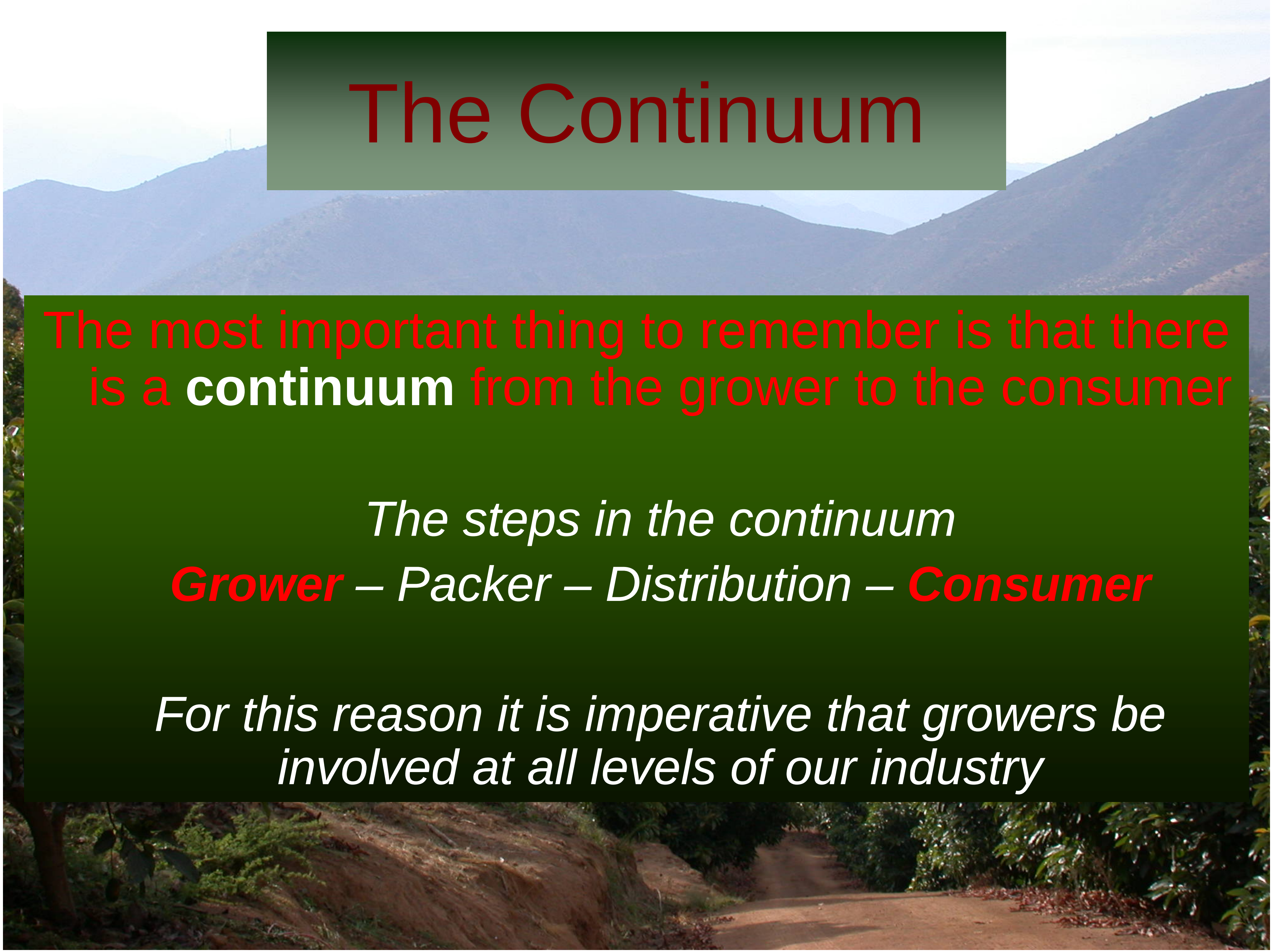
Bases nutricionales para la construcción de fruta de alta calidad

Mary Lu Arpaia

Agricultural Experiment Station
1907 2007
University of California, Riverside



The Continuum

The most important thing to remember is that there is a **continuum** from the grower to the consumer

The steps in the continuum

Grower *– Packer – Distribution –* ***Consumer***

For this reason it is imperative that growers be involved at all levels of our industry

Susceptibility to low storage temperatures

External Chilling Injury

Internal Chilling Injury

There are problems with fruit arrivals

Limitations to postharvest handling

- Preharvest Factors

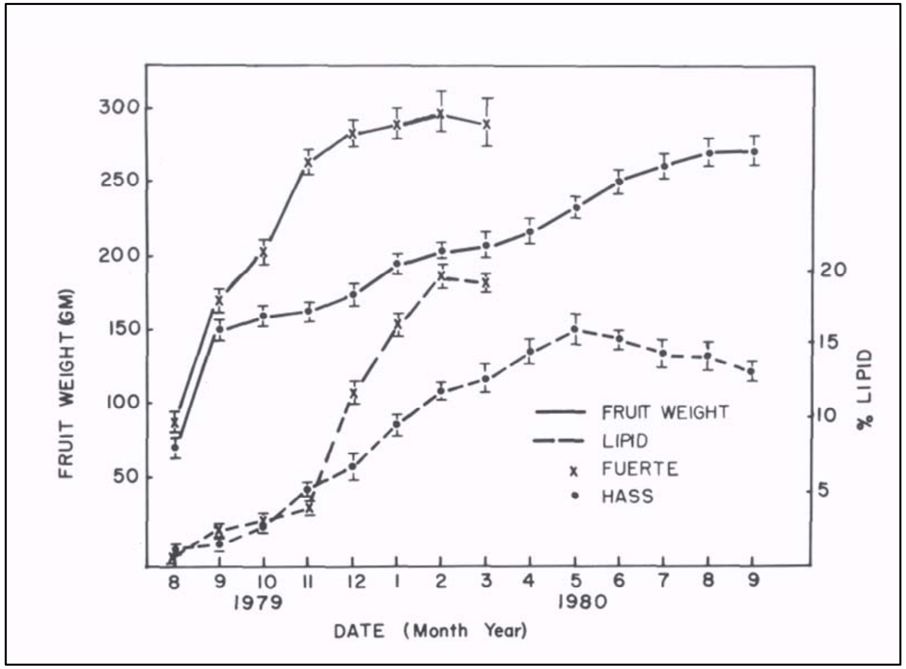
- Postharvest Factors
  - Fruit maturity and quality
  - Storage duration
  - Stage of ripeness

The key for solving our problems are under our control and are profoundly influenced by tree management

WE MUST UNDERSTAND THE AVOCADO

Unusual things about the avocado fruit:

- ✓ Continued cell division during growth and development
- ✓ Contains many healthy phytochemicals and unusual sugars
- ✓ Accumulates large quantities of lipids in the fruit flesh



Eaks, 1990

Bul. 743, U. S. Dept. of Agriculture. PLATE XXII.

THE TERTOH AVOCADO, ONE OF THE LARGEST GUATEMALAN VARIETIES.

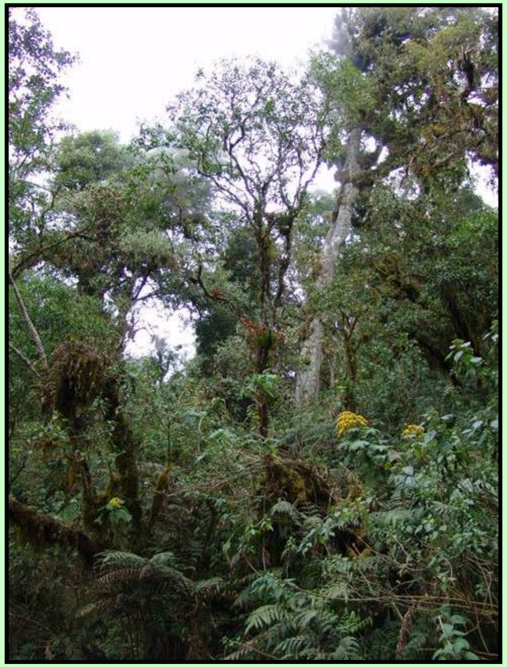
The fruits here shown are not yet fully grown. Good specimens of this variety weigh 3 pounds and are of excellent quality, the flesh being rich yellow in color, free from all discoloration, and of nutty flavor. The seed, as will be noticed in the illustration, is comparatively small. This variety has a considerable reputation in the vicinity of the city of Guatemala, owing principally to its large size. Avocados weighing more than 2 pounds are rare in Guatemala. (Photographed at the city of Guatemala, December 2, 1917; P17466FS.)

Relatively “new” crop to domestication

Highly diverse

Still retains the traits that are adapted to its native neotropical rainforest habitat

The physiology of the tree is poorly understood



“Minimization of stress is increasingly the key to commercial viability. Climate and soil selection are the foremost determinants.”

N. Wolsthenholme, 2002

The link between the preharvest environment and fruit quality

BOTTOM LINE:
Quality does NOT improve after harvest

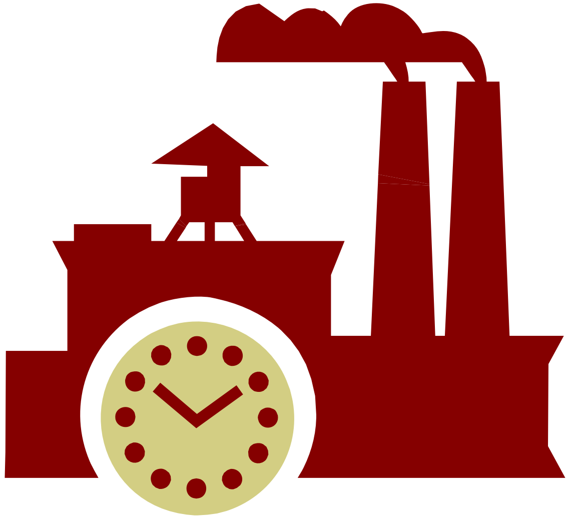
- Nutritional management – N, Ca relationships
- Rootstocks/pollinizers – what influence do they have?
- Stress – cold, salinity, irrigation management
- Canopy management – managing light

All contribute to fruit quality; interact with each other

Important to understand interaction with fruit maturity as well

Raw Materials

Labor



Product

Light
Carbon Dioxide
Temperature
Water
Nutrients

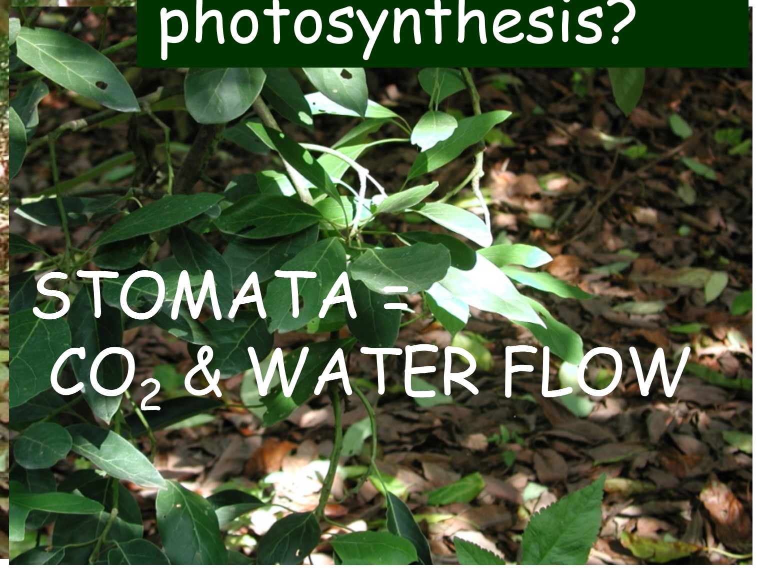
Labor

Fruit

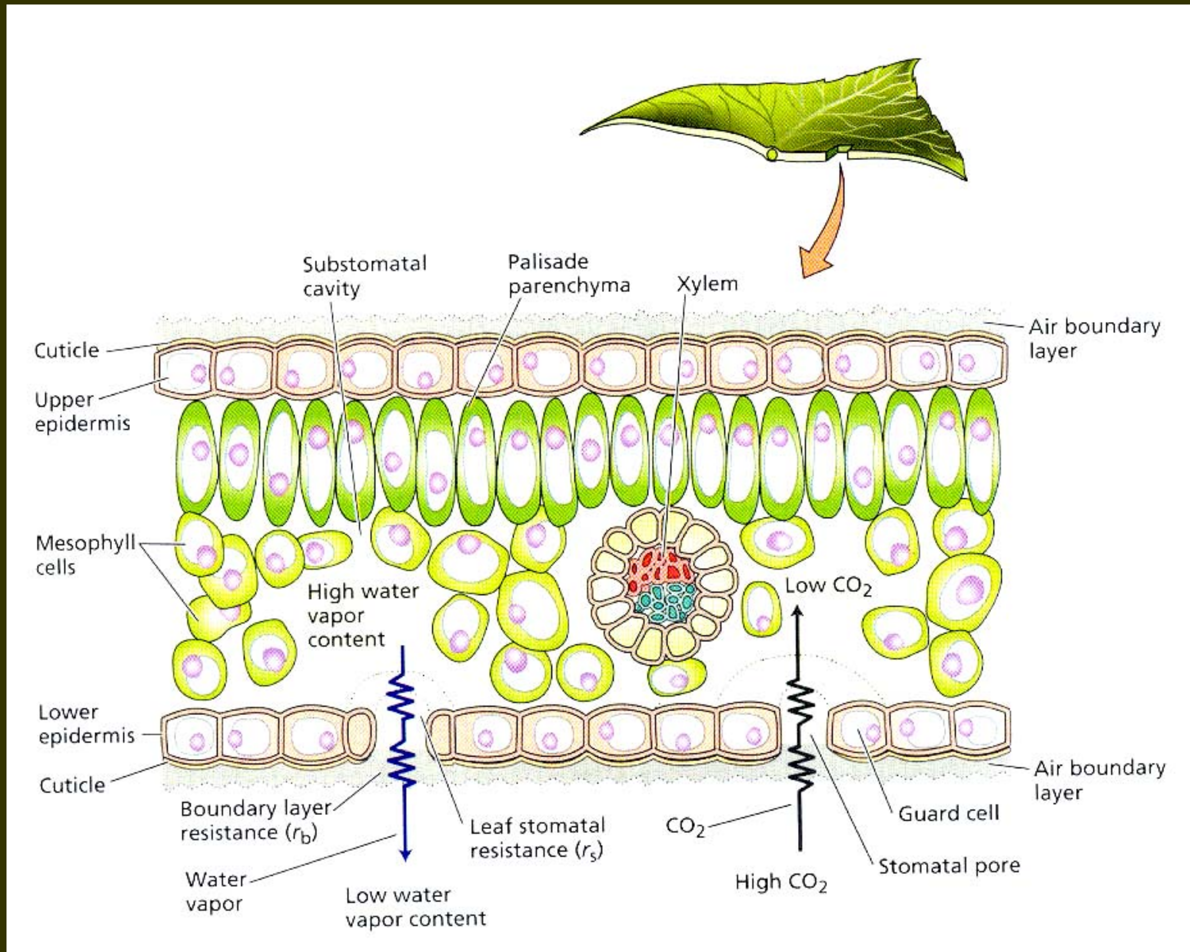

Where is the key control point of the Factory?

Photosynthesis is the "factory"

What factors limit photosynthesis?



