Reading Your Trees

"Tree expression is a composite of physiological, environmental, and cultural influences."

David J. Sher

Agronomist

(Note: The author has requested that we maintain British spellings in this presentation.)

What are some of the factors behind what we see?

- carbohydrate availability and early senescence of over-wintered leaves; temperature and moisture stress, nutrient deficiencies
- endogenous (internal) plant growth regulators (hormones) and their influence on tree behaviour
- cultural imperatives

Do your over-wintered summer shoot leaves look like these?

Over-wintered leaves taken in early March 2013, Orange County, California

Do your over-wintered summer shoot leaves look like these?

Over-wintered leaves taken in early spring, Temecula area, California

AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

Do your over-wintered summer shoot leaves look like these?

Over-wintered leaves taken in late winter, San Luis Obispo, California

Do your over-wintered summer shoot leaves look like these?

Picture taken of yellowing leaves prior to flowering in New Zealand

AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

Simply stated!

- when tree demands (flowering, fruit set, early fruit growth, and shoot development) exceed current carbohydrate supply in spring, re-mobilisation of starch from reserves is needed to satisfy the shortfall
- conversely, when carbohydrate production exceeds requirement (fruit growth, flower bud development, and root flush) during autumn and winter, accumulation of surplus carbohydrate is mobilised as starch into reserves

Simply stated!

- any cultural practice promoting the maximum rate of carbon assimilation by functioning leaves over autumn and winter will be beneficial for optimum tree activity in the following spring
- deficiency of mineral nutrients directly involved in chlorophyll synthesis (N,Mg) results in the formation of chloroplasts with low photosynthetic efficiency and function

AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

Simply stated!

- high yields are generally associated with a high accumulation of starch during the previous winter, yielding high starch levels in spring at the onset of flowering
- insufficient supply can lead to poor fruit set, reduced early fruit growth, and fruit drop
- does flower starch content influence fruit set?

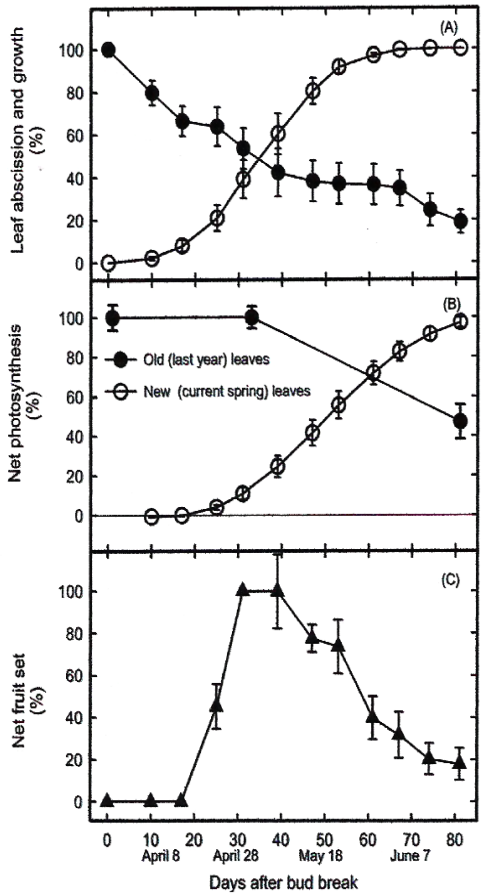
How does 'simply stated' compare with the California study?

- 40% abscission of over-wintered leaves by peak fruit set (4/28)
- by 6/17 remaining over-wintered leaves represent a 90% decrease in carbon production
- max. canopy CO_2 assimilation by new leaves attained in mid-June
- competition for carbon by fruits and shoots leads to poor fruit retention

AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

How does 'simply stated' compare with the California study?

- (A) Seasonal patterns of "Hass' avocado canopy new (current spring) leaf growth and old (last year) leaf abscission as the percentage (%) of the max. total new leaf area.
- (B) New and old leaf light saturated for new and old leaves.
- (C) Canopy net fruit set as a percentage (%) of the max fruit number recorded. Liu et al. (1999)



AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

Is it possible to improve leaf function over winter and delay senescence?

- presence of a good carbohydrate status in the tree favours a desirable hormonal balance
- cytokinins delay leaf senescence, while abscisic acid (ABA) accelerates senescence
- senescence commences with rapid deterioration of chloroplasts thereby reducing starch synthesis

Is it possible to improve leaf function over winter and delay senescence?

