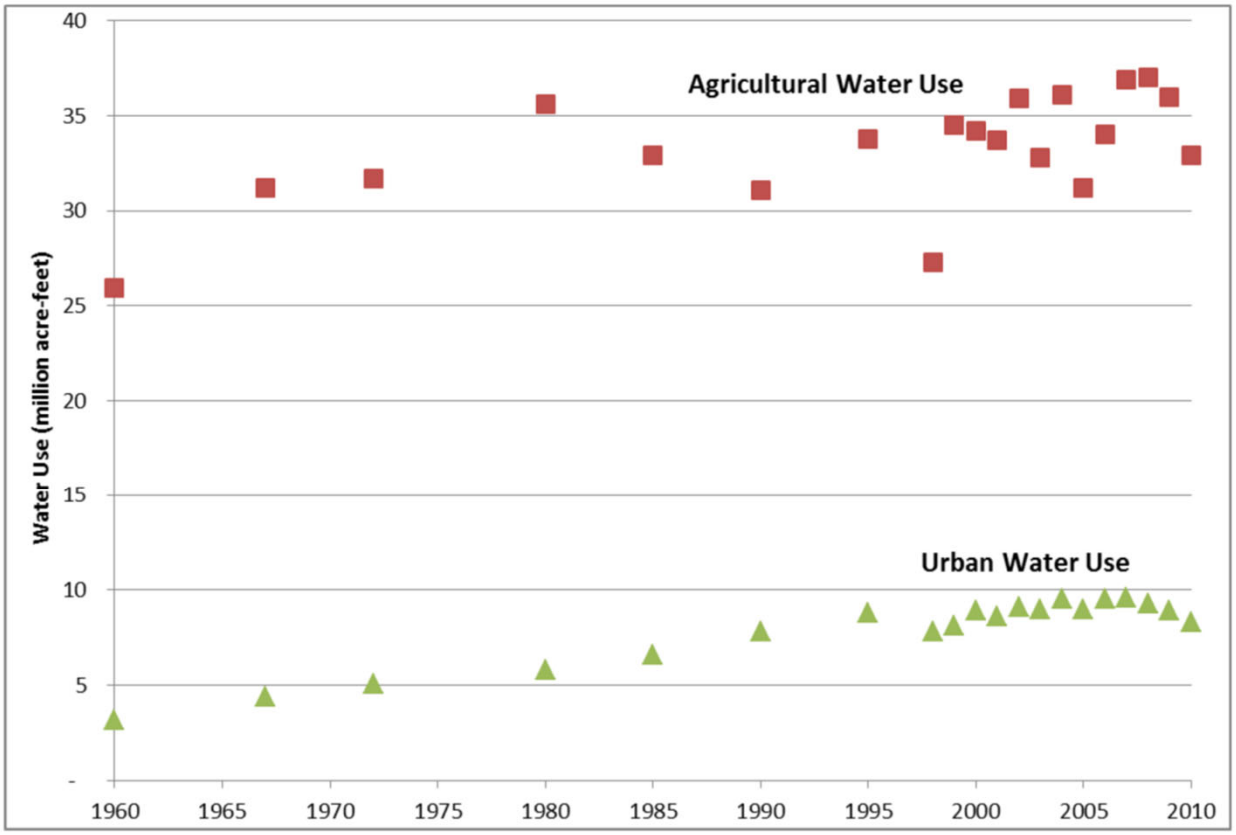


Figure 1. Agricultural and urban water use in California, 1960 – 2010.

Note: These estimates include conveyance losses that occur as water is moved from the source to the end use.
Sources: DWR (1964, 1970, 1974, 1983, 1987, 1993, and 2014)

Water use for agricultural purposes is the main source of water in California

California is not unique, in irrigated agriculture settings this is also true

From: H. Cooley, California Agricultural Water Use: Key Background Information. Pacific Institute. 2016. 9 pp.