Stomates control water loss (transpiration) and CO_2 uptake (photosynthesis)



Stomate (regulated opening in leaf)

CO_2
(air→leaf)

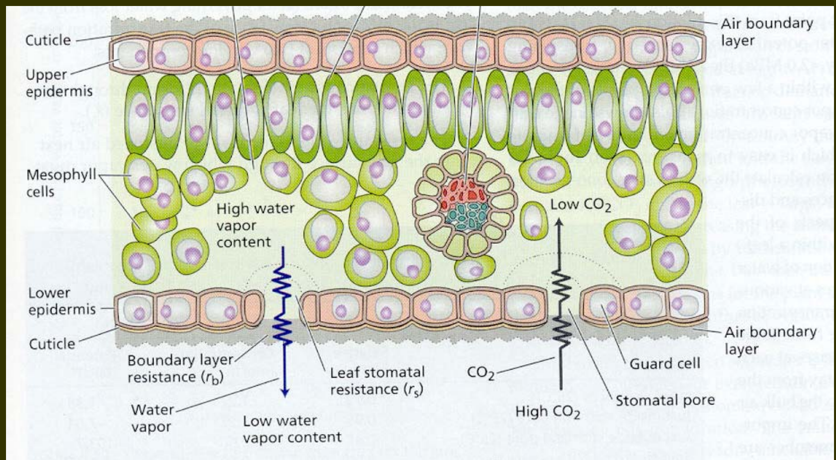
H_2O
(leaf→air)

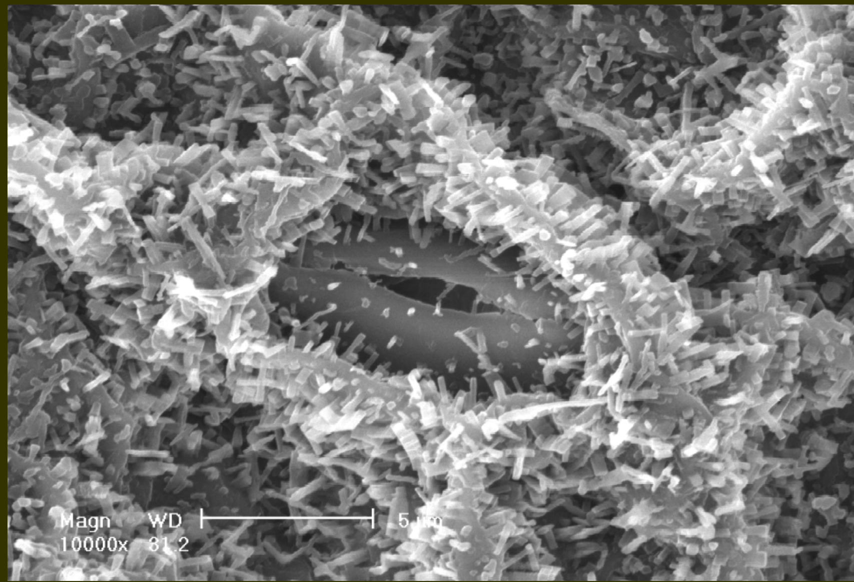
CO_2 Assimilation
[Photosynthesis]

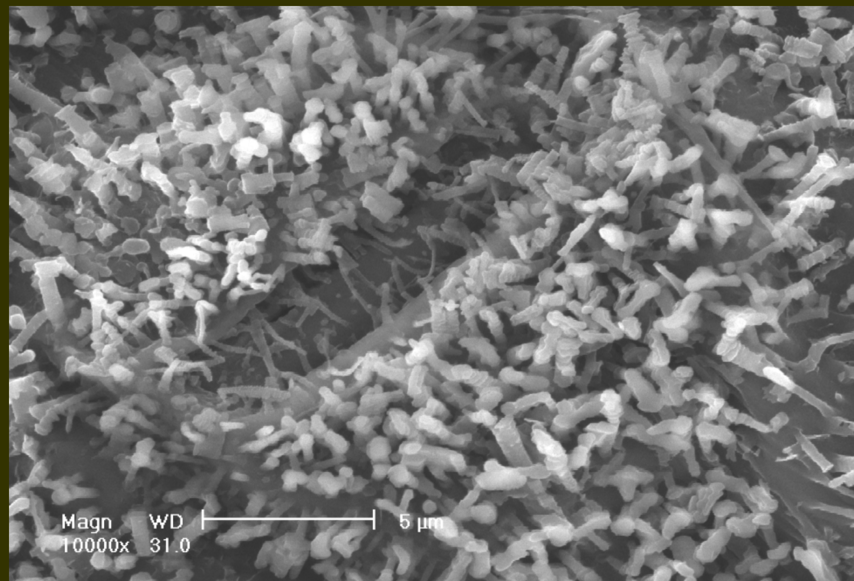
H_2O Loss
[Transpiration]

Carbohydrate
Oil Production

Cooling
Nutrient movement

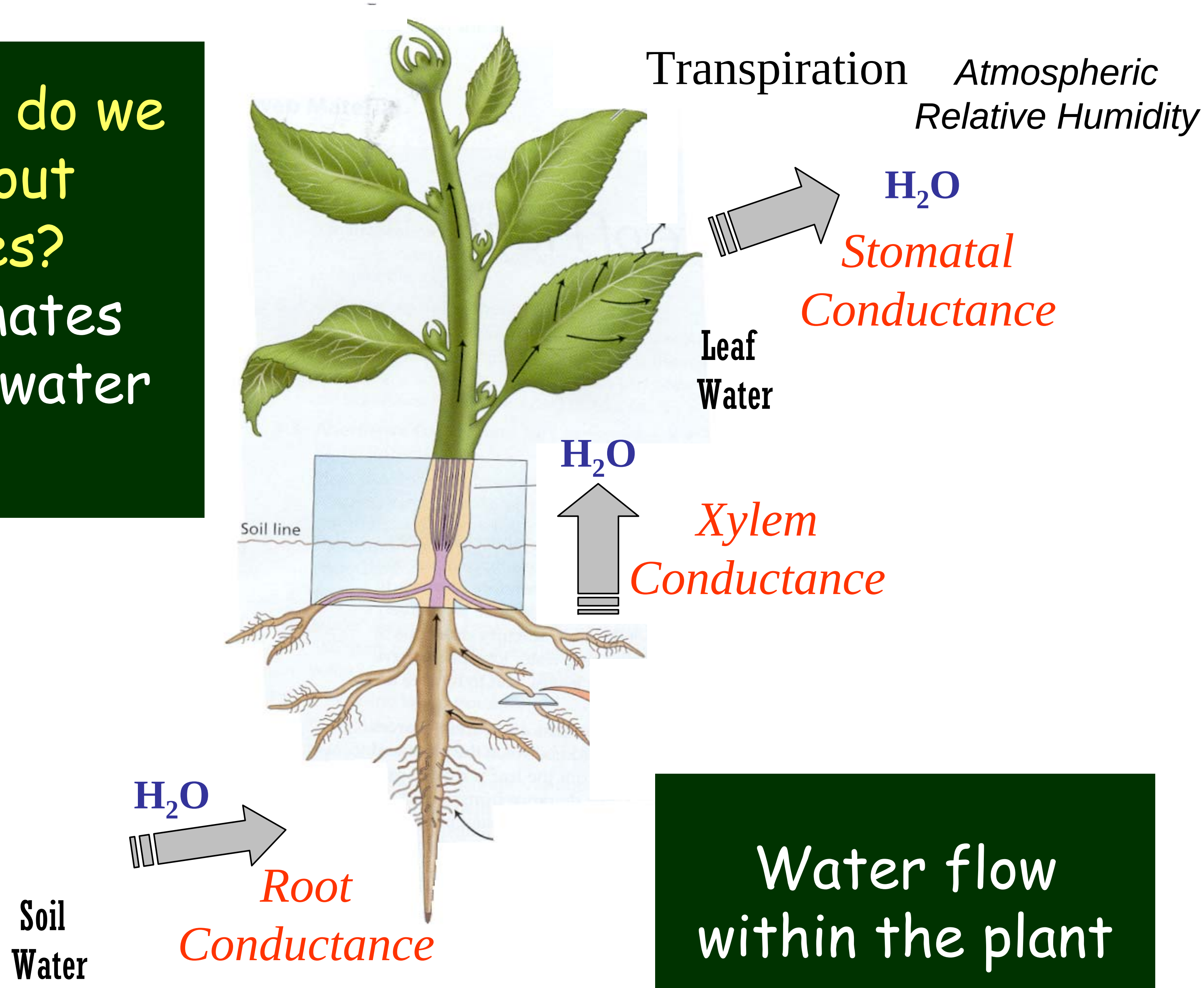




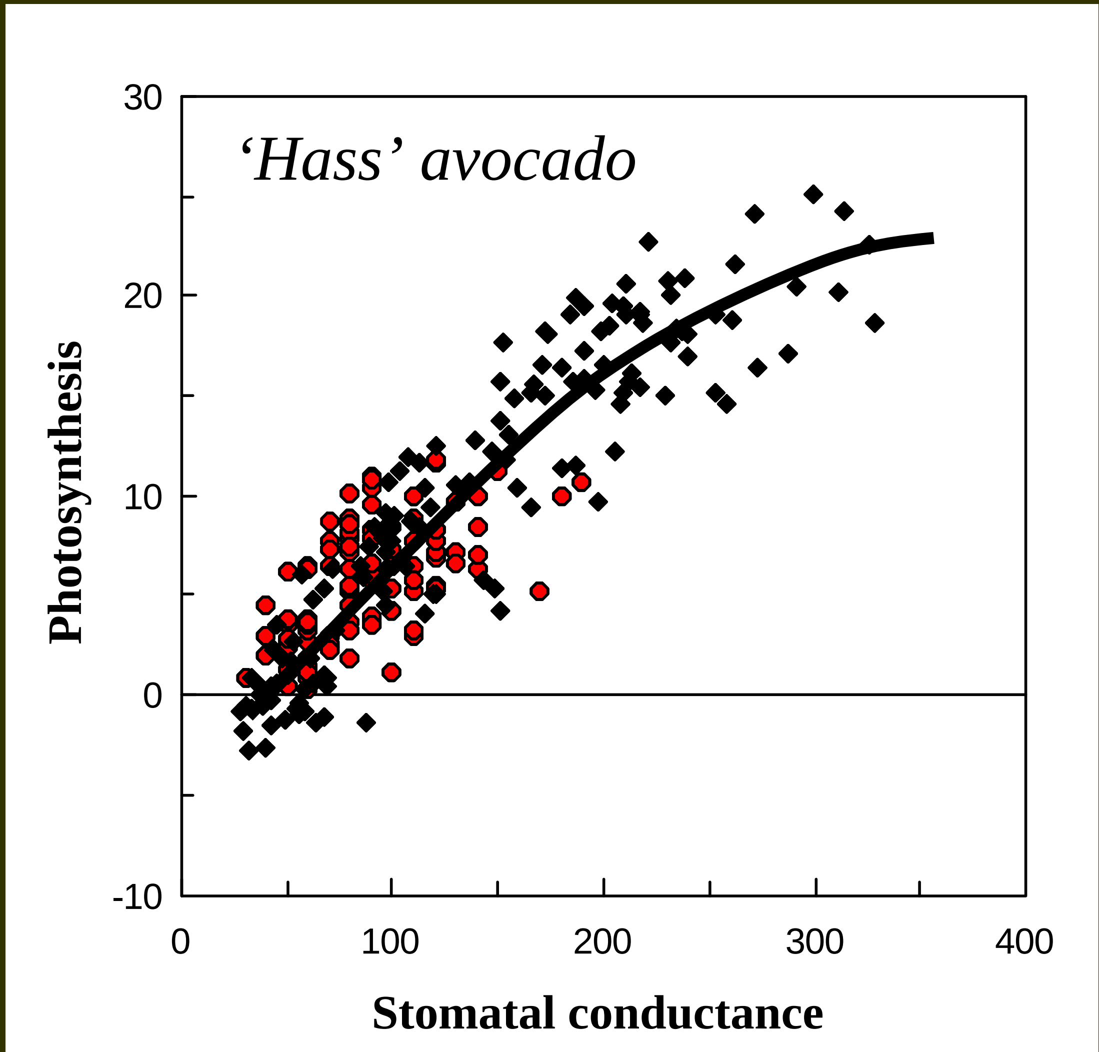


Q: Why do we care about stomates?

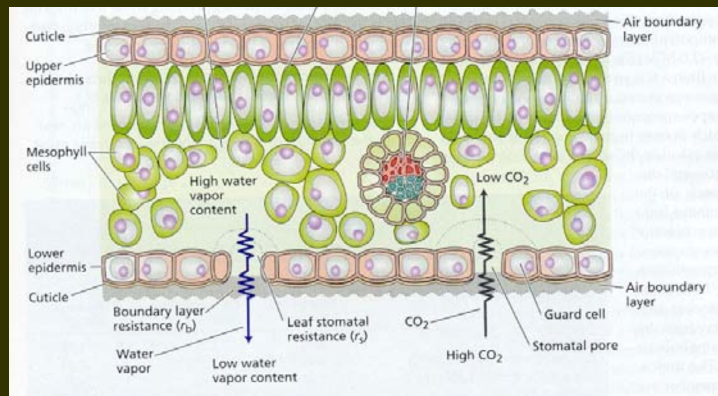
A: Stomates control water loss



Water flow within the plant



Photosynthesis is related to stomatal conductance



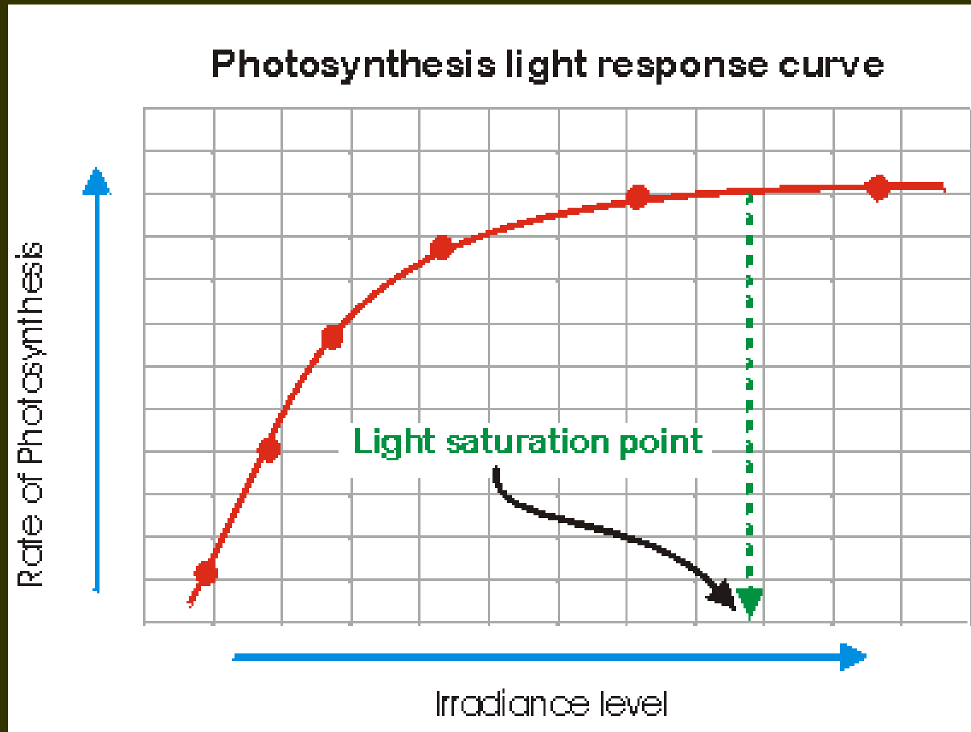
Factors that affect photosynthesis

- Light
- Temperature
- Relative humidity
- Wind
- Water

Light

Avocado leaves reach the light saturation point at 1/4 to 1/3 full sunlight.

Light *quantity* and *quality* are reduced with successive canopy layers.



Low density planting

High Density

Half-tree contour of light penetration – Hedge Row

Extent of effective light penetration

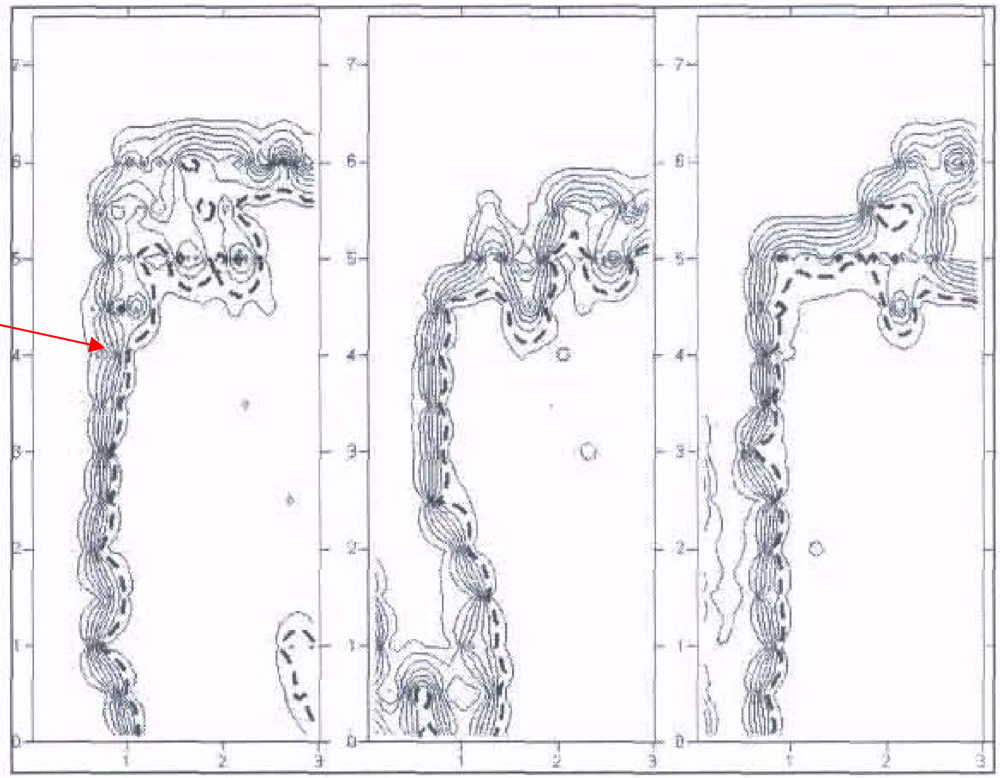


Figure 51– Contours of half-tree cross sections based on measurements done on the 7/9/2003 in 'Shomrat' orchard: CV. Hass: pruned hedgerow: three different cross sections from the same row.

Matan Hadari. 2005. MSc Thesis. A Three Dimensional Model of the Light Regime in an Avocado Orchard. Technion. Haifa. Israel.

Light penetration into the tree

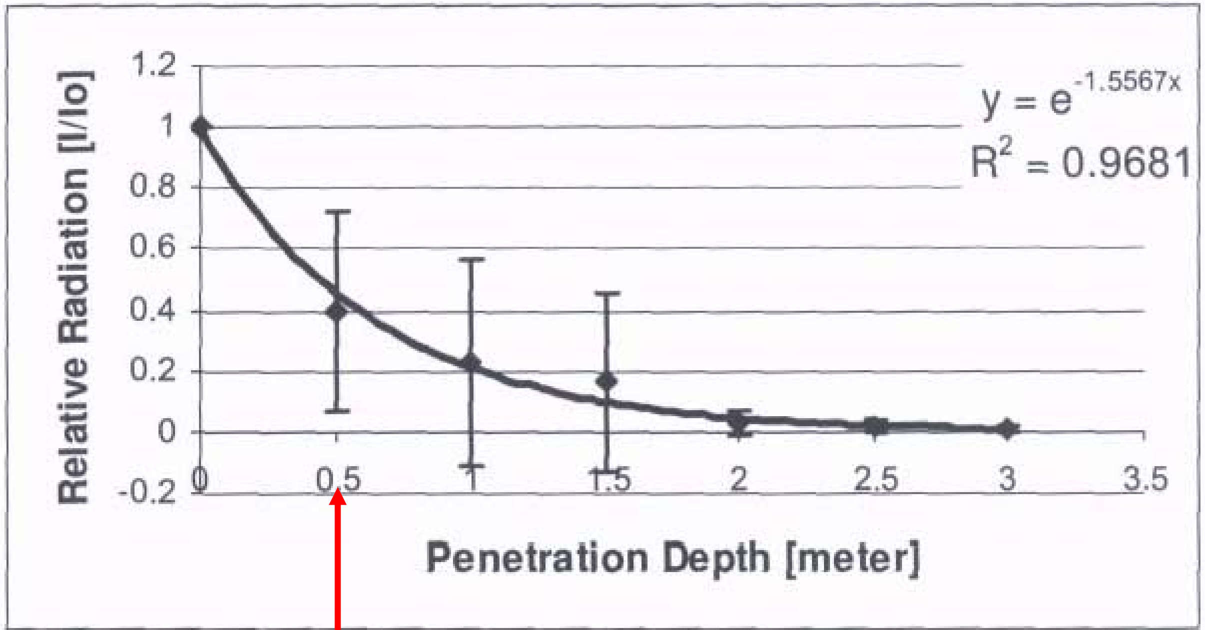


Figure 53- Relative irradiance in different depth of the canopy as measured on the 3/9/2003; "Shomrat orchard", CV. 'Hass'.