- lack of function promotes ageing
- mineral nutrition over winter maintains leaf colour, longevity, and photosynthetic activity (NZ)
- initiated by specific environmental and developmental cues, e.g. temp., salinity stress and moisture deficit
- plasticity of Group A cultivar (Hass)

AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

Aged, over-wintered leaves after 17 months on a fruitful determinate shoot

Cutting Orchard, Te Puna,
Bay of Plenty, New Zealand

Heat stress

- low water availability reduces evaporative cooling of leaves
- leaf temperature higher than ambient air temperature
- imbalance between photosynthesis and respiration
- affects leaf membrane stability
- CO_2 assimilation declines by 80% at air temperature of 38°C in Hass

AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

Reading Your Trees

As the proximal leaves yellow they suffer more from photo-inhibition/ oxidation, a loss of photosynthetic function and nitrogen content, and age prematurely.

Reading Your Trees

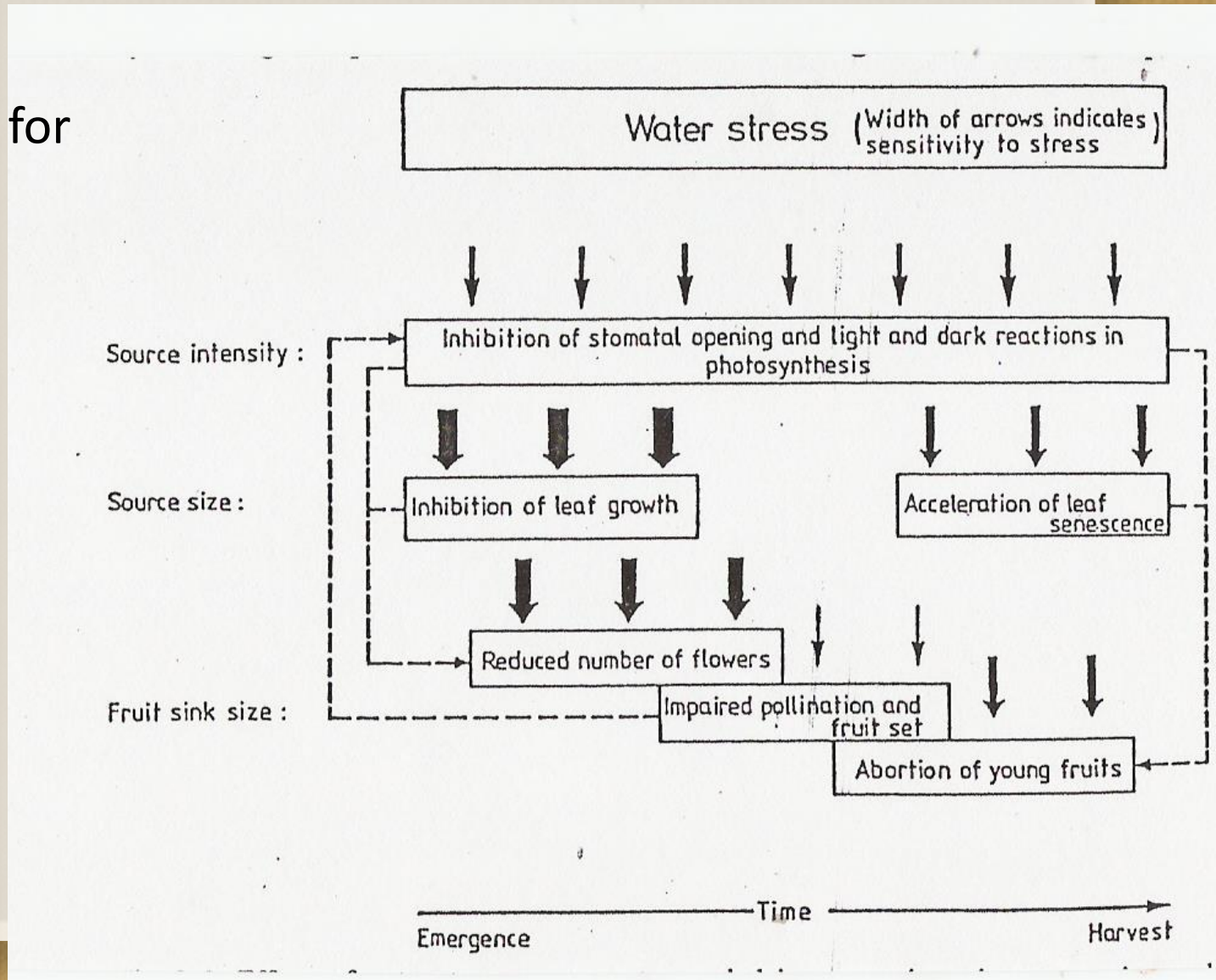
On the other hand, green proximal leaves at flowering reverse the negative effects of yellow leaves and delay senescence