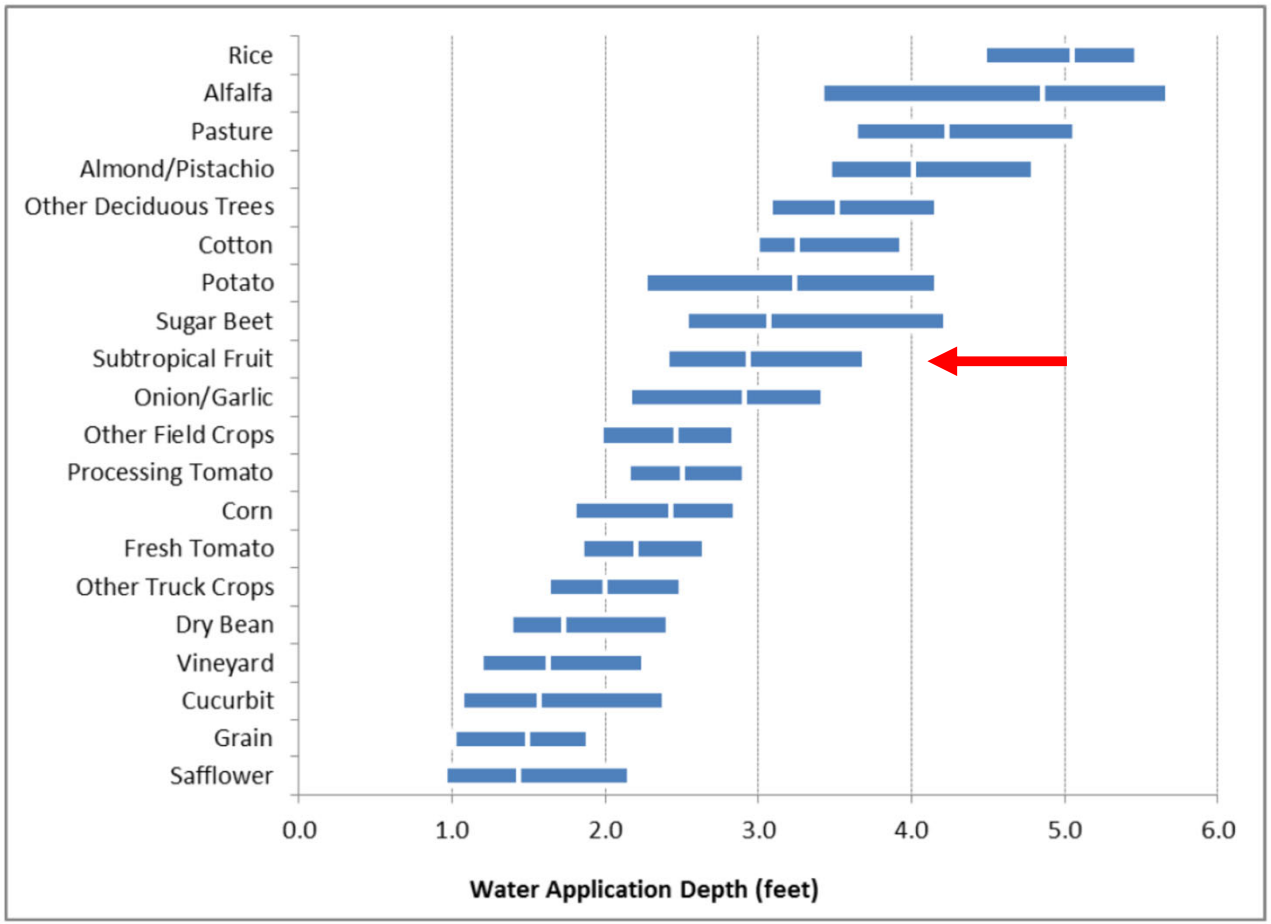


Figure 3. Water intensity of California crops, as measured by water application depth

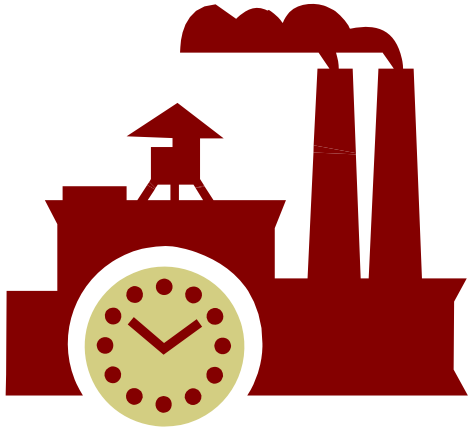
Note: The range shown reflects the first and third quartile of the water application depth for the period 1998-2010, and the white line within that range reflects the median application depth during that period.
Source: DWR 2014

Subtropical fruits include citrus, avocado, olives, kiwifruit and other subtropical tree crops

From: H. Cooley, California Agricultural Water Use: Key Background Information. Pacific Institute. 2016. 9 pp.

Raw Materials

Labor



Product

Light
Carbon Dioxide
Temperature
Water
Nutrients

Labor

Fruit

Carbohydrates are one of the major building blocks that contribute to productivity

Why is water essential to the tree?