60% reduction of light penetration within 0.5 m

Matan Hadari. 2005. MSc Thesis. A Three Dimensional Model of the Light Regime in an Avocado Orchard. Technion. Haifa. Israel.

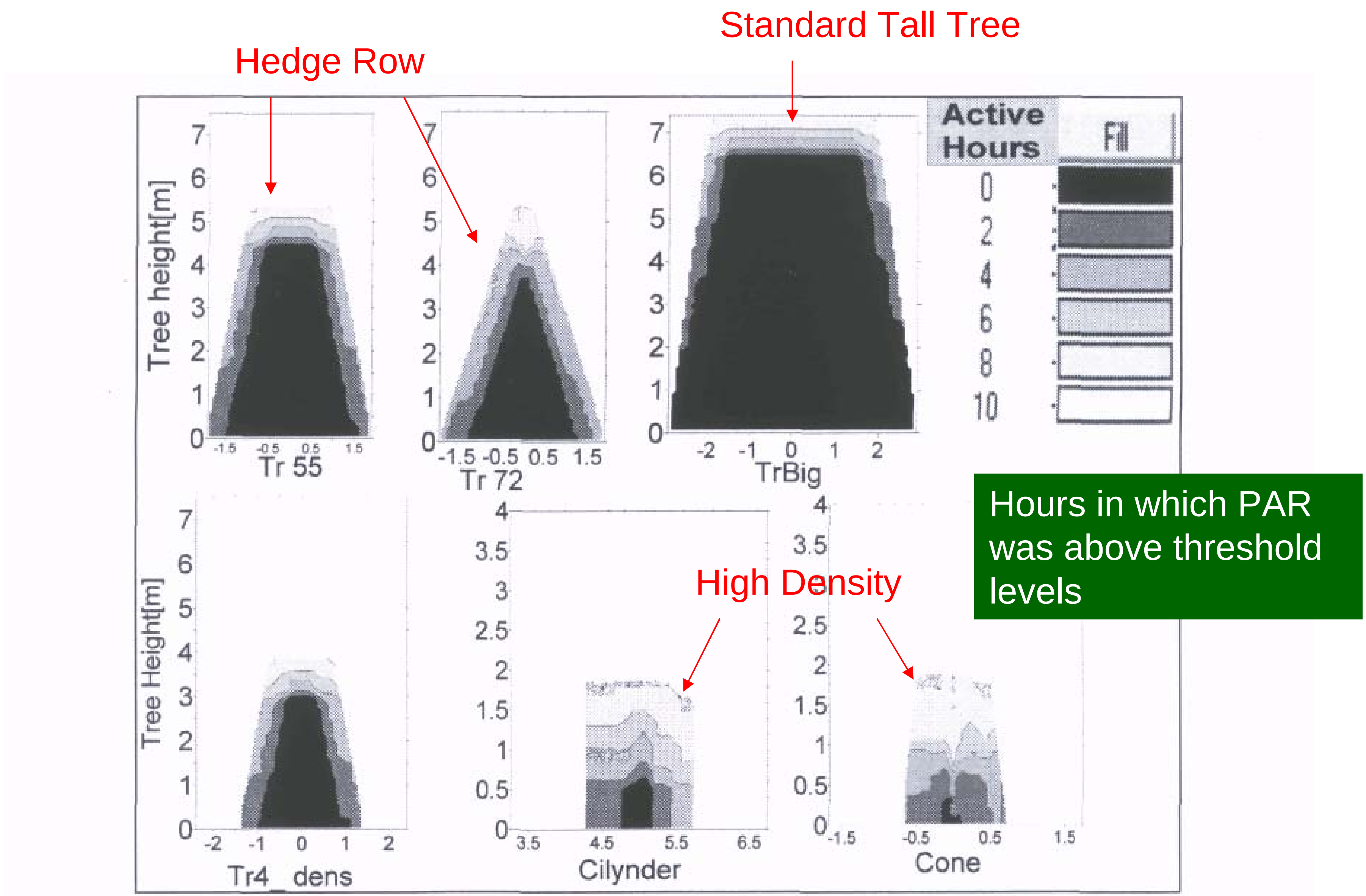
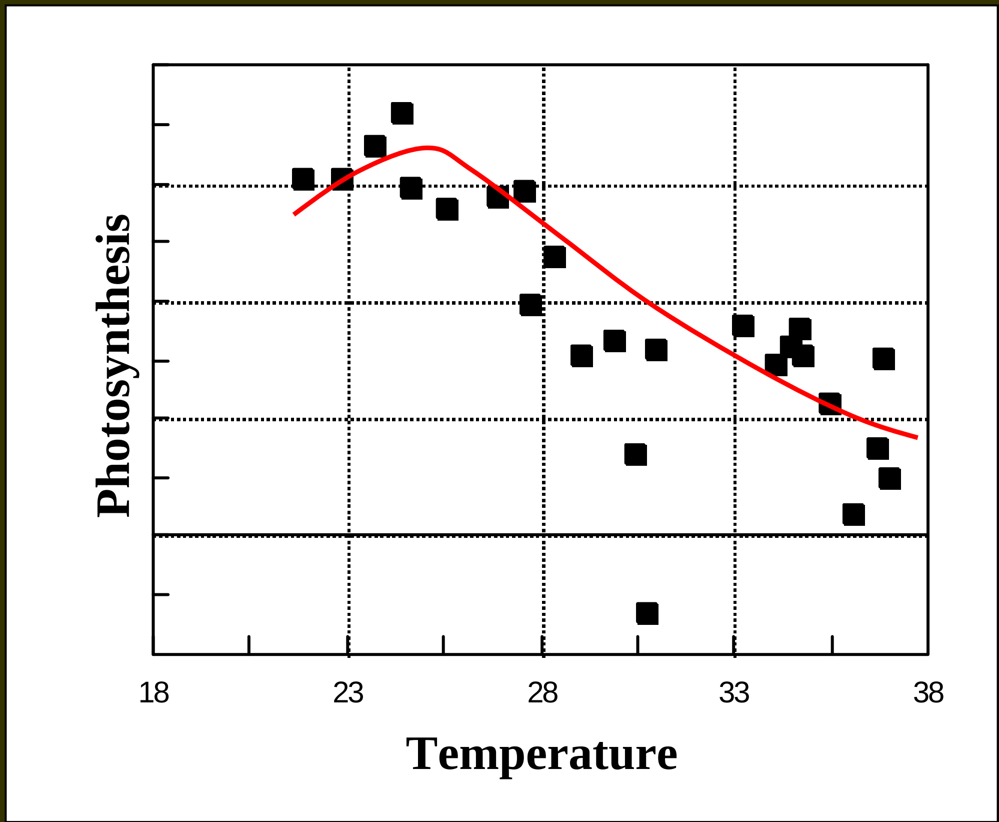


Figure 50 - Seasonal averaged daily exposure hours with PAR above the threshold level in selected models.

Matan Hadari. 2005. MSc Thesis. A Three Dimensional Model of the Light Regime in an Avocado Orchard. Technion. Haifa. Israel.

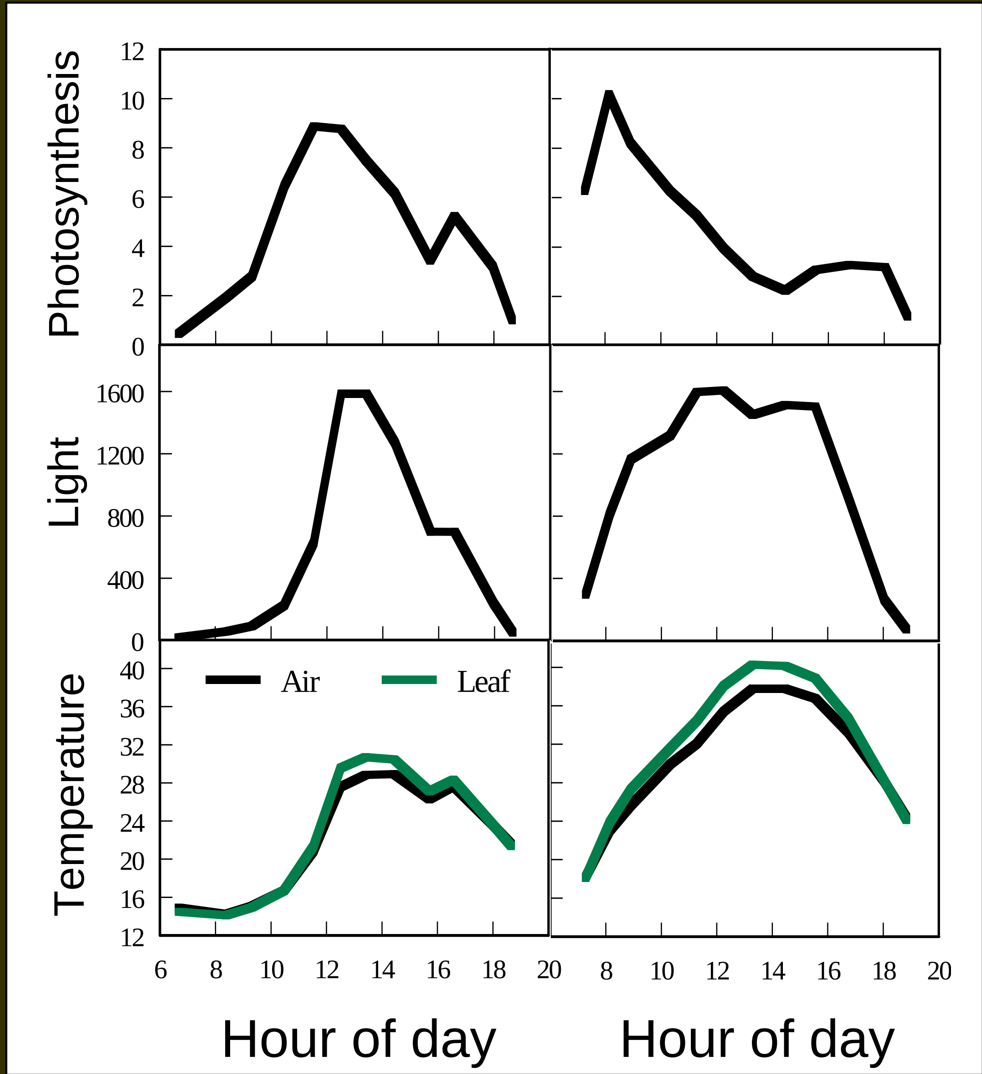
Temperature



Photosynthesis is reduced at high temperatures.

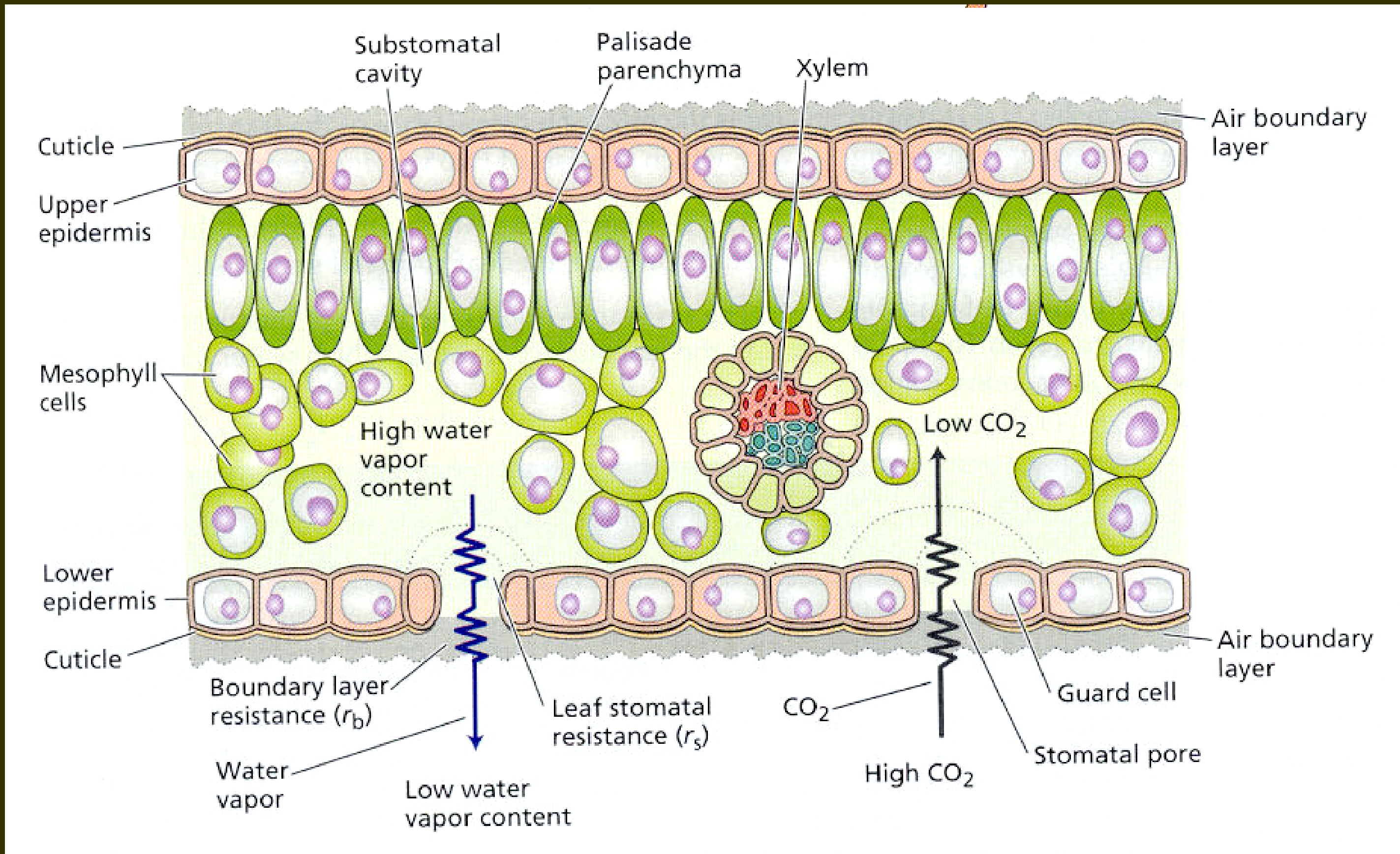
Temperature

High afternoon temperatures reduce photosynthesis.

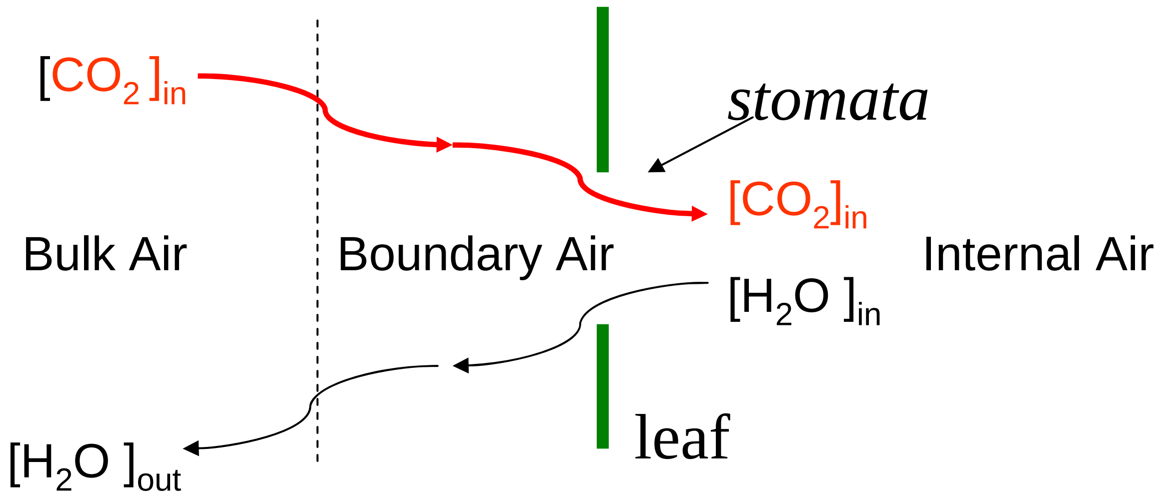


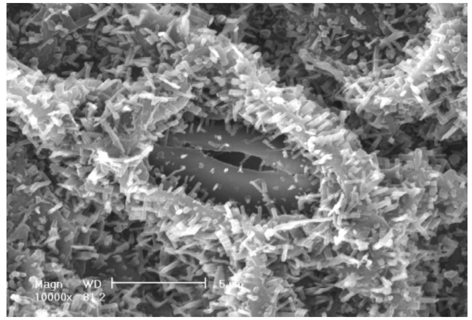
Wind

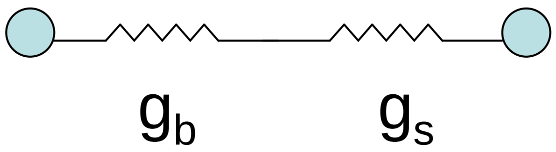
Boundary layer increases with low air movement, limiting photosynthesis.