Salinity stress

- rootstock sensitivity - Mexican/Guatemalan/West Indian
- salt exclusion versus salt inclusion
- chloride accumulates in leaf tissue
- excess Na+ impacts on K+ uptake
- increased respiration rates can deplete stored carbohydrates
- affect on CO_2 assimilation

Effects of water stress

(generalised for fruit crops)



AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

Flower quality with reference to starch content

- receptive stigma secretes a complex substance of carbohydrates and lipids to promote pollen germination and tube growth
- provides source of energy for tube growth and fully utilised within 18 hr after flower (stage 1) opening
- at flower opening some flowers show starch amounts 1000 times higher than others

Flower quality with reference to starch content

- early flowers have a higher starch content than later inflorescences
- the higher the starch content, the greater the ability of that flower to successfully set fruit
- the flowers that set fruit have a higher starch content than those that abscise

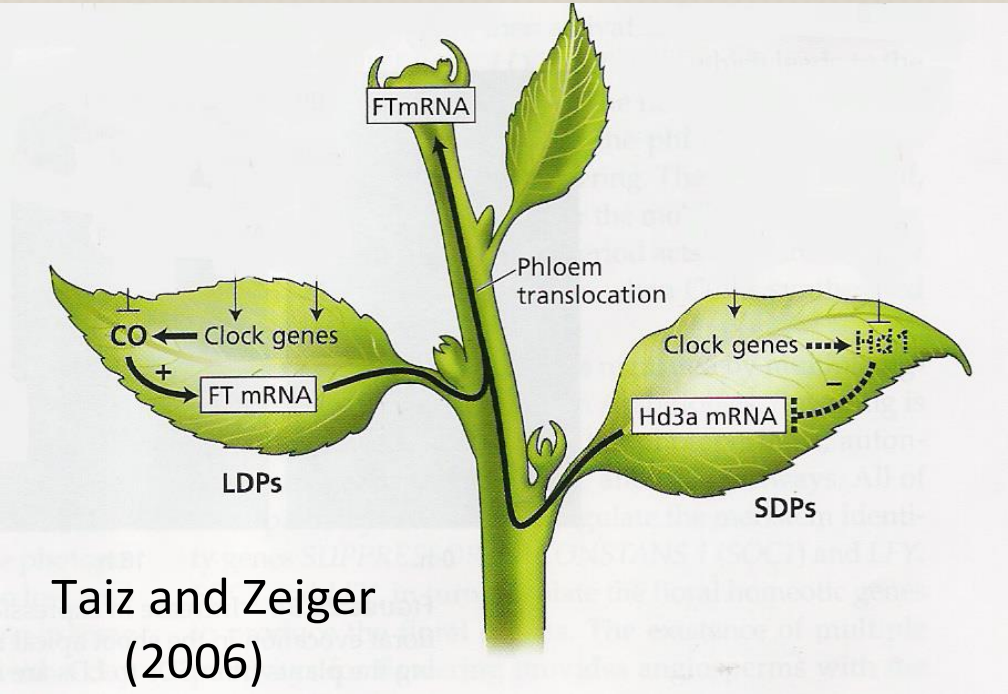
AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

What are the triggers for autumn flowering (flora loca)?

- preceding light crop
- accumulation of starch reserves
- favourable autumn conditions in terms of light, temperature, moisture
- leaf build-up of starch (Mg linkage)
- impaired feedback mechanism
- leaf-derived floral stimulus involving the hormone gibberellin (GA)
- expression of autumn flowering

AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

Autumn flowering: The response to day length - photoperiodism- promotes flowering at a particular time of the year. The pathways for autumn flowering are; the *carbohydrate or sucrose pathway* which reflects the metabolic state of the tree, and the *gibberellin pathway* for flowering under non-inductive short days



Taiz and Zeiger (2006)

AVOCADO CULTURE INDEX FRESH INC SEMINAR SERIES

What are the messages from the expression of autumn flowering?

