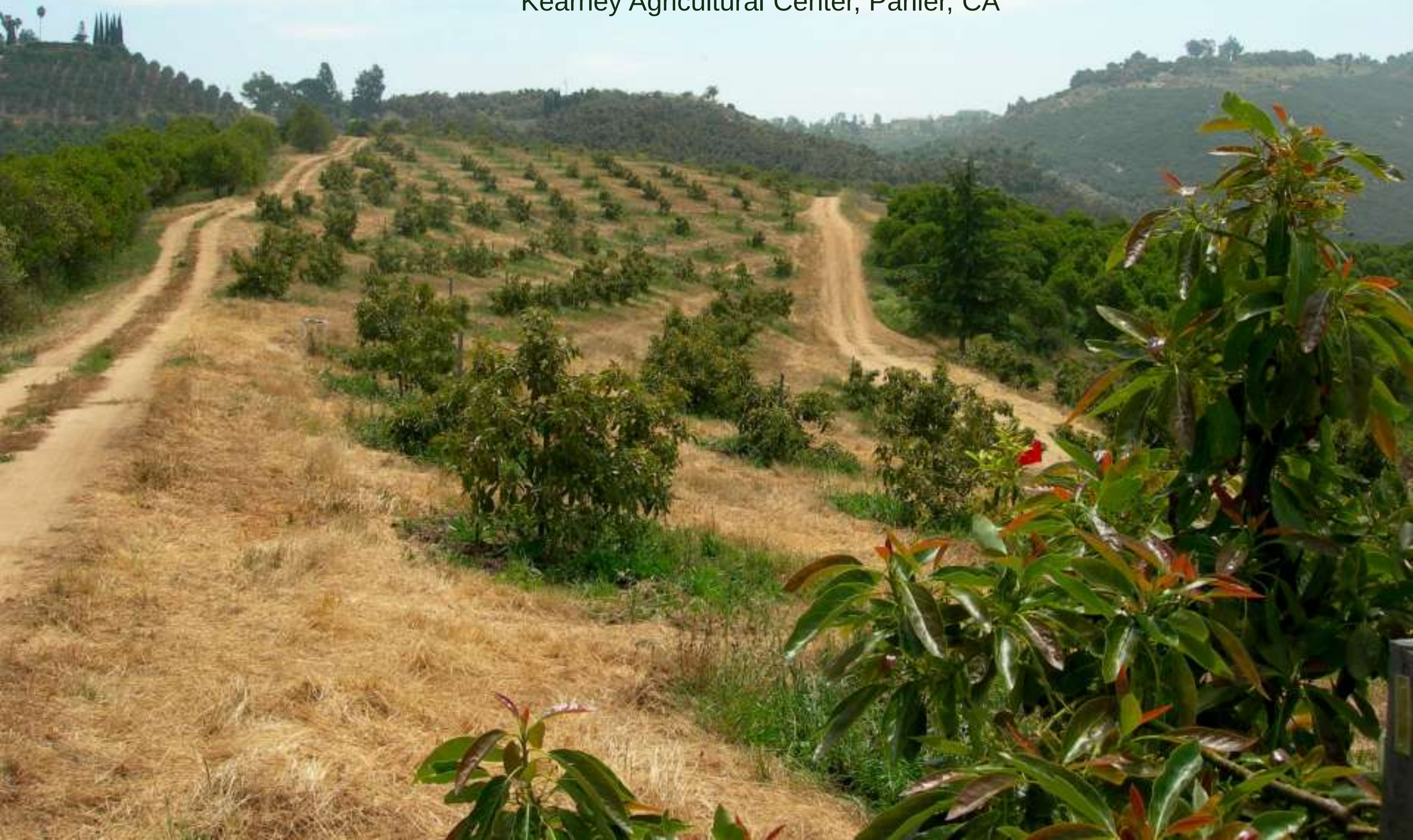
Decision Support Tools for Optimizing Water Use Efficiency, Fruit Quality, and Profitability in Avocado Production

David Crowley, Mary Lu Arpaia, Ariel Dinar, Julie Escalera
Dept of Environmental Sciences, University of California, Riverside, and UC Kearney Agricultural Center, Parlier, CA



Current Challenges for Avocado Production in California

- Water
  - Irrigation management
  - Salinity
  - Soil aeration
  - Conversion to recycled water