Wind







total flow is:

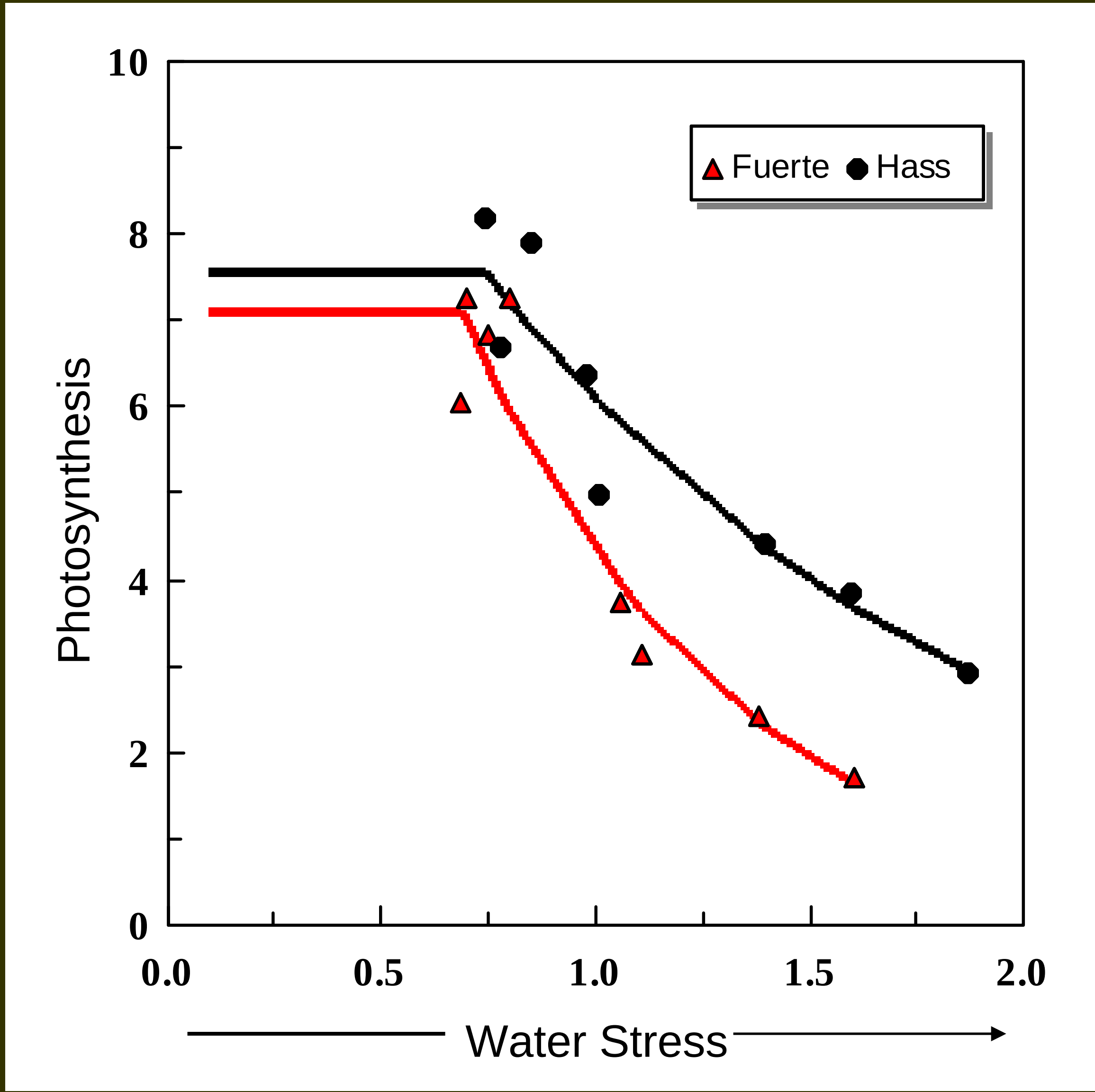
$$g_T = g_S\, g_b \,/\, (g_S + g_b)$$

Goal is lowest water loss dependent upon the roots' ability to gather water.

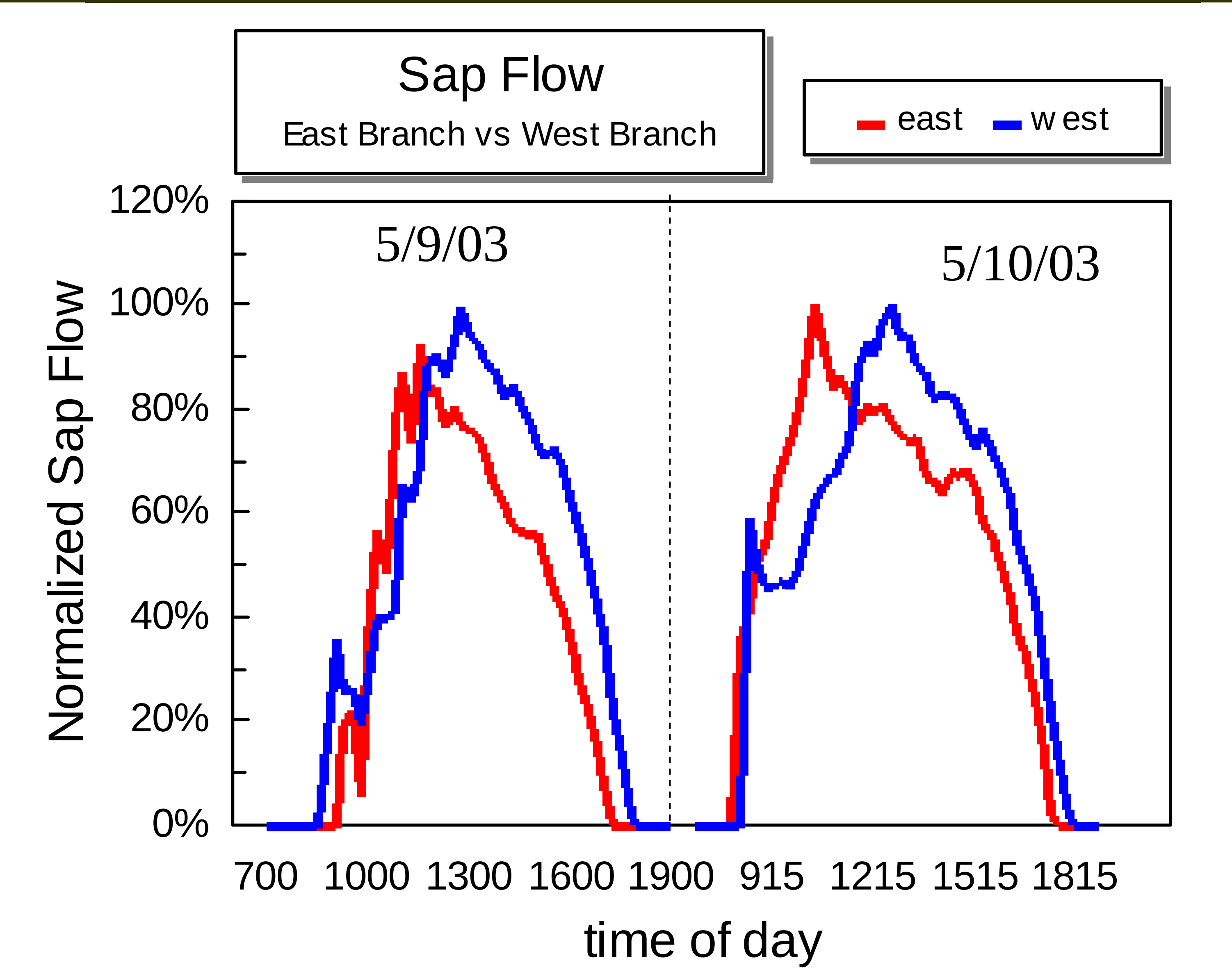
Goal is highest photosynthetic rate (dependent upon light intensity) but also upon flow of CO_2

Water

Leaf water stress reduces photosynthesis.



Water Flow



Sap Flow
East Branch vs West Branch
east
west
120%
100%
80%
60%
40%
20%
0%
Normalized Sap Flow
5/9/03
5/10/03
700
1000
1300
1600
1900
915
1215
1515
1815
time of day

Canopy Management/Pruning

May have an effect on fruit quality

Aim at fruit requirements not wood

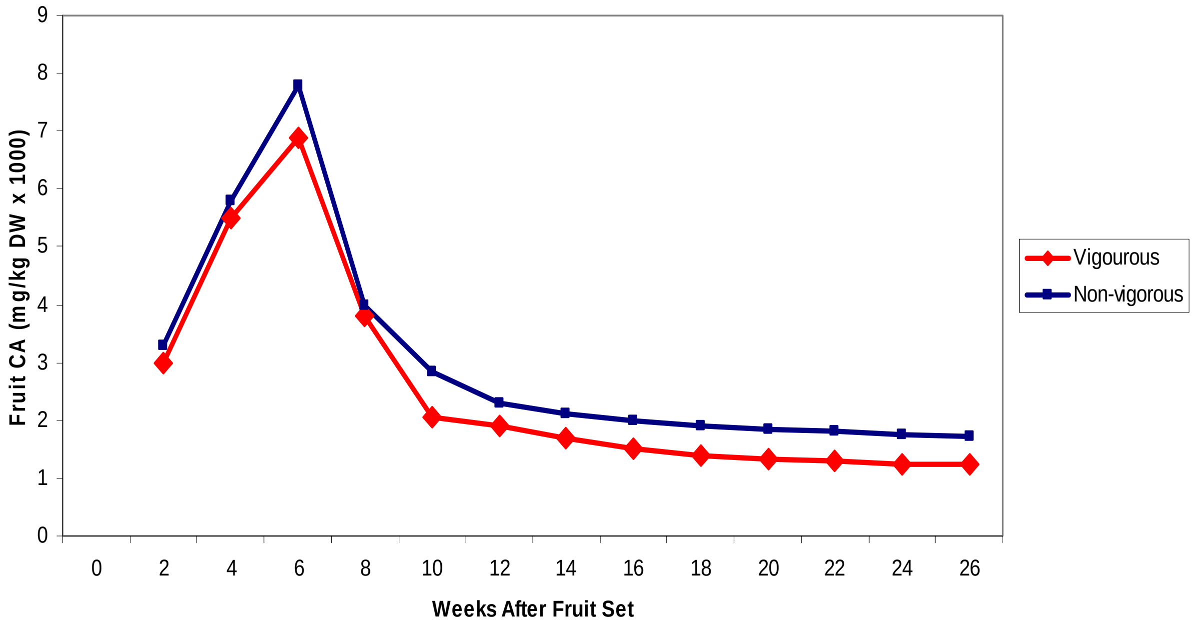
Effects of tree vigor on fruit quality

Individual tree yield records were maintained

Based on overall tree yield and storage quality the following observations were made:

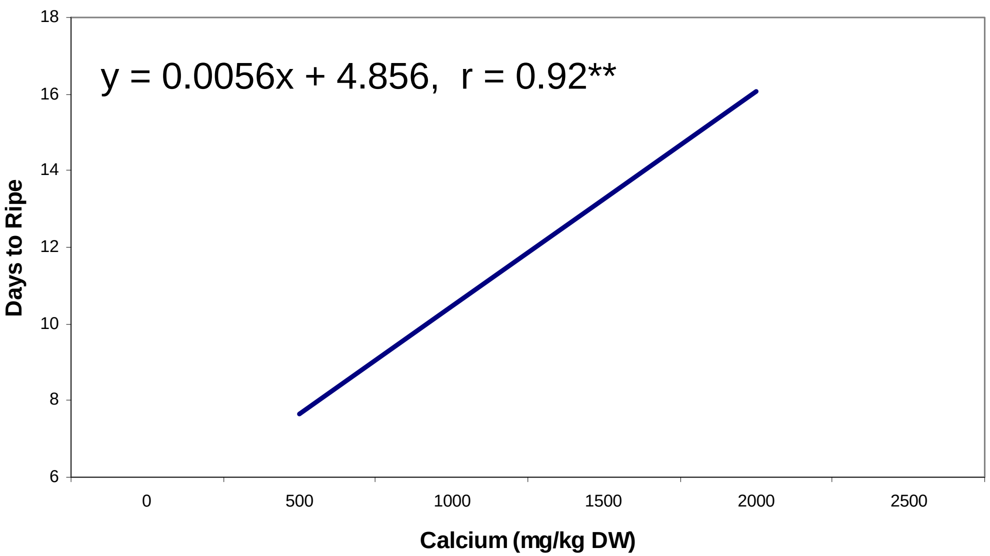
- In vigorous, low yielding trees all forms of chilling injury were observed in higher amounts following 28 days at 5.5C
- Low yielding trees had lower pulp calcium, zinc and manganese