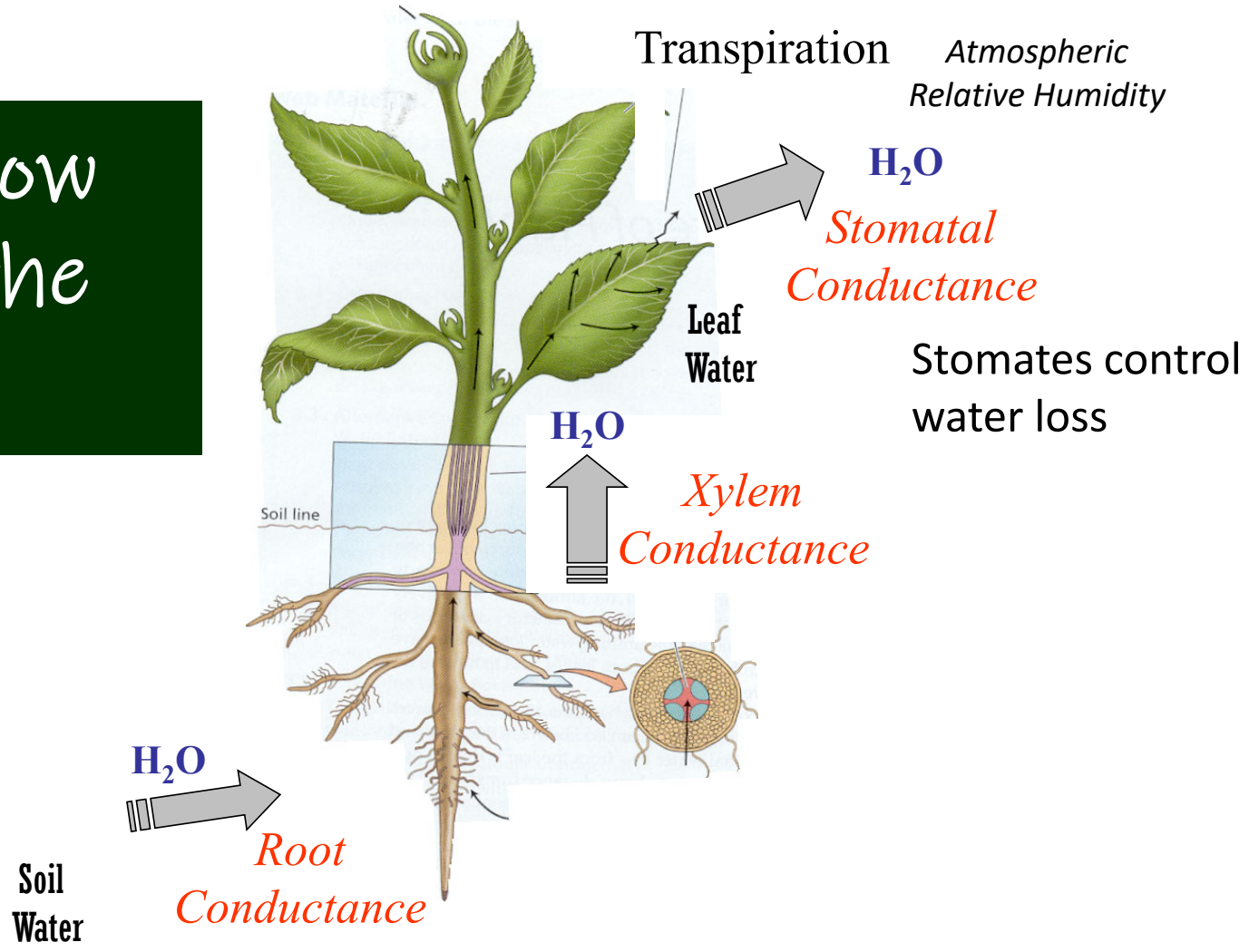
80 – 90% of the plant is water

~90% of the water taken up by the tree is loss through transpiration

Transpiraton *occurs when water is pumped up from the soil through the roots and into the plant by loss of water through the stomates*

Water fills a number of important roles in the physiology of the plant

Water flow within the plant



Stomates control water loss

The roles of water in the plant due to its physical and chemical properties

Thermal properties –

Temperature regulation as it does not heat or cool too quickly, *cools plants by evaporating from leaf surface through process of TRANSPIRATION*

Source: http://www.horticulture.com.au

The roles of water in the plant due to its physical and chemical properties

Solvent properties –

Carries nutrients and solutes required for growth

Source: http://www.horticulture.com.au

The roles of water in the plant due to its physical and chemical properties

Transparency –

Allows sunlight to penetrate to power photosynthesis in the plant cells

Source: http://www.horticulture.com.au

The roles of water in the plant due to its physical and chemical properties

Biochemical properties –

Many of the biochemical reactions that occur within the plant requires water such as *Respiration* and *Photosynthesis*

Source: http://www.horticulture.com.au

What is Respiration?

- The process of respiration provide energy for the metabolic processes occurring in the plant.
- It provides the Energy for Life

$$C_6H_{12}O_6 + 6O_2 \quad \text{--->} \quad 6CO_2 + 6H_2O + \text{Heat}$$

Glucose	Oxygen	Carbon Dioxide	Water

What is Photosynthesis?