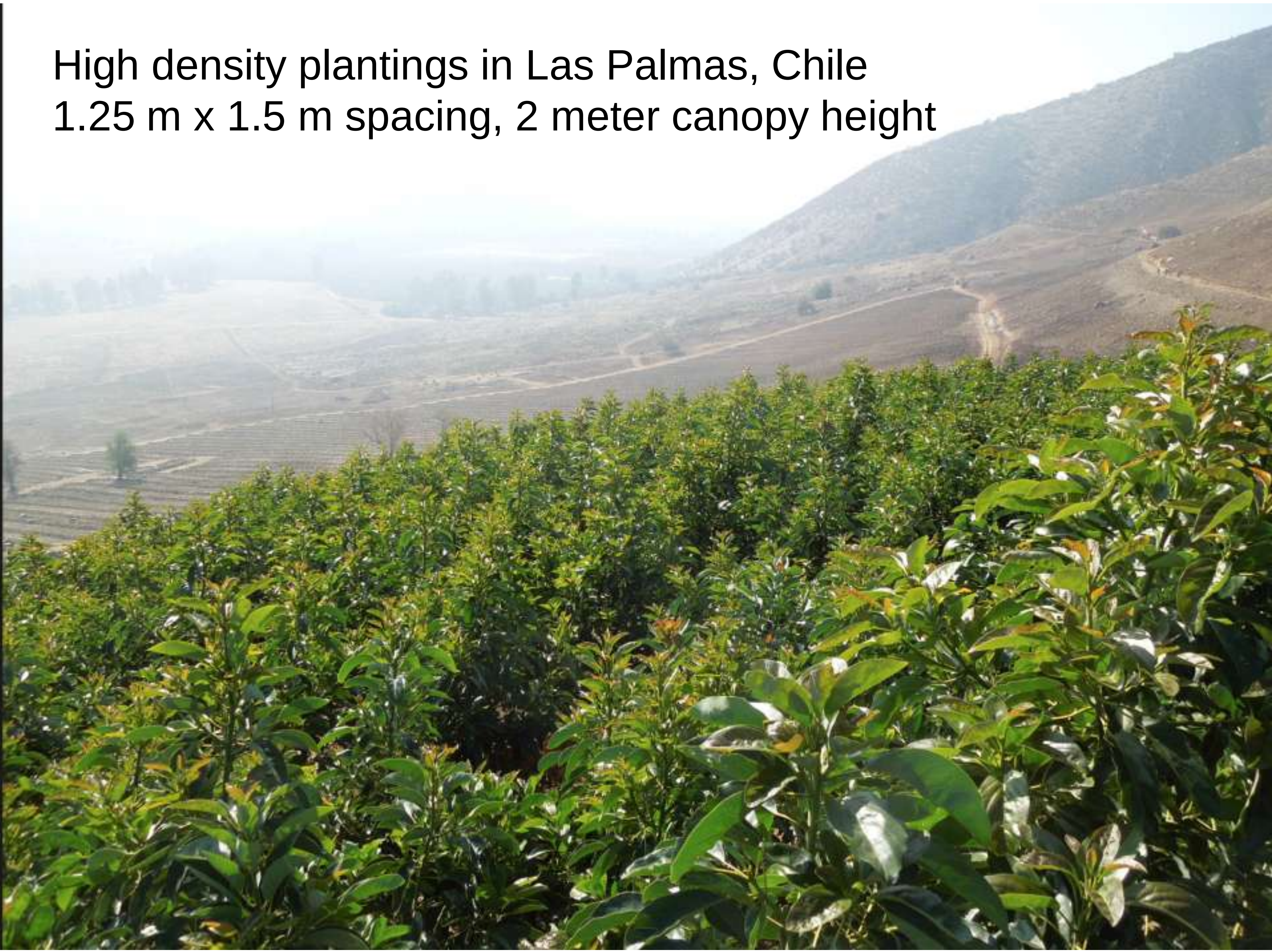
- Disease and pest management
  - Phytophthora root rot
  - invasive pests

- Canopy management

- Nutrient management
  - Nitrate pollution
  - Alternate bearing

Canopy management

High density plantings in Las Palmas, Chile
1.25 m x 1.5 m spacing, 2 meter canopy height



READ SAFETY DIRECTIONS BEFORE OPENING OR USING

SUNNY®

PLANT GROWTH REGULATOR

ACTIVE CONSTITUENT: 50 g/L UNICONAZOLE-P

A plant growth regulating material for use on avocados to enhance fruit shape, increase fruit size and reduction in vegetative growth.