D. Smith, 1992 (unpublished RSA)

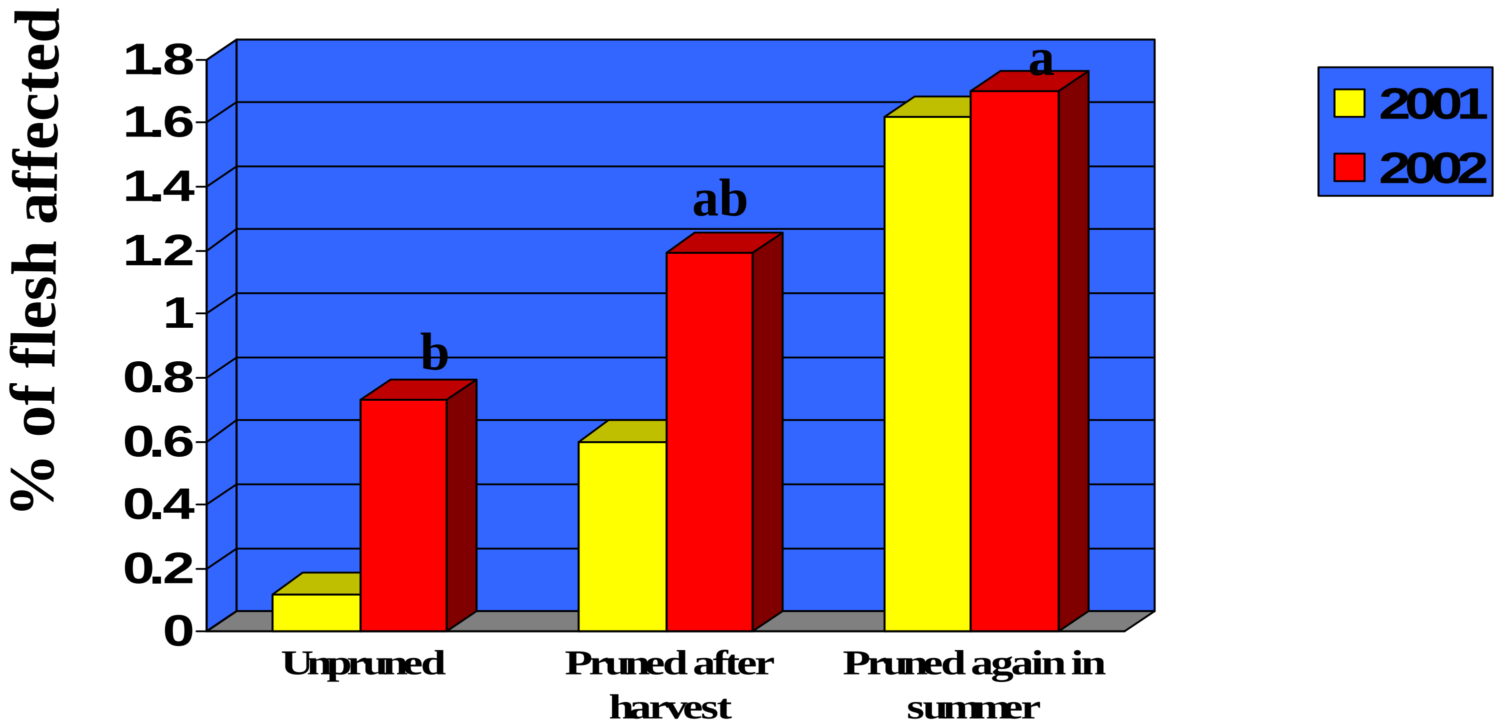


Tree vigor influences calcium levels in the fruit

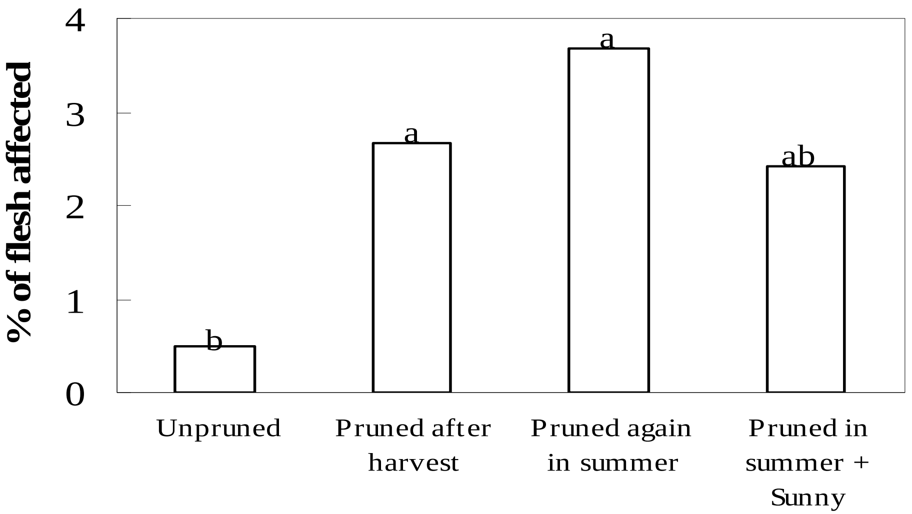
Calcium affects the rate of ripening



Witney et al, 1991



Diffuse discoloration

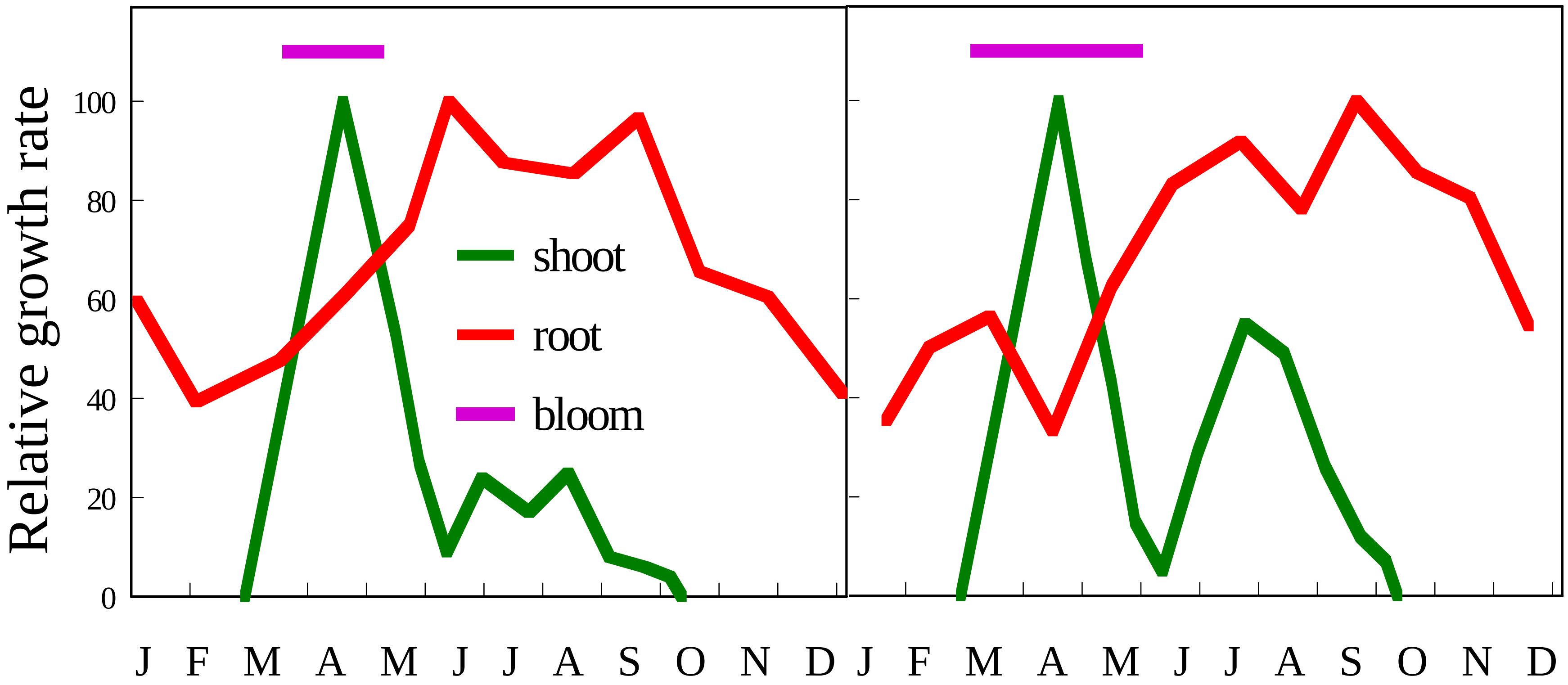


Increased vegetative vigor from pruning can result in increased decay and physiological disorders

Leonardi, Whiley, Hofman

Phenology model

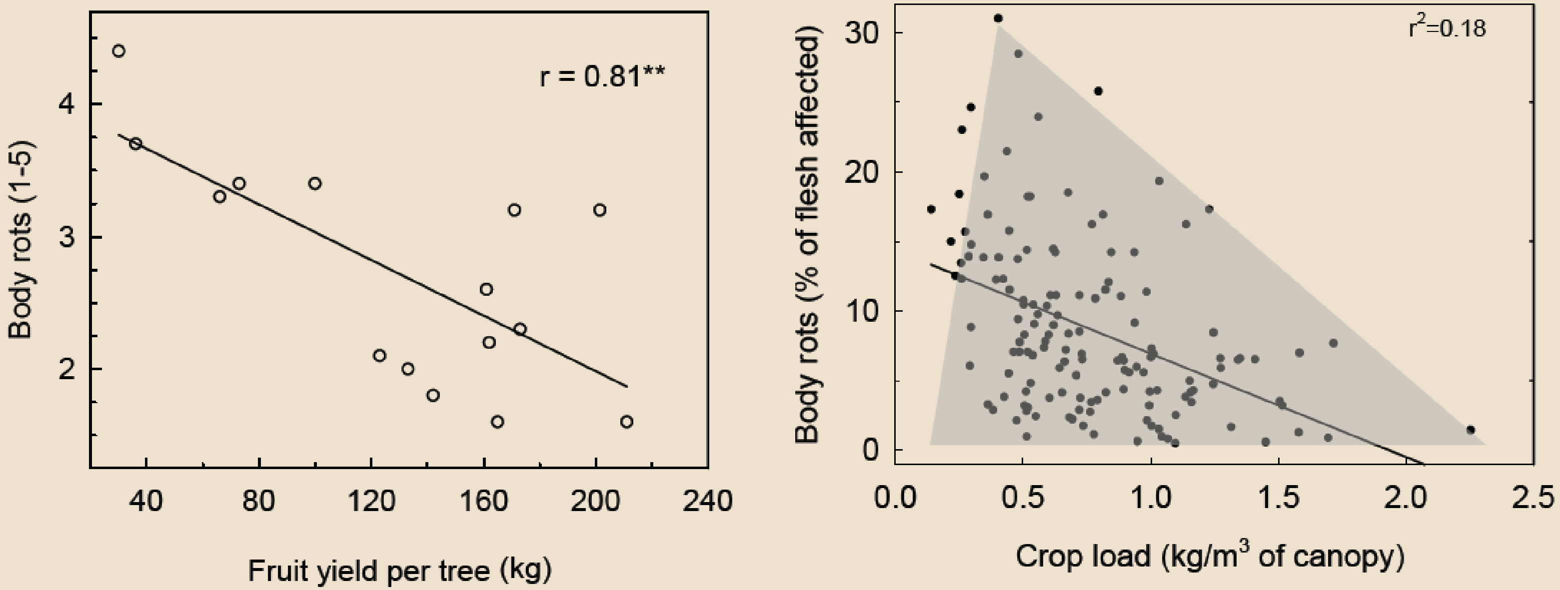
"On" year = heavy crop load **"Off" year** = light crop load



Hass on clonal rootstocks at UC South Coast REC, Irvine, CA

Crop Load and PH Decay

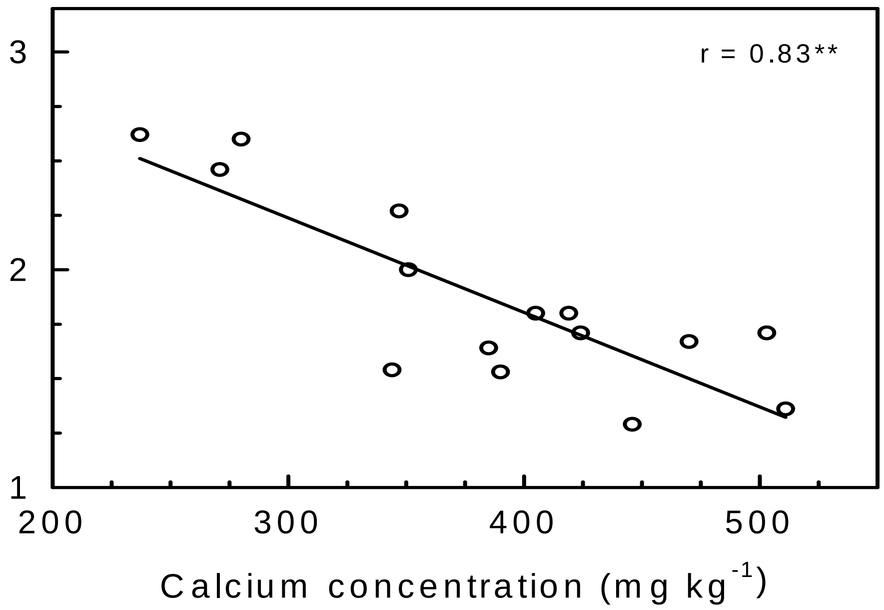
On-year good quality
Off-year reduced quality



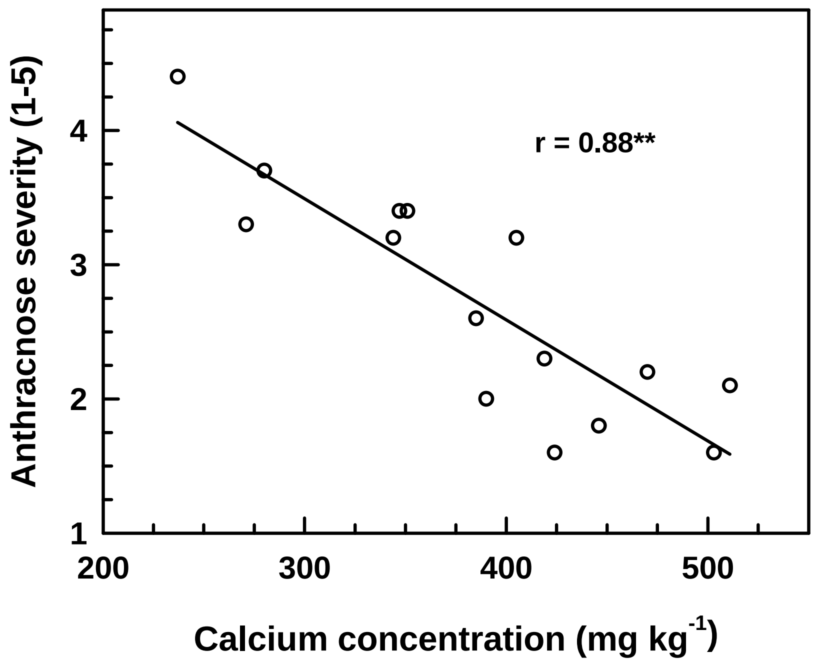
Associated with smaller fruit and higher fruit Calcium

Hofman, Vuthapanich, Whiley, Klieber, Simmons 2001

Diffuse discoloration (1-5)



Calcium fruit levels influences susceptibility to physiological problems and decay



Hofman, Vuthapanich, Whiley, Klieber, Simmons 2001

Crop cycling and leaf analysis

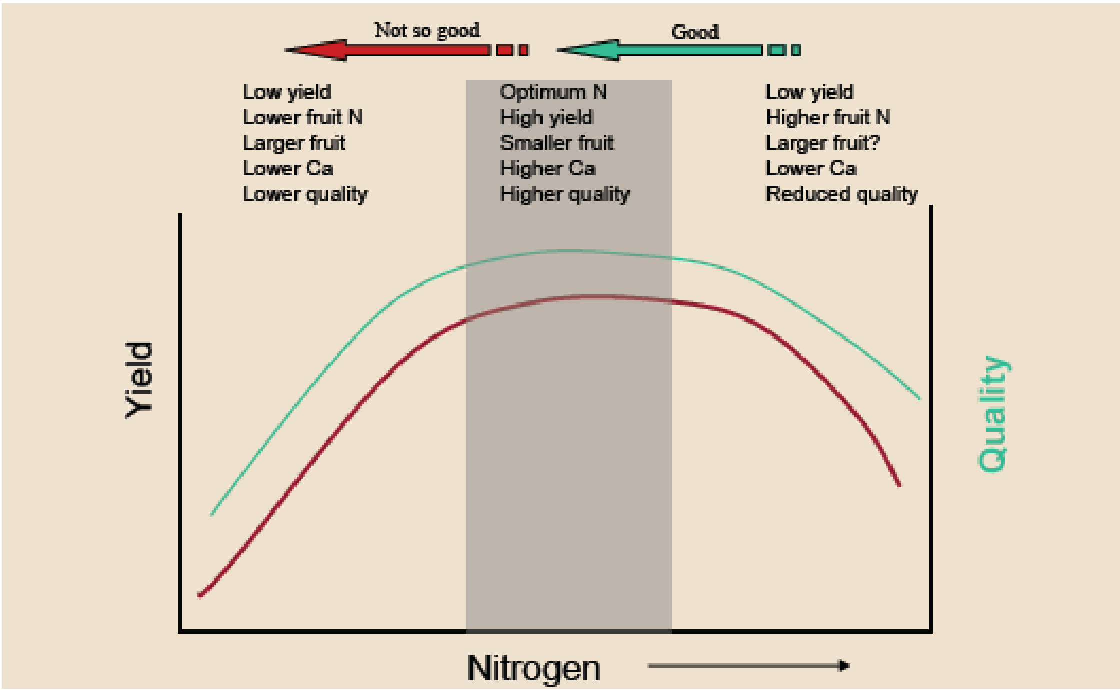
On/off cycles influences several elements:

- Lower in "On" crop: P, S, Ca, B, Zn, Cu
- Higher in "On" Crop: N, Na, Cl, Mn, Fe
- No difference: K, Mg

From: Clonal Rootstock Trial with no P. cinnamomi in Irvine, CA.
Data collected over 6 year period for 'Hass' on 10 rootstocks

NITROGEN

- High levels may result in EXCESSIVE Vigor
- High levels may influence other nutrients



Nitrogen

- Comparing fruit from high/low N sites
  - N strongly related to quality (van Rooyen and Bower 2003; Kruger et al, 2004)
- Recommendations for fruit N in fruit (Kruger et al, 2004)
  - <1.7% in December and <1% during February
- Increased N applications
  - Indications of increased decay (Willingham et al 2003)

The link between plant nutrition and postharvest problems - Pinkerton

….differences in quality were noted between fruit from different origins.

Excessive nitrogen concentrations were found to have the most significant role in determining the severity of mesocarp discolouration. In addition, decreasing copper, manganese and boron concentrations during the season also appeared to contribute to the development of the disorder.

The results of this study indicate that interactions between minerals could be more important in determining quality than evaluating individual elements.

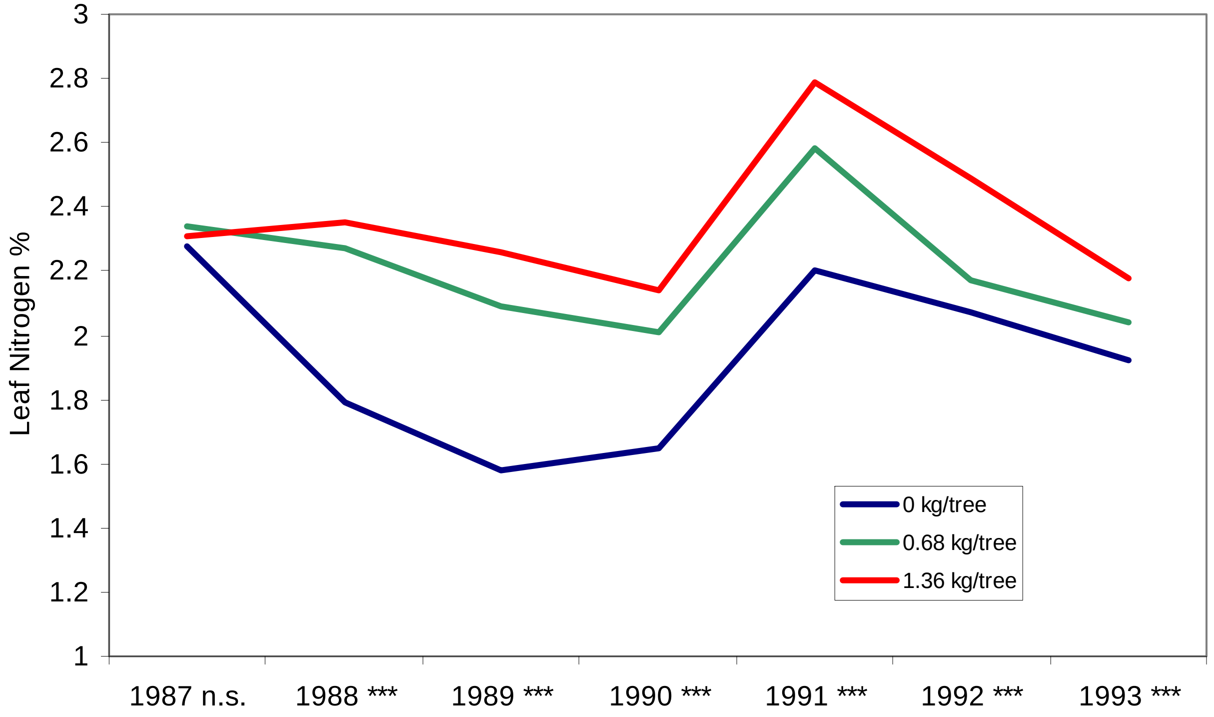
Van Rooyen and Bower, 2005

Trial in San Diego Count, CA

Long term N management

Ran for several years (split application)