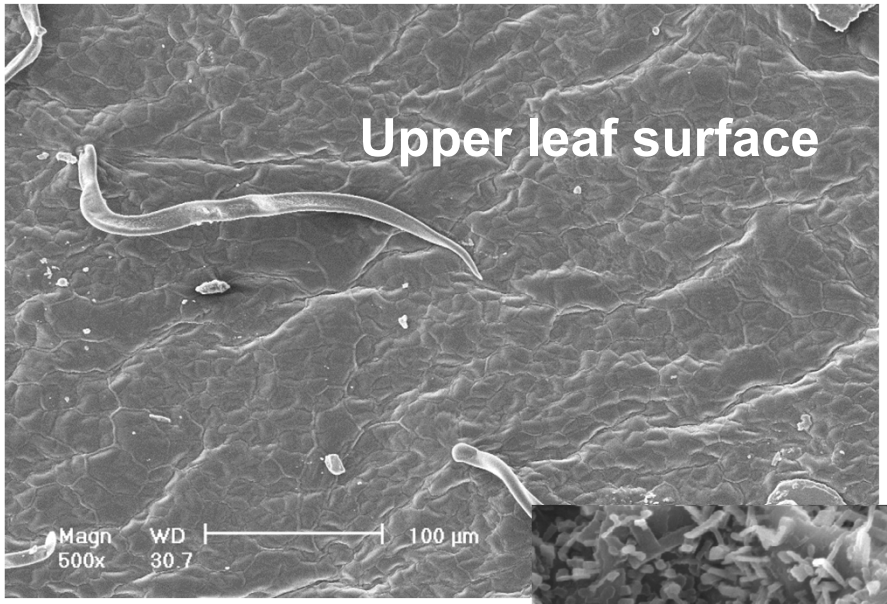
- Plants make carbohydrates out of carbon dioxide from the air and water and a few minerals from the soil
- They do this with the aid of sunlight, in a process called PHOTOSYNTHESIS, which means "putting together with light."

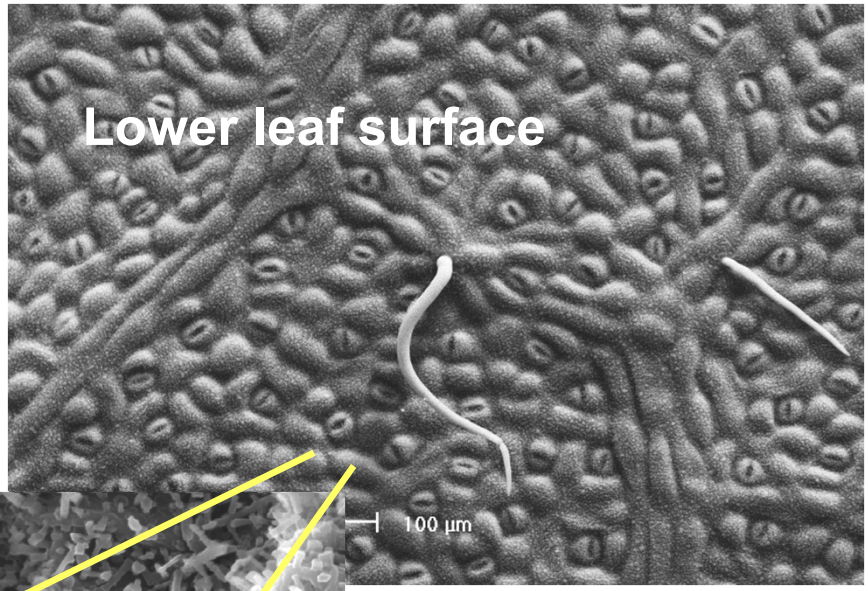
$$CO_2 + H_2O + \text{energy} \longrightarrow C_6H_{12}O_6 + O_2$$