GENERAL INSTRUCTIONS:

SUNNY is a plant growth regulator that acts by influencing gibberellin production. Its use will result in enhanced fruit shape (less necky fruit) and increased average fruit size. In well managed, healthy orchards an increase in total yield may result.

- 65% of spray volume should be aimed at the top 1/3 of the tree
- 25% of spray volume should be aimed at the centre 1/3 of the tree
- 10% of spray volume should be aimed at the bottom 1/3 of the tree

VW225T
Cota 650 Norte
Cota 650 Sur
Valvula de aire
Cota 625 Norte
Cota 625 Sur
Invierno
Login
Contraseña
Cota 600 Norte
Cota 600 Sur
LAS PALMAS
Inicio
ASUS

New Technologies for Avocado Production

Online Decision Support Tools
- Irrigation and Fertilizer Management
- Neural network based disease and yield forecasting models

Evaluation of rootstocks for salinity tolerance

Biofertilizers:
- PGPR (plant growth promoting rhizobacteria)
    - Control of phytophthora root rot
    - Production of plant growth hormones
    - Suppression of stress ethylene
        - Improved water use efficiency
        - Improved salinity tolerance

Use of charcoal (biochar) amendments
- Improved CEC, pH, lower bulk density, soil aeration
- Improved water holding capacity, soil structure
- Increased microbial activity, mycorrhizae, root growth

California Avocado Association 1933 Yearbook 18: 39-49

Fertilizing Avocado Groves

(With especial reference to the use of and the supplementing of manure)

L. D. Batchelor
University of California, Citrus Experiment Station

California Avocado Society 1952 Yearbook 37: 201-209

NUTRIENT COMPOSITION AND SEASONAL LOSSES OF AVOCADO TREES

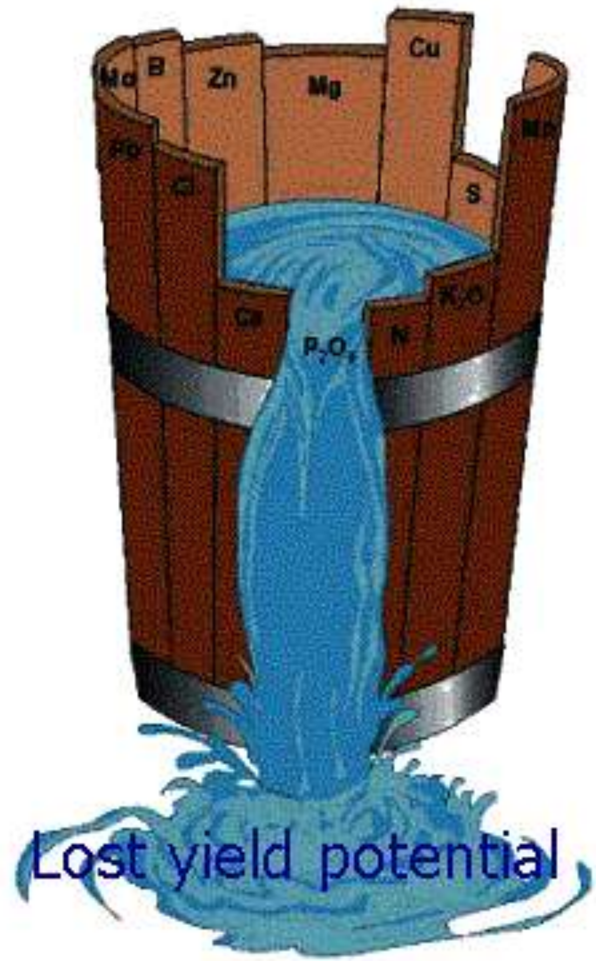
S. H. Cameron, R. T. Mueller, and A. Wallace

http://www.avocadosource.com/

Law of the Minimum - Liebig's Law

Justus von Liebig, generally credited as the "father of the fertilizer industry", formulated the law of the minimum: if one crop nutrient is missing or deficient, plant growth will be poor, even if the other elements are abundant.

Liebig likens the potential of a crop to a barrel with staves of unequal length. The capacity of this barrel is limited by the length of the shortest stave (in this case, phosphorus) and can only be increased by lengthening that stave. When that stave is lengthened, another one becomes the limiting factor.