- indicative of starch status in the tree
- anticipate starch reserve draw-down to resource flowering, fruit set, and fruit growth over winter and spring
- urgent need to maintain maximum photosynthetic activity over winter to conserve declining starch reserves
- winter nutrient programme with emphasis on nitrogen and magnesium and possibly potassium

What are the messages from the expression of autumn flowering?

- strong flowers well-supplied with starch and good fruit set can be expected in spring
- be mindful of additional starch needed for root and shoot growth
- opportunity exists to counter biennial bearing by judicious use of fertiliser and water
- without prior intervention trees may be ill prepared for heavy flowering and fruit set *and* some spring shoot and root growth

The case for over winter inputs of nitrogen and magnesium

- prolong leaf quality, colour, activity, and longevity
- increase carbon requirement for fruit growth, flower bud development, root flush, and tree maintenance
- protects and delays yellowing of leaves due to photo-inhibition, -oxidation, and nutrient loss
- promotes carbon transfer to roots

The case for over winter inputs of nitrogen and magnesium

- loss of leaf N of 0.5%DM (NZ)
- loss of leaf Mg of 0.05%DM (NZ)
- soil nutrient levels insufficient for adequate supply over winter
- N and Mg deficient leaves abscise earlier than normal leaves
- min. winter soil temperatures of ±50°F (10°C) similar to New Zealand
- high fruit loads may also need K

AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

The case for over winter inputs of nitrogen and magnesium

(the New Zealand experience)

- winter rainfall higher than Calif.
- monthly winter foliar applications insufficient to arrest leaf decline
- monthly fert. inputs of ±100g/N/tree is recommended (10t/Ha yield)
- positive response has been noted
- protects against cold injury
- N applied either as KNO_3 or NH_4NO_3

Reading Your Trees

The above-ground proportion of trees does not necessarily reflect the size of the root system below ground

Dixon and Sher (2003)

Composite picture of a 9 yr ‘Hass’ grafted onto ‘Zutano’ rootstock

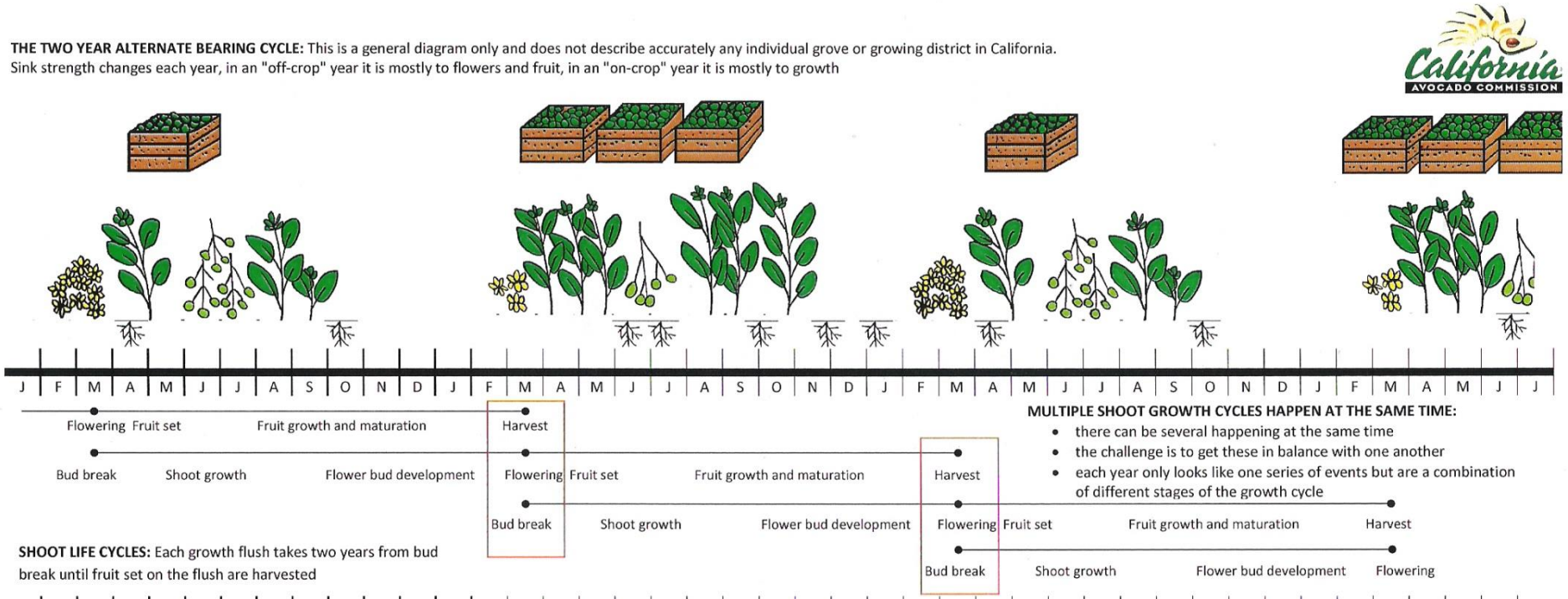
Why raise the issue of roots?