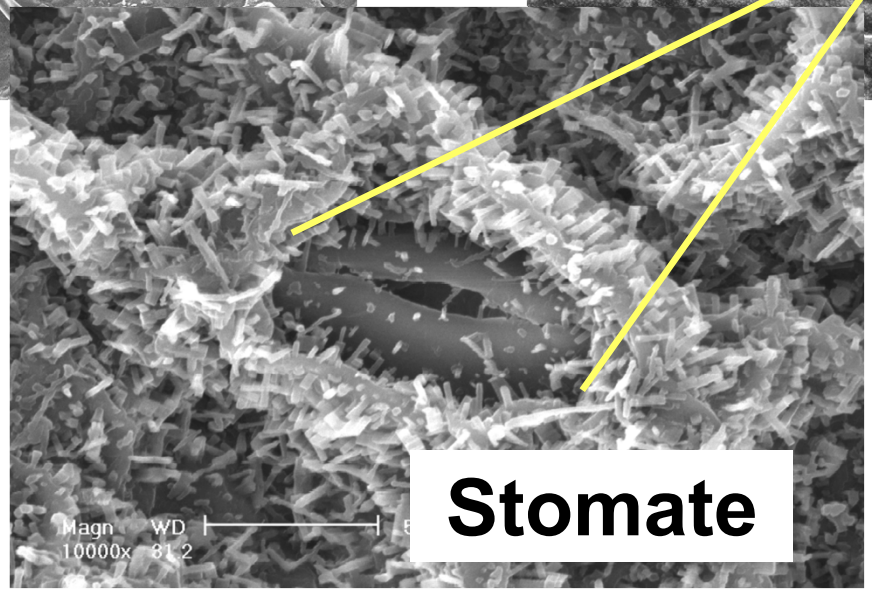
Carbon Dioxide Water Sun Glucose Oxygen

Photosynthesis is the "Critical Control Point"

The leaves control the movement of water in the plant and where Photosynthesis takes place







'Hass' avocado leaf surface

Stomate (regulated opening in leaf)

CO_2 (air→leaf)

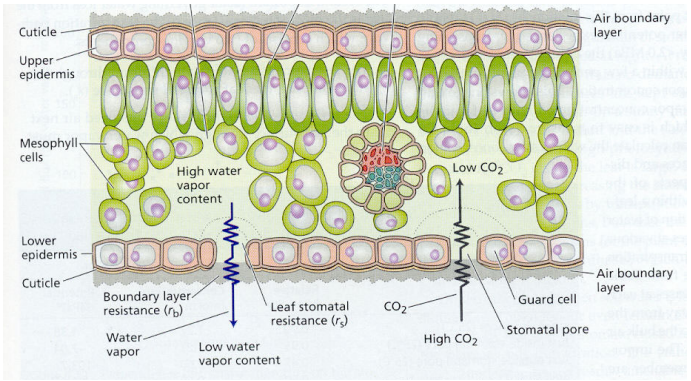
CO_2 Assimilation [Photosynthesis]

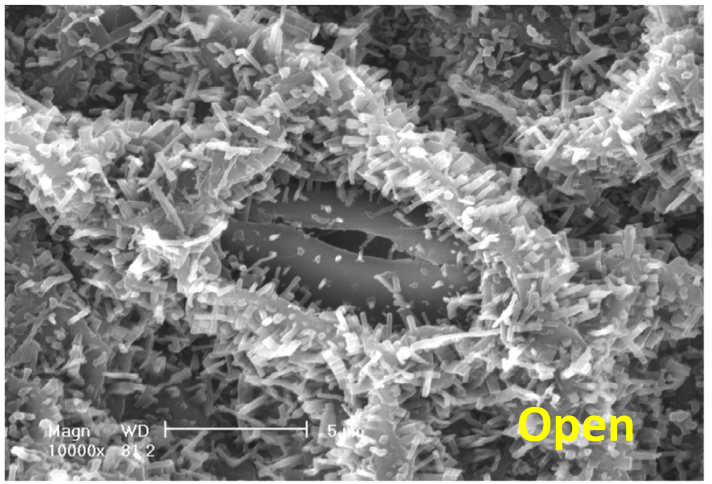
Carbohydrate Oil Production

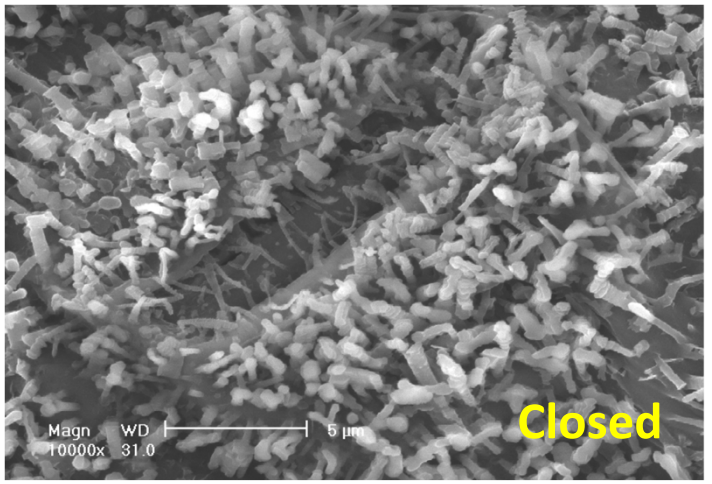
H_2O (leaf→air)

H_2O Loss [Transpiration]