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AVOCADOSOURCE.COM Search Tools Site Index: <SELECT PAGE>

Total Fruit Nutrient Removal Calculator for Hass Avocado in California

Calculate the amount of nutrients that are removed when you harvest your crop. Enter your production below. **No commas or periods please!**

Production Volume: 6000 lbs.

Calculate

Nitrogen:	16.827 lb.	Arsenic:	0.0096 oz.
Phosphorus:	6.3588 lb.	Barium:	0.1728 oz.
P_2O_5:	14.5617 lb.	Cadmium:	0.0384 oz.
Potassium:	40.2906 lb.	Chromium:	0.0672 oz.
K_2O:	48.7516 lb.	Cobalt:	0.0096 oz.
Iron:	1.1232 oz.	Lead:	0.1248 oz.
Manganese:	0.2112 oz.	Lithium:	0.1536 oz.
Zinc:	3.7056 oz.	Mercury:	0 oz.
Copper:	1.3824 oz.	Nickel:	0.3456 oz.
Boron:	9.5328 oz.	Selenium:	0.048 oz.
Calcium:	3.3516 lb.	Silicon:	2.2752 oz.
Magnesium:	6.7608 lb.	Silver:	0.0096 oz.
Sodium:	6.1728 lb.	Strontium:	0.4224 oz.
Sulfur:	12.1866 lb.	Tin:	0.0864 oz.
Molybdenum:	0 oz.	Titanium:	0 oz.
Aluminum:	2.2464 oz.	Vanadium:	0 oz.
		Chloride:	6.7314 lb.

http://www.avocadosource.com/

Fertilizer Calculator

English Units | Metric Units | Calculate

Primary Nutrient:	Nitrogen (N)		**Nutrient Information**
Amount of Primary Nutrient:	165	lbs.	
Fertilizer:	Ammonium Nitrate		**Fertilizer Information and MSDS**
Price of Fertilizer:	1	/ lb.	
Fertilizer Formula:	NH_4NO_3		
Amount of Fertilizer:	471.43	lbs.	
Price of Primary Nutrient:	2.86	/ lb.	
Secondary Nutrient:			
Amount of Secondary Nutrient:		lbs.	
Price of Secondary Nutrient:		/ lb.	

Using the Fertilizer Calculator
Sources of Fertilizer Calculator
Nutrient Removal Calculator
Scientific Calculator
Chart of the Effect of Soil pH on Nutrient Availability
Country Specific Normal Leaf Level Ranges
Soil Levels
Nutrient Interaction Chart
Law of the Minimum - Liebig's Law
Plant Stress by S. Kant and U. Kafkafi - Hebrew University

Created by Reuben Hofshi and Shanti Hofshi

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The Essential Elements

- Primary Elements Required for Growth
  - Carbon, Hydrogen and Oxygen
    - Supplied from carbon dioxide and water, essential for photosynthesis
  - Nitrogen
  - Phosphorous
  - Potassium

Nutrient	Units	Range
Nitrogen	% N	2.2 - 2.6
Phosphorous	% P	0.08 - 0.25
Potassium	% K	0.75 - 2.0
Sulphur	% S	0.2 - 0.6
Calcium	% Ca	1.0 - 3.0
Magnesium	% Mg	0.25 - 0.8
Zinc	ppm Zn	40 - 80
Copper	ppm Cu	5.0 - 15
Sodium	% Na	less than 0.25
Chloride	% Cl	less than 0.25
Iron	ppm Fe	50 - 200
Boron	ppm B	40 - 60
Manganese	ppm Mn	30 - 500

Nitrogen Deficiency

Slow growth, stunting, reduced yields

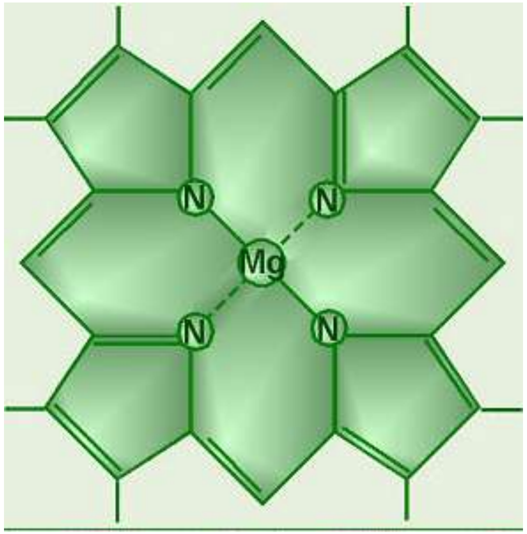
Yellow-green color to leaves
(a general yellowing)