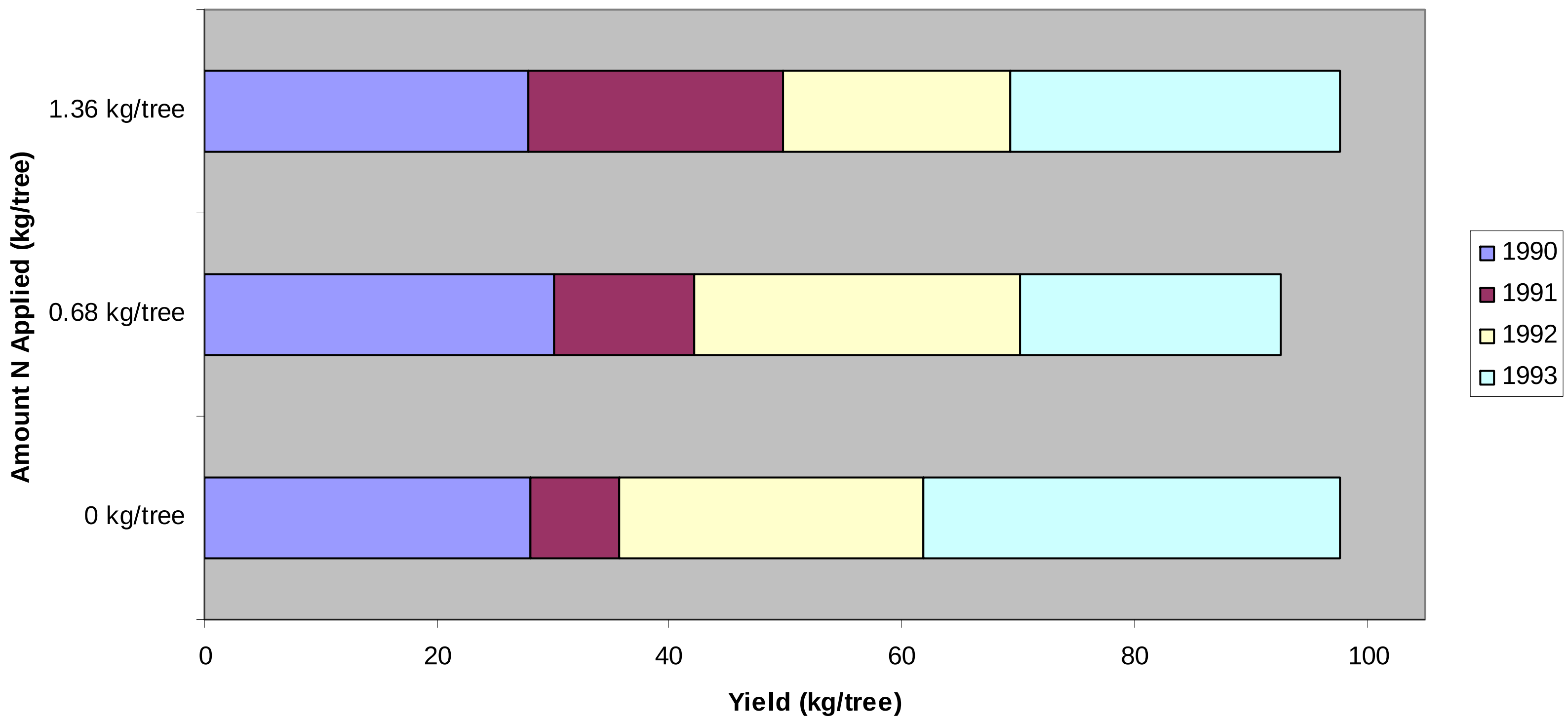
Monitored several factors including leaf analysis



Yield

Long term N management

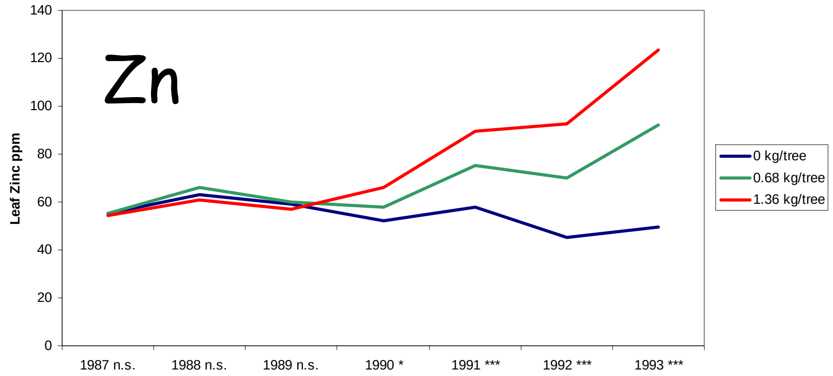
Observed no large differences in spite of differential application amounts

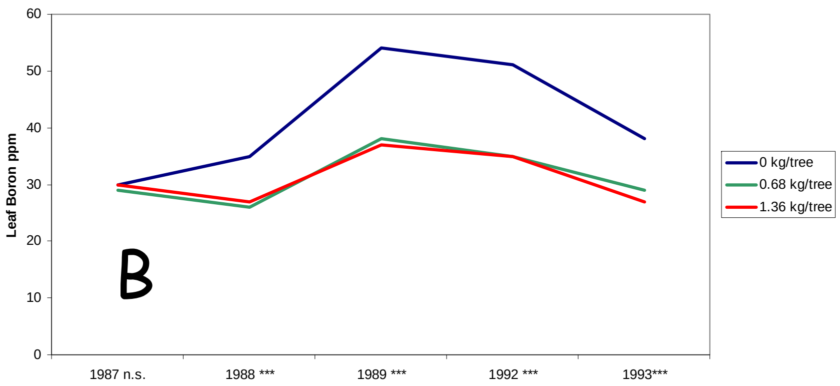


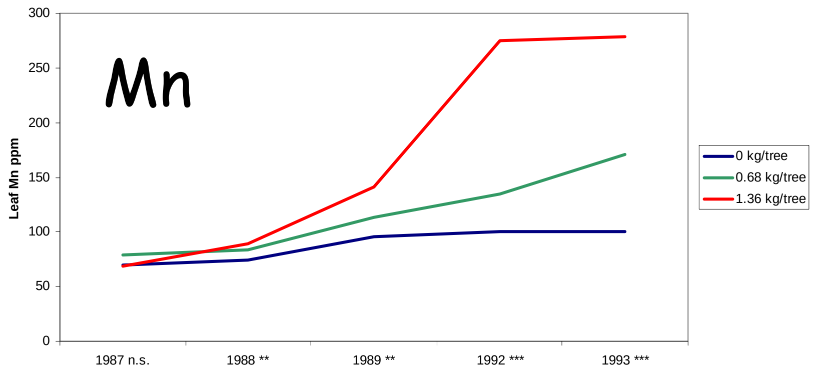
Long term N management – Leaf Analysis

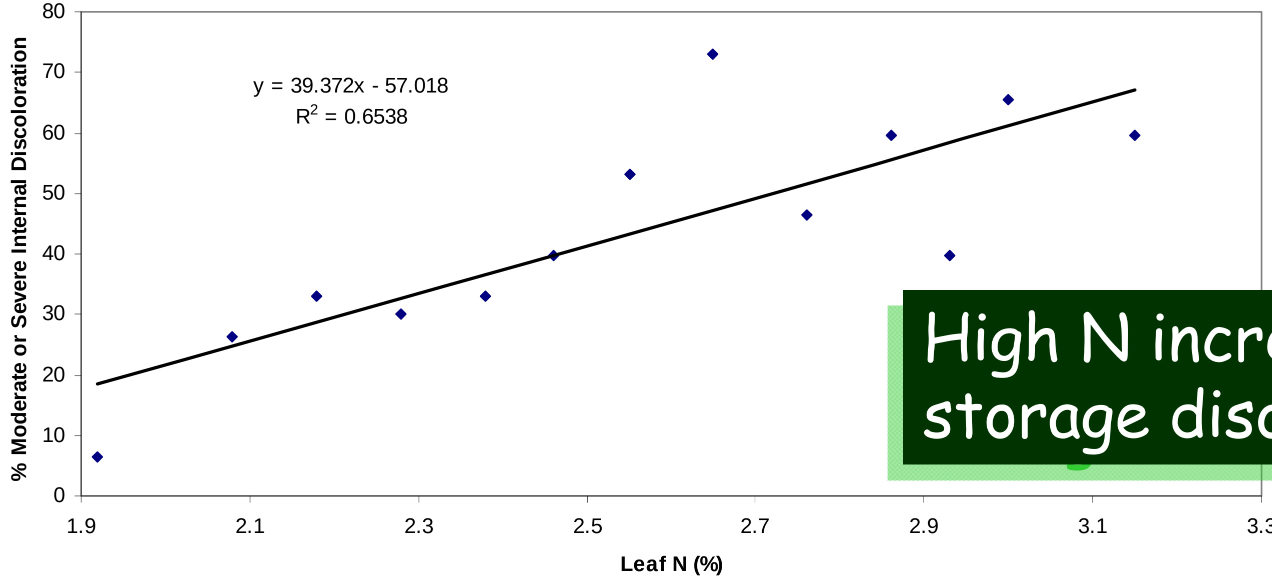
High N treatments

- Increased Zn, Mn and Fe
- Decreased B



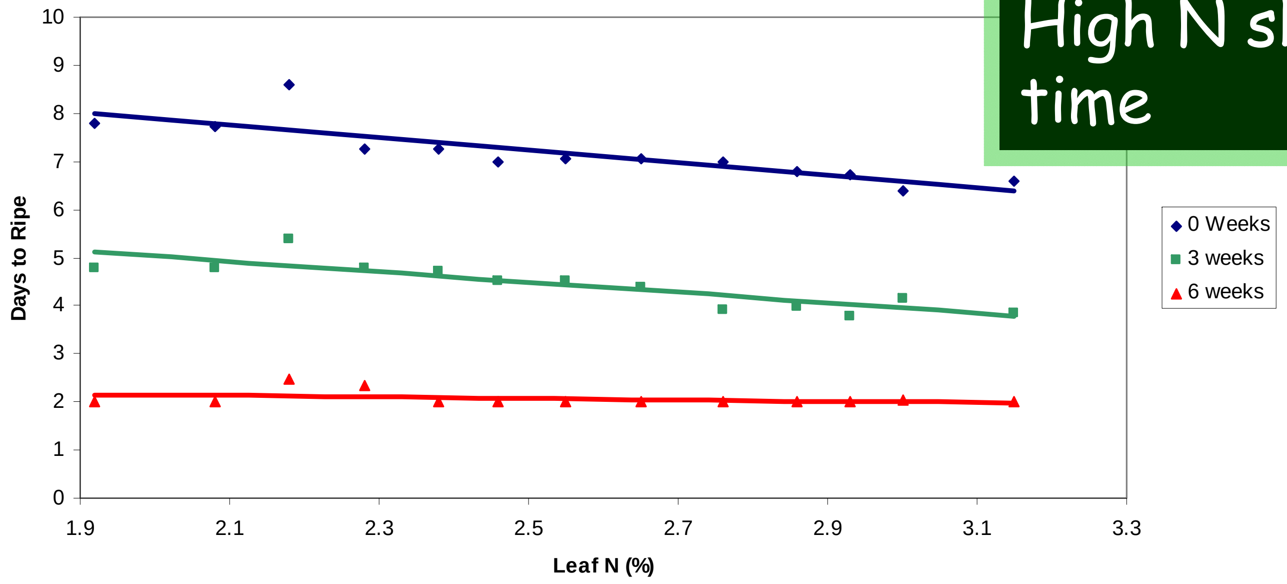






High N increases severity of storage disorders

High N shortens ripening time



Arpaia et al.

Clonal Rootstocks
Can they make a difference?

Rootstocks can influence many scion characteristics

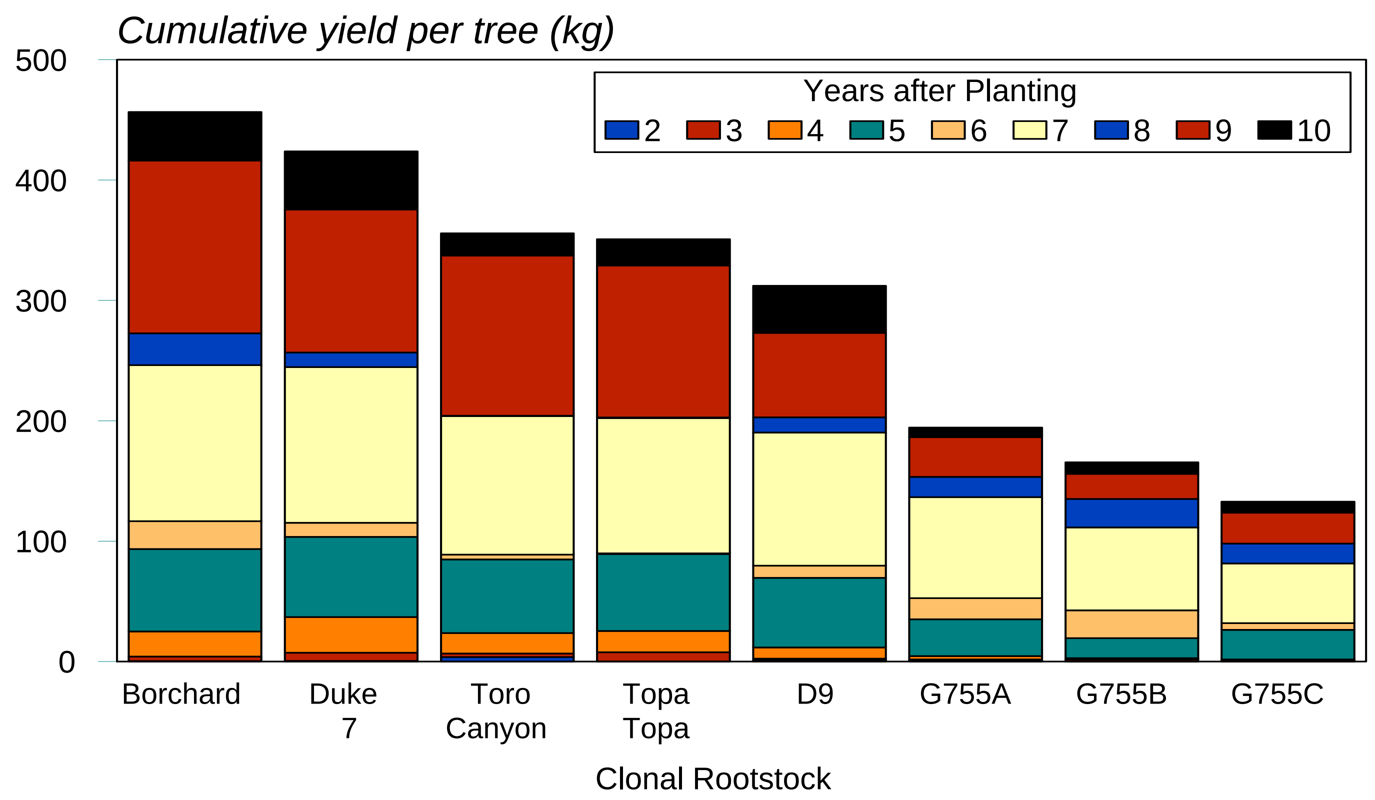
- Yield
- Tree size/vigor
- Yield efficiency
- Leaf nutrient status
- Tolerance to environmental stresses

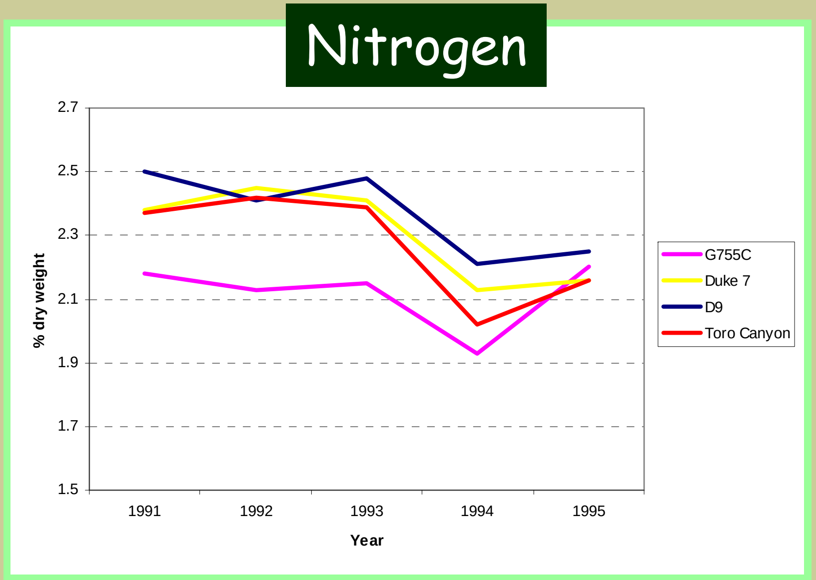
Use of clonal rootstocks relatively new

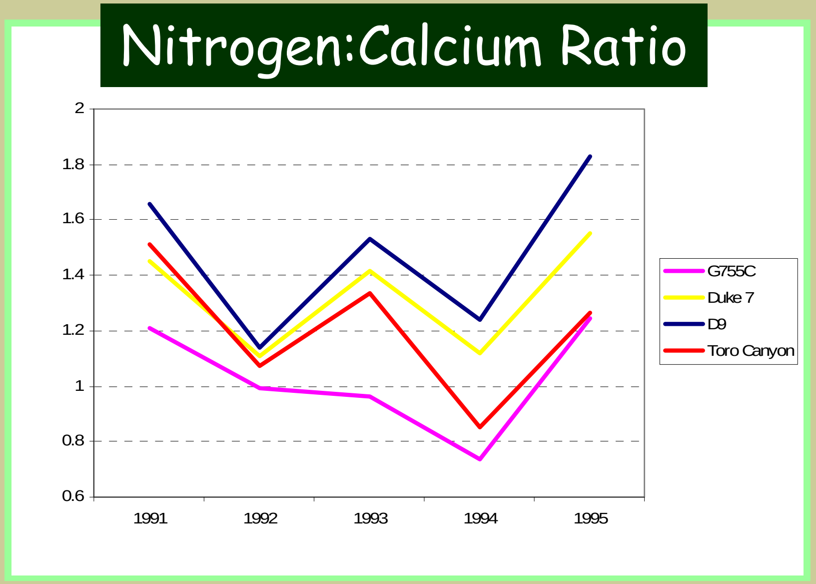
- Potential for future improvements high
- Significant differences due exist
- More uniform tree performance possible