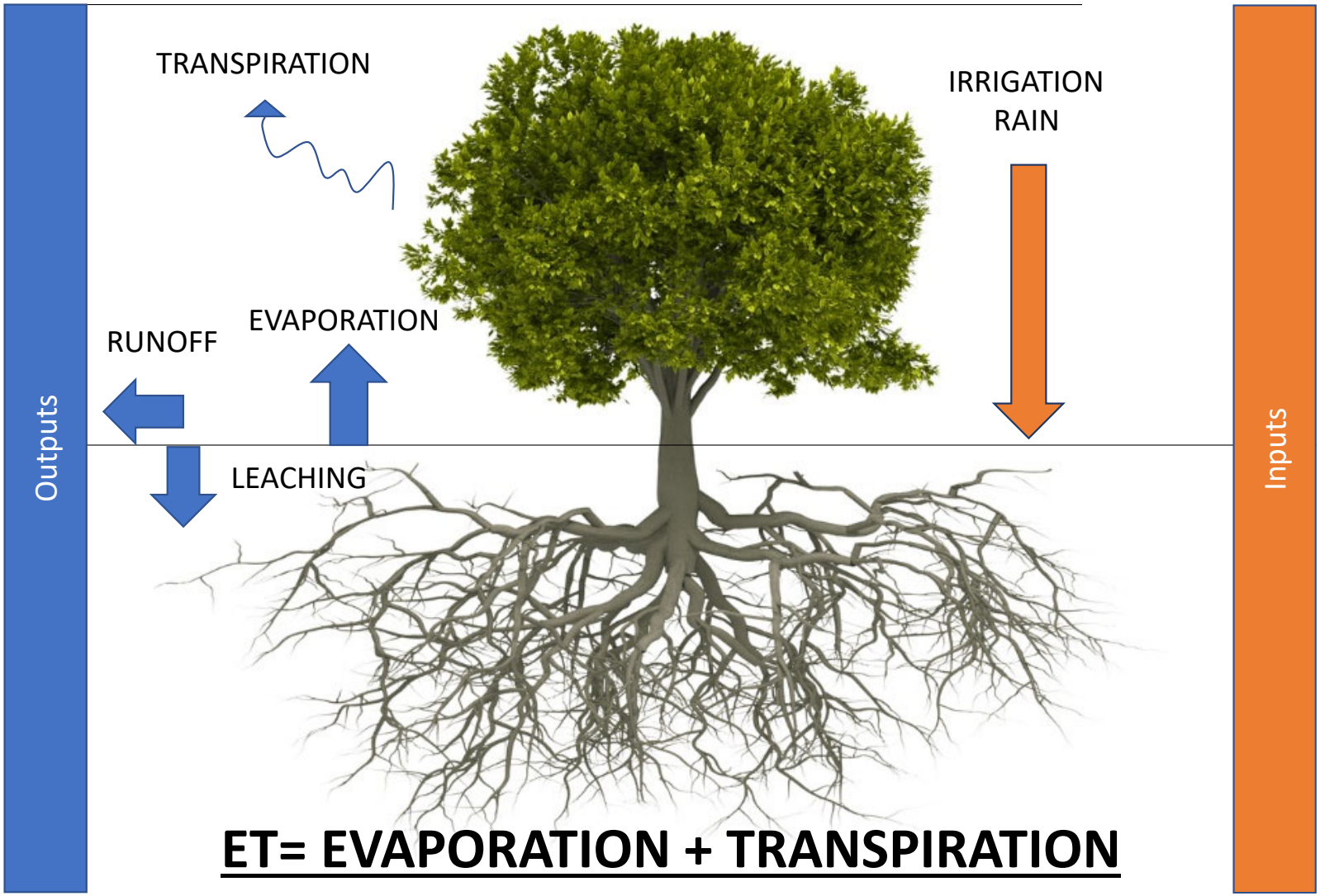
Cooling Nutrient movement

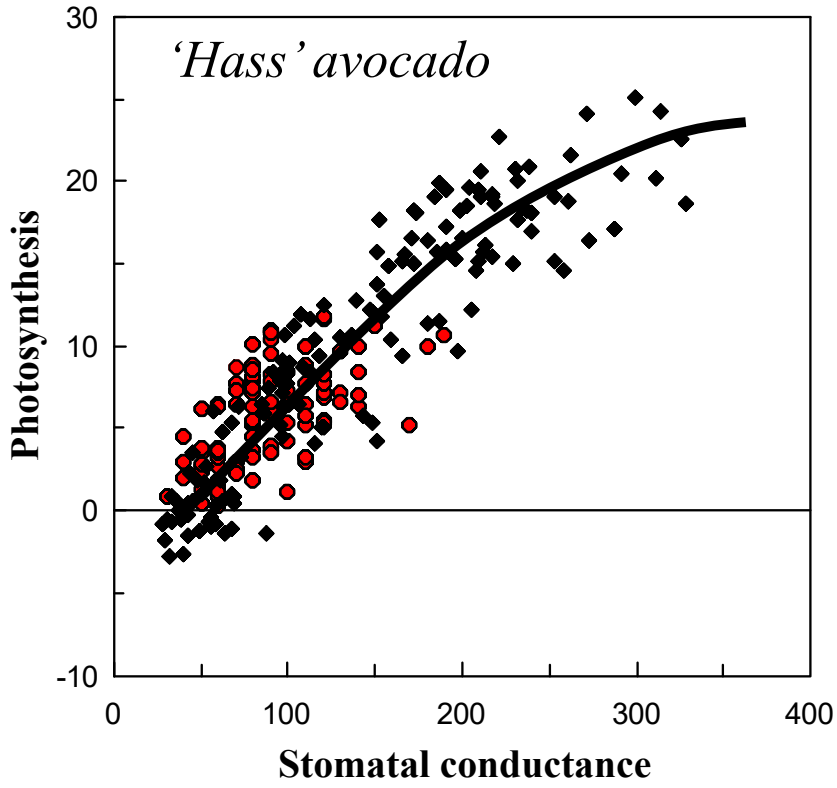






Water balance