- last in carbon apportionment hierarchy before reserves
- represents no more than 20% of tree on weight basis
- site for cytokinin and abscisic acid production
- while transport of auxin to roots triggers flush, starch content is crucial to response

AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

INDEX FRESH INC.™ Reading Your Trees

THE TWO YEAR ALTERNATE BEARING CYCLE: This is a general diagram only and does not describe accurately any individual grove or growing district in California.
Sink strength changes each year, in an "off-crop" year it is mostly to flowers and fruit, in an "on-crop" year it is mostly to growth



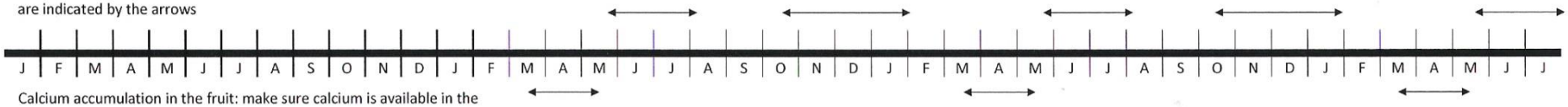
MULTIPLE SHOOT GROWTH CYCLES HAPPEN AT THE SAME TIME:

- there can be several happening at the same time
- the challenge is to get these in balance with one another
- each year only looks like one series of events but are a combination of different stages of the growth cycle

SHOOT LIFE CYCLES: Each growth flush takes two years from bud break until fruit set on the flush are harvested

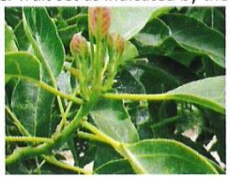
EXAMPLES OF CRITICAL TIMES FOR:

Phytophthora control: apply control measures when the roots are the primary sink; the best application times are indicated by the arrows



Calcium accumulation in the fruit: make sure calcium is available in the soil water in the first 6-8 weeks after fruit set as indicated by the arrows.


Roots


Bud break


Shoot growth


Flower development


Flowering and shoot growth


Fruit set


Fruit ready to harvest

Reading your trees: points to remember

- quantity of nutrient loss through leaf and flower abscission is substantial
- each year a tree loses 40% of its N, 60% of P and K, and 75% of its Mg
- flowers are high in N = 3.0%DM (NZ)
- dry weight of flowers varies from 2Kg to 10Kg depending on tree size
- abscised leaves contain 0.8-1.0%DM of nitrogen

AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

Reading your trees: points to remember

- carbon resource limitations linked to poor fruit sets
- flowering expensive in terms of carbon, nutrients, and water
- current assimilation from over-wintered leaves reduce depletion of starch reserves during spring
- leaves are the factory, roots the control room

AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

Reading your trees: points to remember

- Healthy, over-wintered leaves, well supplied with nitrogen, chlorophyll, and starch, are retained longer into the new season, and provide stored and current photosynthates for flowering, fruitset, and spring vegetative growth. Constructive husbandry with sufficient light enhances the probability towards a more regular cropping outcome.

Reading your trees: points to remember

- leaf size, colour, and longevity are key indicators of tree health
- simple test - compare leaf colour between south and north quadrants, also leaf thickness for function
- density of canopy - full coverage of tree framework at all times is ideal
- deficiencies in tree health encourage root rot infection

AVOCADO CULTURE INDEX FRESH INC. SEMINAR SERIES

Acknowledgments

Index Fresh Inc

John Cornell

Dr Jonathan Dixon

Our thanks to David Sher for his presentation on

Reading Your Trees.

For more information,

please contact us at (909) 877-0999

or visit

www.IndexFresh.com/growers.htm