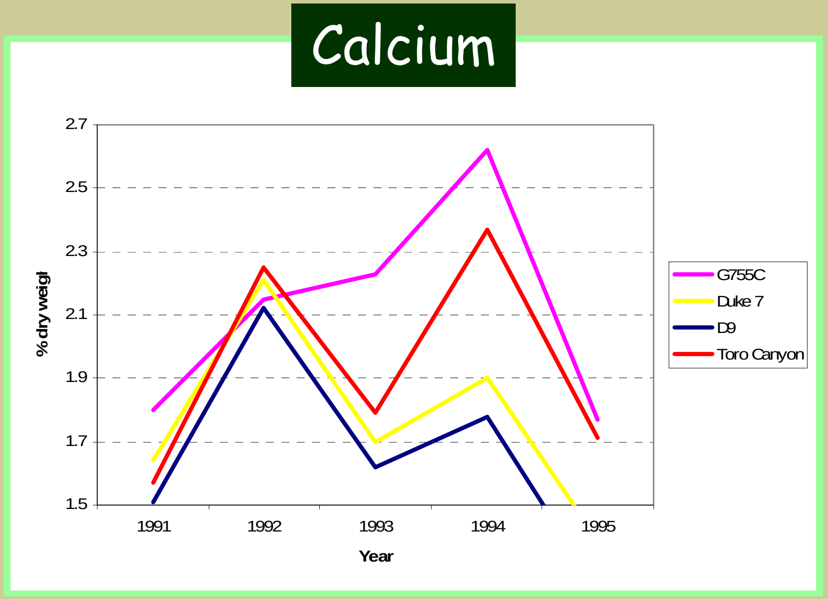
Clonal Rootstocks

- Enhanced yield possible
- Control of root rot and other soil related issues





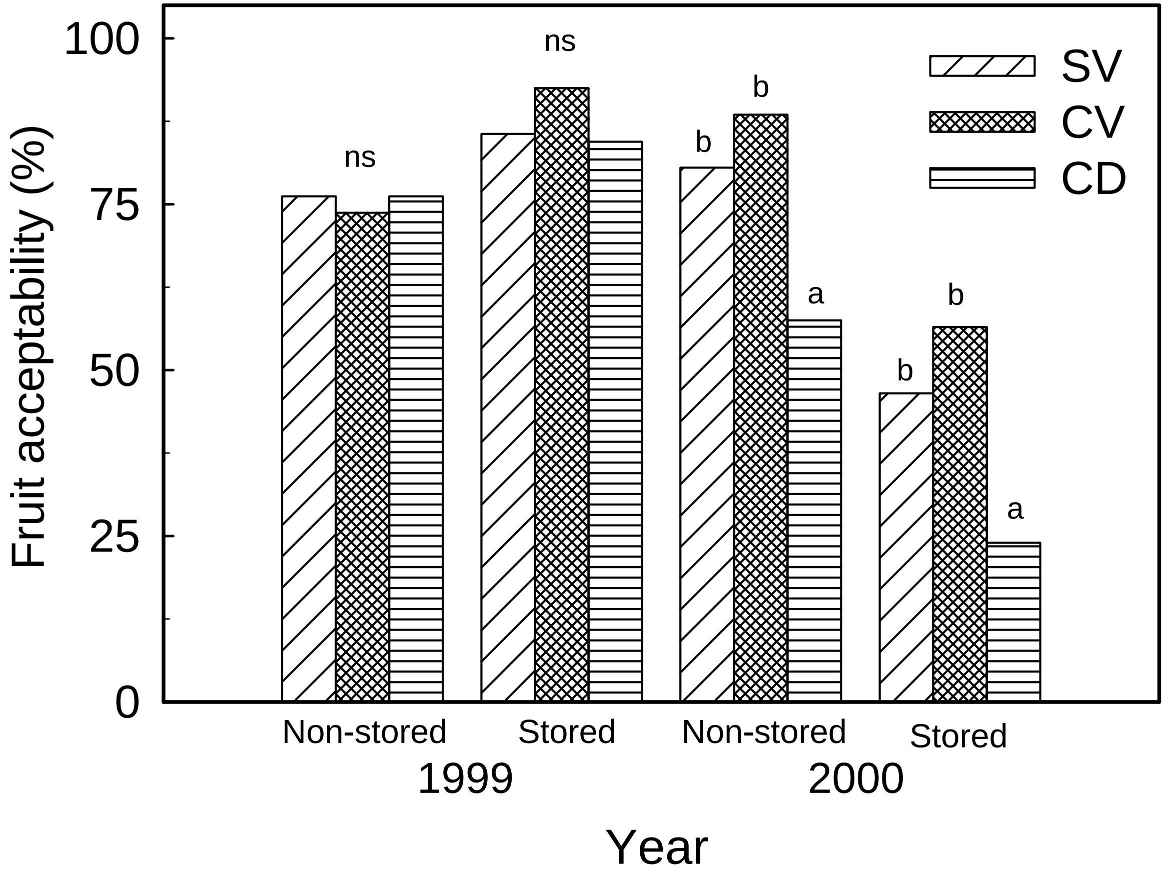




Rootstock can influence nutrient composition

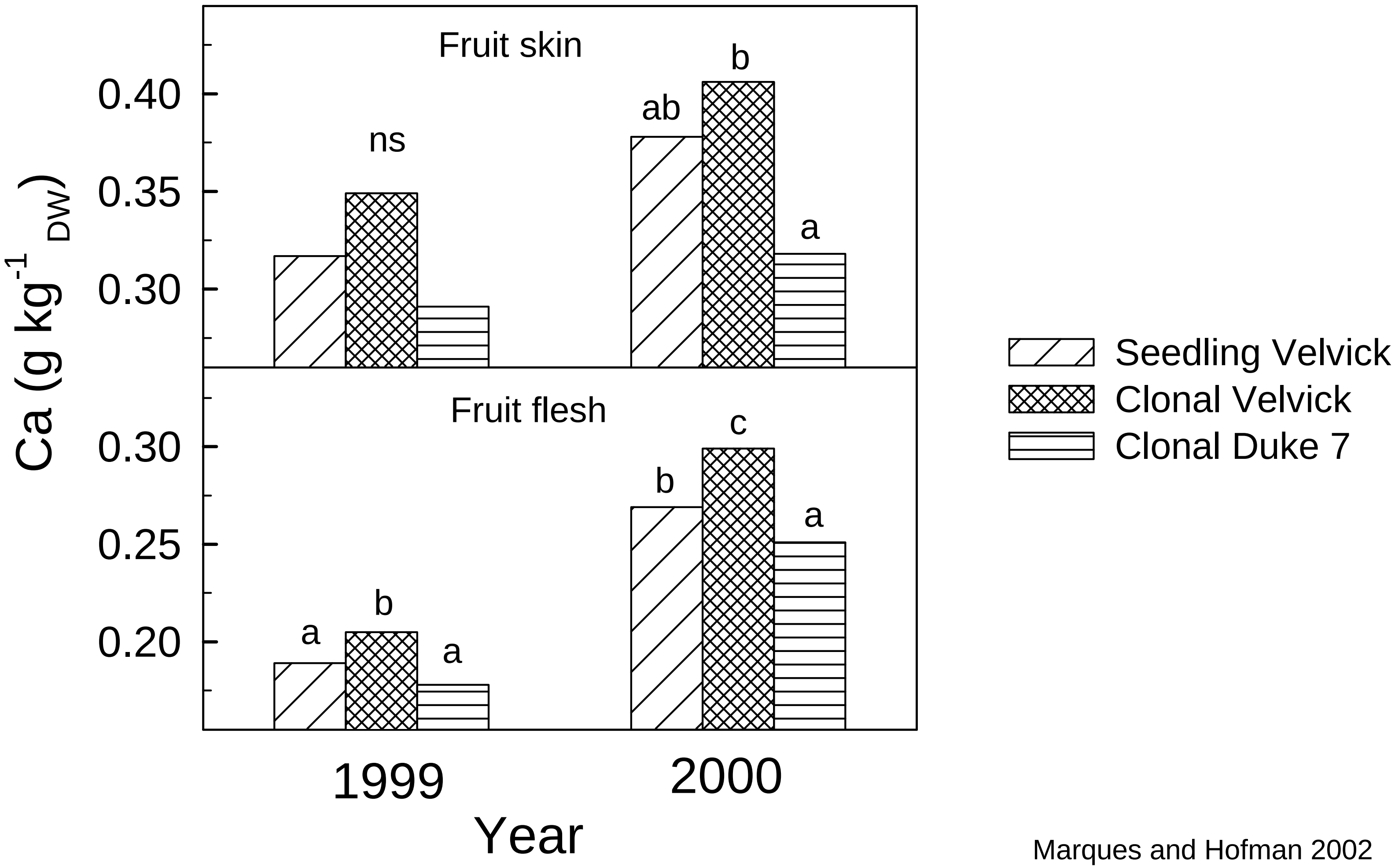
Leaf analysis results

Rootstock affects body rots



Marques and Hofman 2002

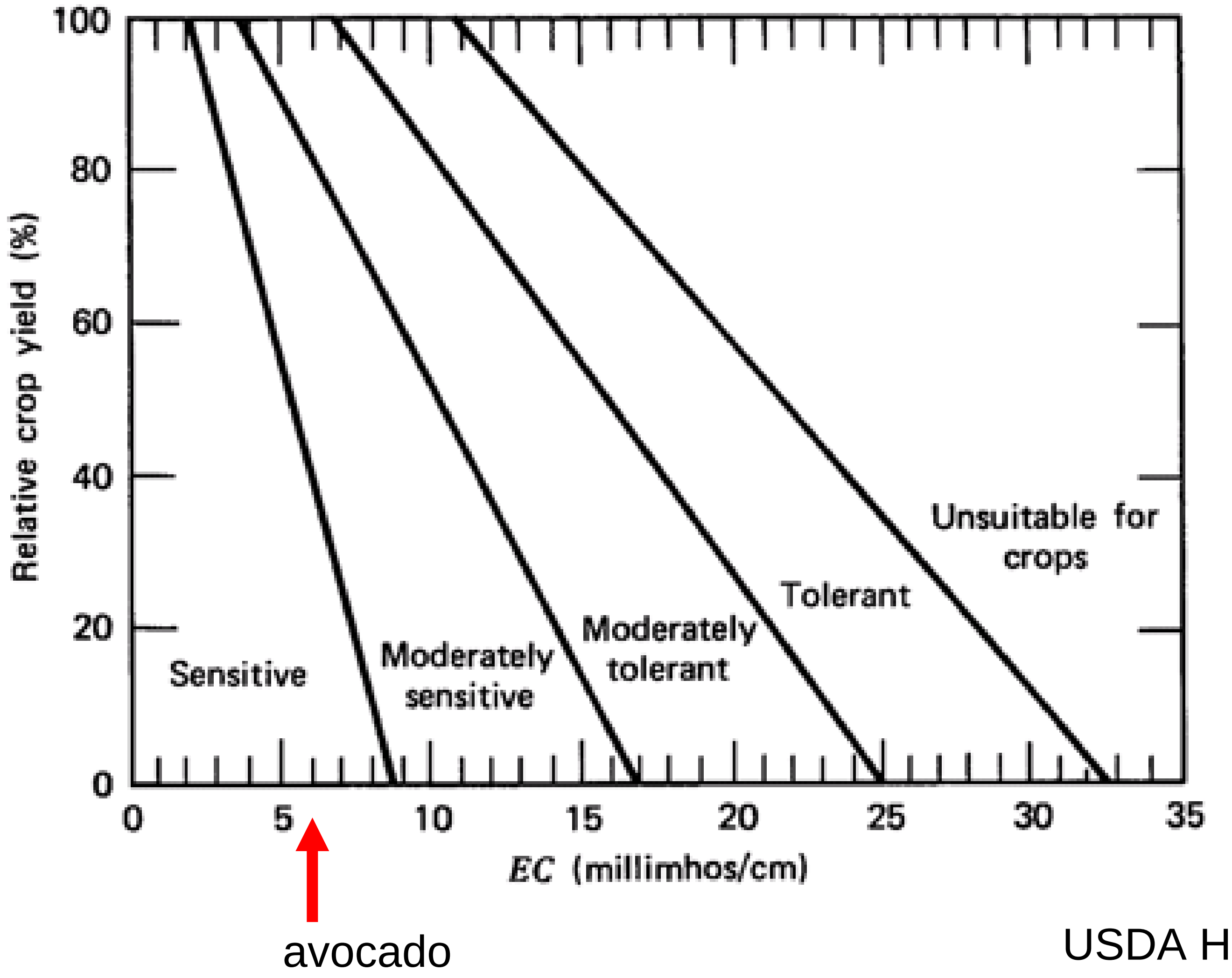
Rootstocks affect fruit minerals



Marques and Hofman 2002

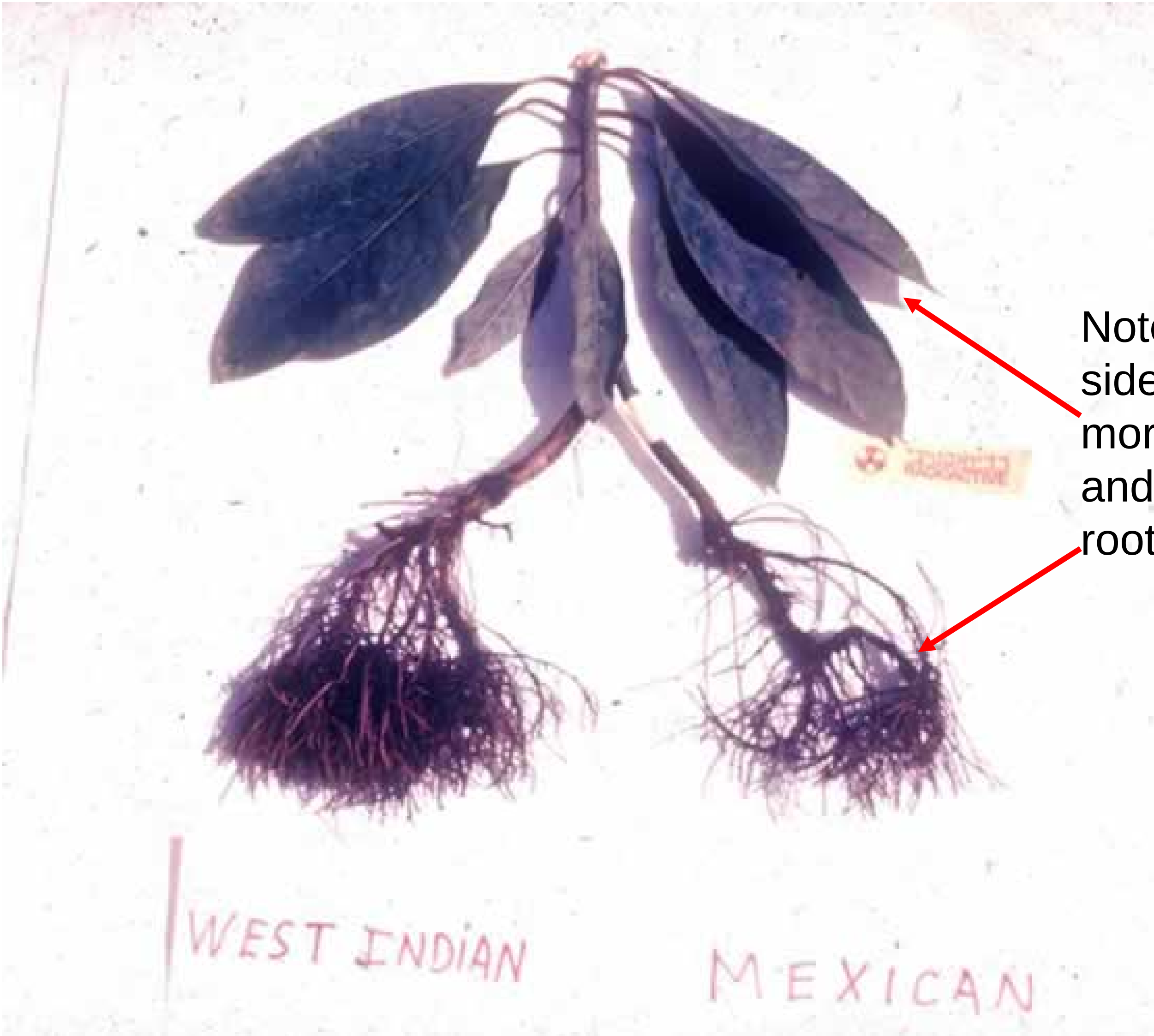
Salinity – Impact on Avocados

Avocado is one of the most saline sensitive crops, and is subject to yield reduction when irrigated with saline irrigation water. This is due to a combined effect of dissolved solids (EC) and chloride toxicities. Threshold (Oster et al., 2007) = 0.06 dS/M or EC = 6.



USDA Handbook 60

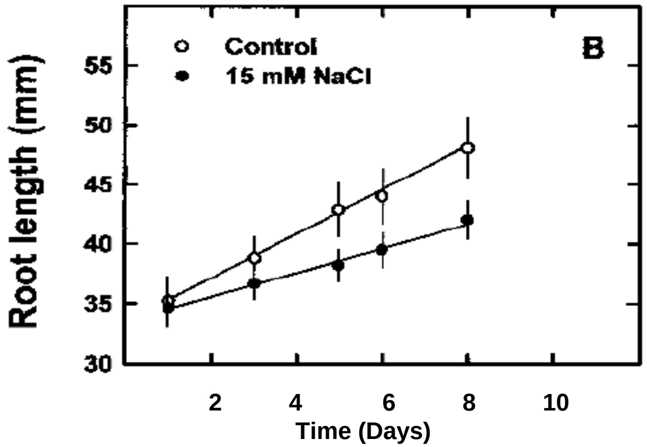
Differential Root Growth of West Indian and Mexican Rootstocks After Inarch Grafting to ‘Hass’
(Source: Kadman ca. 1970, www.avocadosource.com)



Note that MX side of tree has more leaf burn and reduced root mass

Root Growth of Avocado is More Sensitive to Salinity than Shoot Growth

N. Bernstein[1] and A. Meiri
Institute of Soil, Water and Environmental Sciences, Volcani Center, PO Box 6, Bet Dagan 50250, Israel
M. Zilberstaine
Ministry of Agriculture Extension Service, Bet-Dagan, 50250, Israel

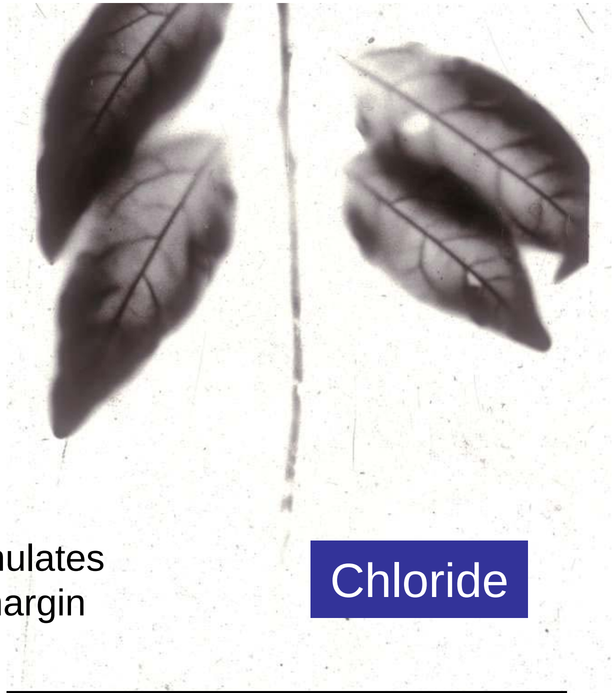


WI Degania 117 seedlings

- The threshold NaCl concentration that causes root and shoot growth reduction occurs between 5 and 15 mM.
- A concentration of 15 mM NaCl decreased leaf biomass production by 10%, but induced a 43% reduction in the rate of root elongation and decreased the root volumetric growth rate by 33%.