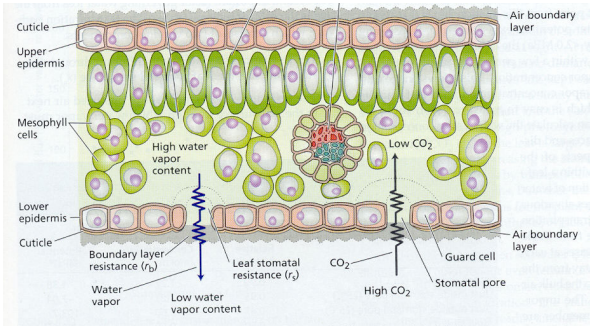




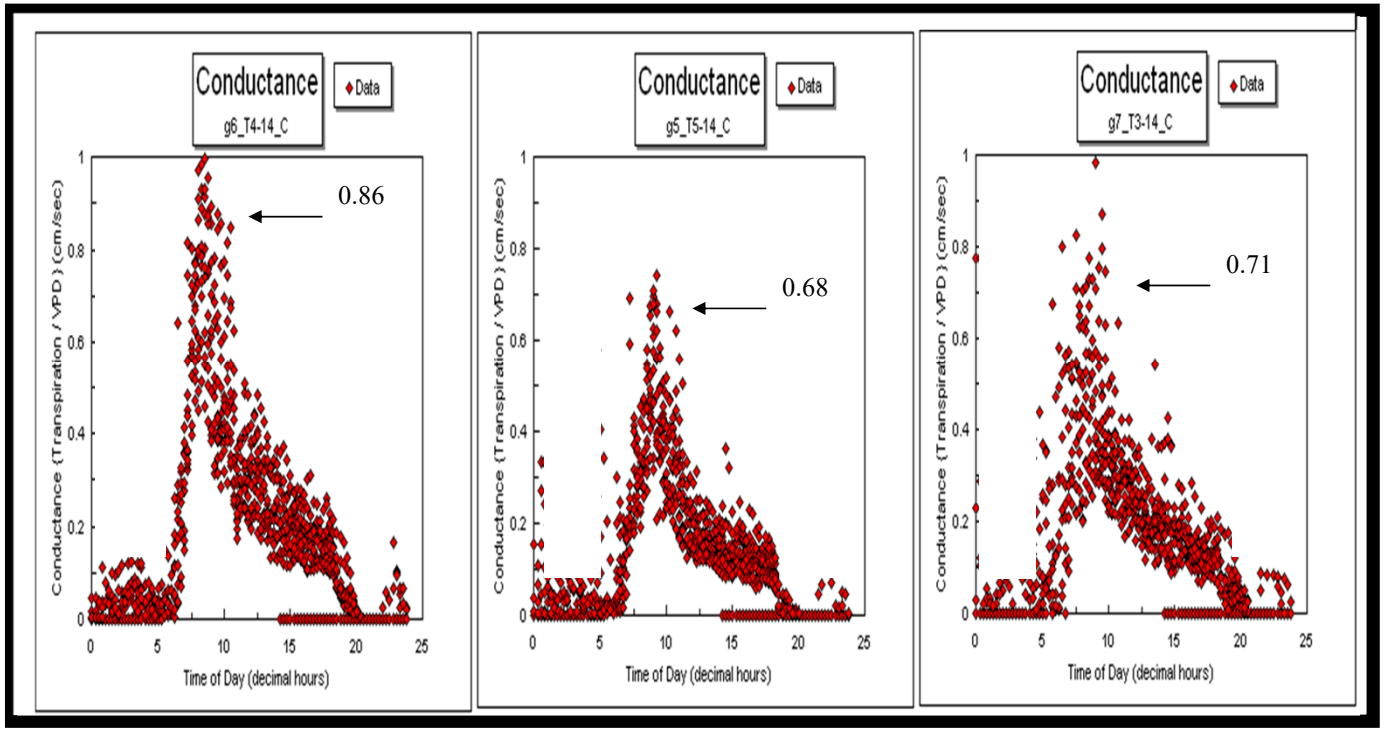
Photosynthesis

is related to stomatal conductance

(how open are the stomates)