J. AMER. SOC. HORT. SCI. 129(2):188–192. 2004.

Uptake and Distribution of Radiolabeled Chloride and Sodium



Cl accumulates
on leaf margin

Chloride

Sodium

Na accumulates
in the leaf veins

(Kadman ca 1960s, slides from Platt, www.avocadosource.com)

Salinity impacts on growth and photosynthesis

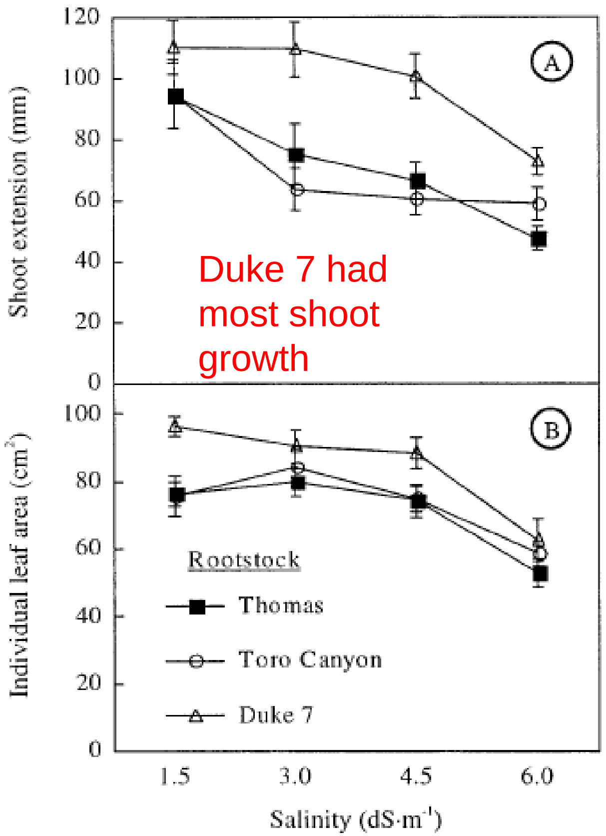


Fig. 4. (A) Shoot extension and (B) individual leaf area of F2 leaves of 'Hass' avocado trees on 'Thomas', 'Toro Canyon', or 'Duke 7' rootstocks exposed to one of four salinity levels [1.5 (control), 3.0, 4.5 or 6.0 dS·m^{-1}] for 72 d. Each symbol represents the mean of five replications and five subsamples per replication (shoot extension) or four replications and two subsamples per replication (leaf area). Vertical bars represent SE values.

Photosynthesis declines with increasing salinity; Thomas declines the most

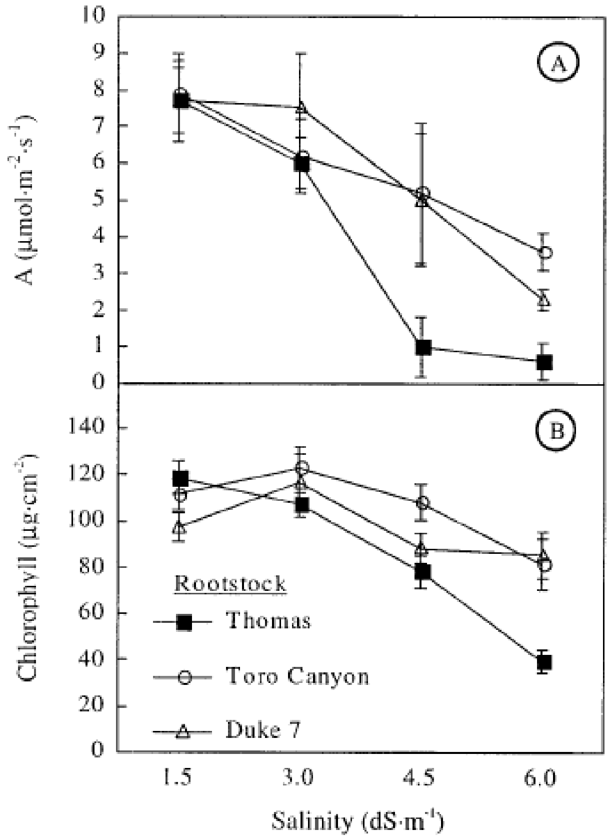


Fig. 6. (A) Net CO_2 assimilation (A) and (B) chlorophyll concentrations of F2 leaves of 'Hass' avocado trees on 'Thomas', 'Toro Canyon', or 'Duke 7' rootstocks exposed to one of four salinity levels [1.5 (control), 3.0, 4.5 or 6.0 dS·m^{-1}] for (A) 66 or (B) 73 d. Each symbol represents the mean of five (shoot extension) or four (leaf area) replications and two subsamples per replication. Vertical bars represent SE values.

Mickelbart, Arpaia – 2002

Thomas showed the highest accumulation of both Na and Cl regardless of leaf age

Sodium

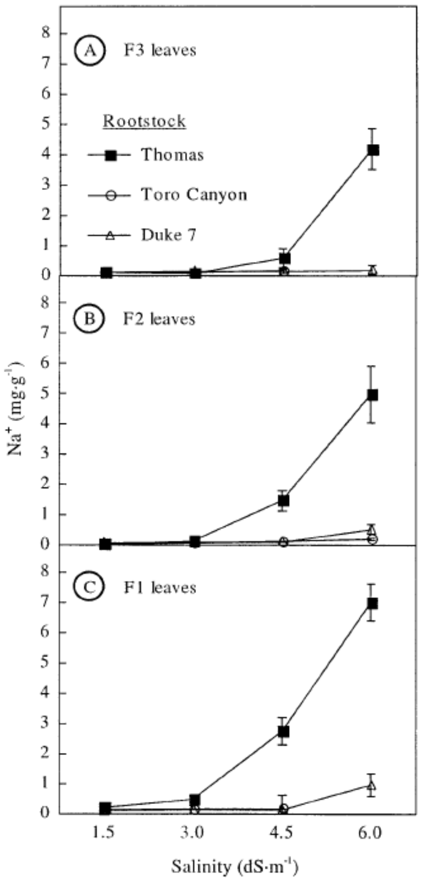


Fig. 1. Sodium ion concentrations of (A) F3, (B) F2, and (C) F1 leaves of 'Hass' avocado trees on 'Thomas', 'Toro Canyon', or 'Duke 7' rootstocks exposed to one of four salinity levels [1.5 (control), 3.0, 4.5 or 6.0 $dS \cdot m^{-1}$] for 80 d. Each symbol represents the mean of five replications and two subsamples per replication. Vertical bars represent SE values. Samples for F1 and F3 leaves of trees on 'Toro Canyon' were too small for accurate measurements of Na^+ concentrations and are therefore not presented.

Chloride

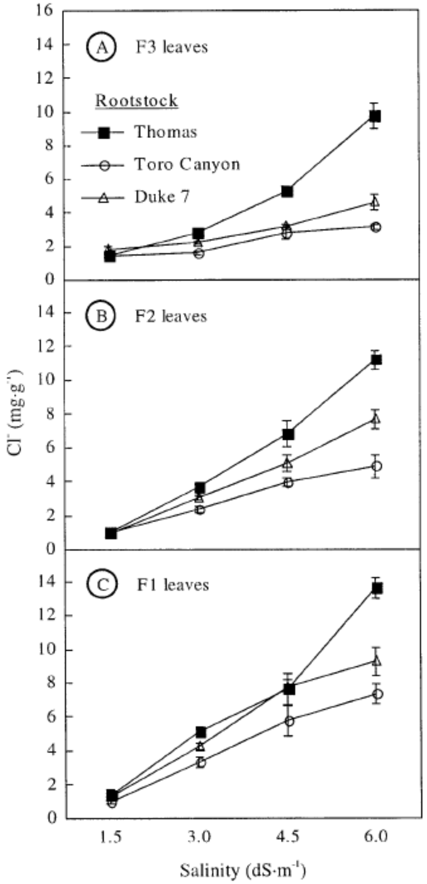


Fig. 2. Chloride ion concentrations of (A) F3, (B) F2, and (C) F1 leaves of 'Hass' avocado trees on 'Thomas', 'Toro Canyon', or 'Duke 7' rootstocks exposed to one of four salinity levels [1.5 (control), 3.0, 4.5 or 6.0 $dS \cdot m^{-1}$] for 80 d. Each symbol represents the mean of five replications and two subsamples per replication. Vertical bars represent SE values.

Cl and leaf necrosis

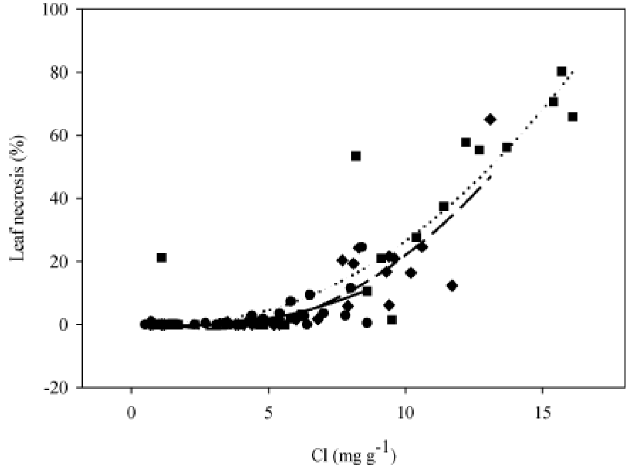


Figure 6. Relationship between Cl concentrations and necrosis in oldest (F1) leaves of trees on 'Duke 7' (♦, dashed line), 'Toro Canyon' (●, solid line), or 'Thomas' (■, dotted line) rootstocks.

Salinity also influenced Mg, Ca, K distribution in the tree

There were RS affects: Thomas the worse and Toro Canyon the most tolerant

Mickelbart, Arpaia – 2002

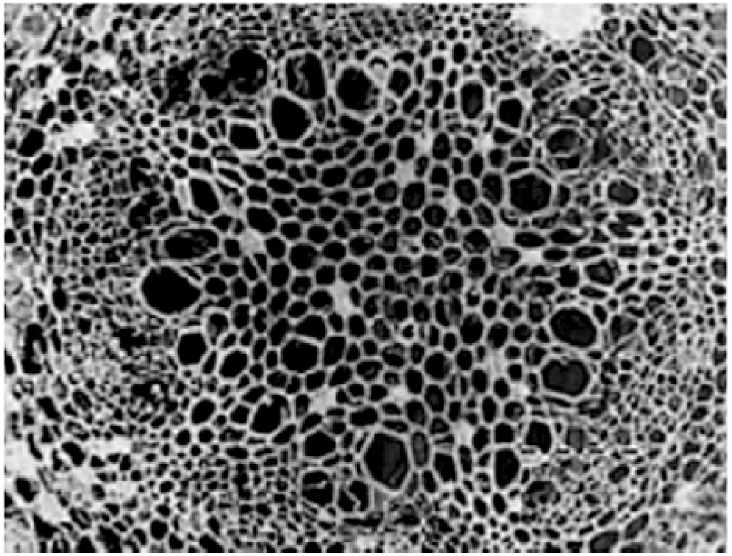
Mickelbart et al – 2007

Rootstocks and Water Uptake

Work of Fassio et al, 2009

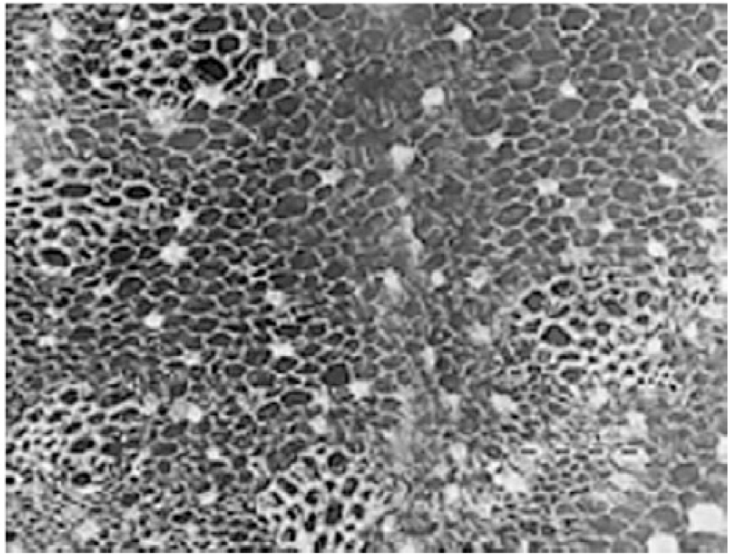
Compared Duke 7 and Toro Canyon clonal rootstocks

(E)



Duke 7

(F)



Toro Canyon

Rootstocks and Water Uptake

- Demonstrated that root structure varies between rootstocks
- Water flow (as measured with sap flow) varied with rootstock and may be related to root structure

Implications for salinity/nutrient management

Fassio et al, 2009

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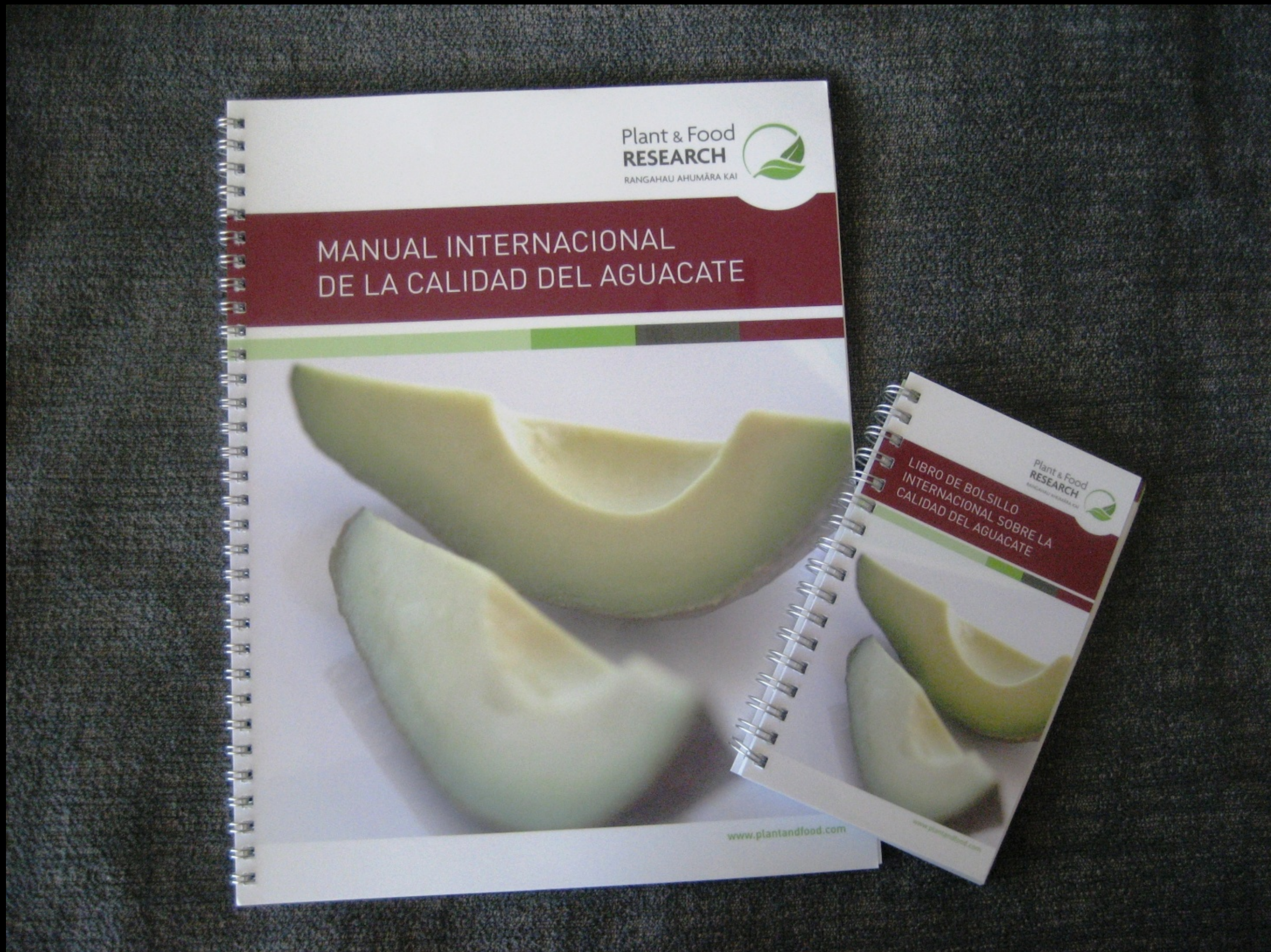
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Quiero dar gracias por la oportunidad de compartir información con ustedes hoy día
Muchas gracias