Conductance in field (in units of cm/sec)



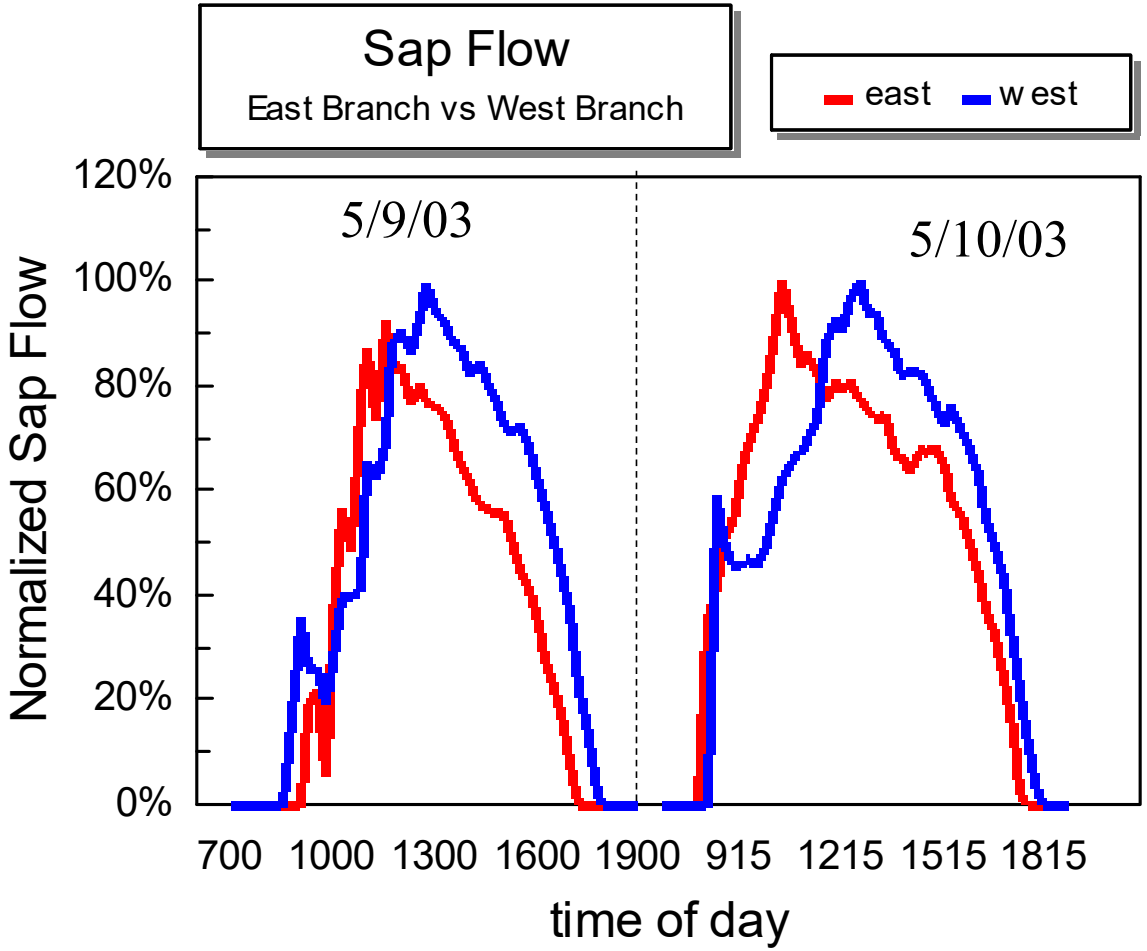
Stomatal Conductance varies

- Time of day
- Between trees
- Is not 100% (open)

Therefore, the rate of photosynthesis varies and is not at the maximal rate throughout the day

Comparison of the Calculated Conductance between Hass on Duke 7 in the Field.
Sap flow (g/hr) converted by leaf area (m2) into transpiration (mmol/m2 sec). Using VPD from relative humidity and air temperature, the transpiration is converted into conductance. These are total conductance, not those from LICOR measurements (which misses the boundary layer).
Data are from six trees planted at a field plot at ACW, Fallbrook, spaced by 10 feet from 7/6 to 7/17/06.

Water Movement



Water flow within the tree varies across the day depending on movement of sun

Light regulates water flow within the tree

Why is water essential to the tree?

For the plant to grow and produce fruit a tree needs an adequate supply of water

Water is important for:

- Cooling of the plant
- Movement of minerals and nutrients
- Substrate for many of the biochemical processes occurring during growth and development