More pronounced in older leaves since N is a mobile element that will move to younger leaves

Don't confuse with root rot and gopher damage

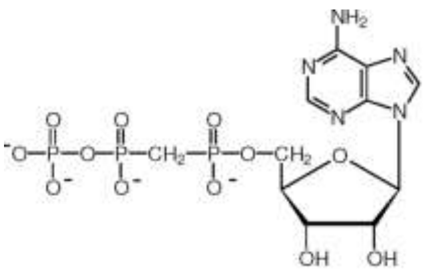
Functions of Essential Elements

- Nitrogen (N)
  - Nitrogen is utilized by plants to make amino acids, which in turn form proteins, found in protoplasm of all living cells. Also, N is required for chlorophyll, nucleic acids and enzymes



Functions of Essential Elements

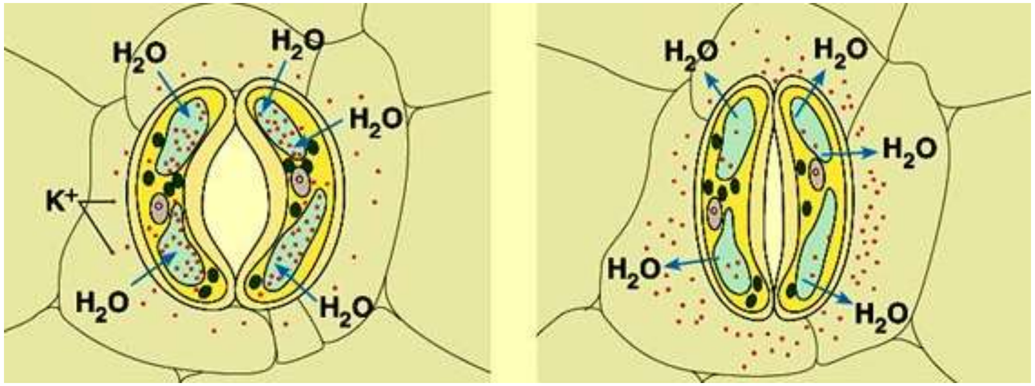
- Phosphorus (P)
  - Phosphorus is used to form nucleic acids (RNA and DNA), it is used in storage and transfer of energy (ATP and ADP)



  - P fertilizer stimulates early growth and root formation, used to drive nutrient uptake, cell division, metabolism
  - Generally sufficient in most California soils. Least response by plants in summer with extensive root systems (tree crops). Mainly taken up by mycorrhizae

Functions of Essential Elements

- Potassium (K)
  - Potassium is required by plants for translocation of sugars, starch formation, opening and closing of guard cells around stomata (needed for efficient water use)



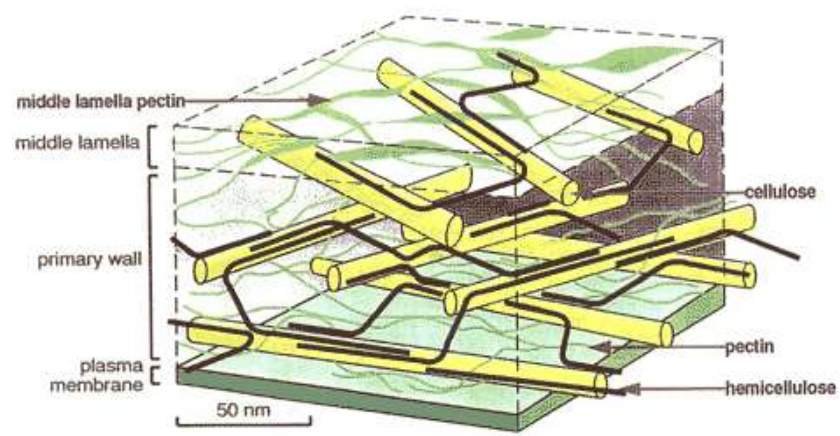
  - Increases plant resistance to disease
  - Increases size and quality of fruit
  - Increases winter hardiness

Functions of Essential Elements

- Calcium
  - Essential part of cell walls and membranes, must be present for formation of new cells
  - Has been shown to make avocado root tips less leaky, therefore less attractive to Phytophthora zoospores

Deficiencies:

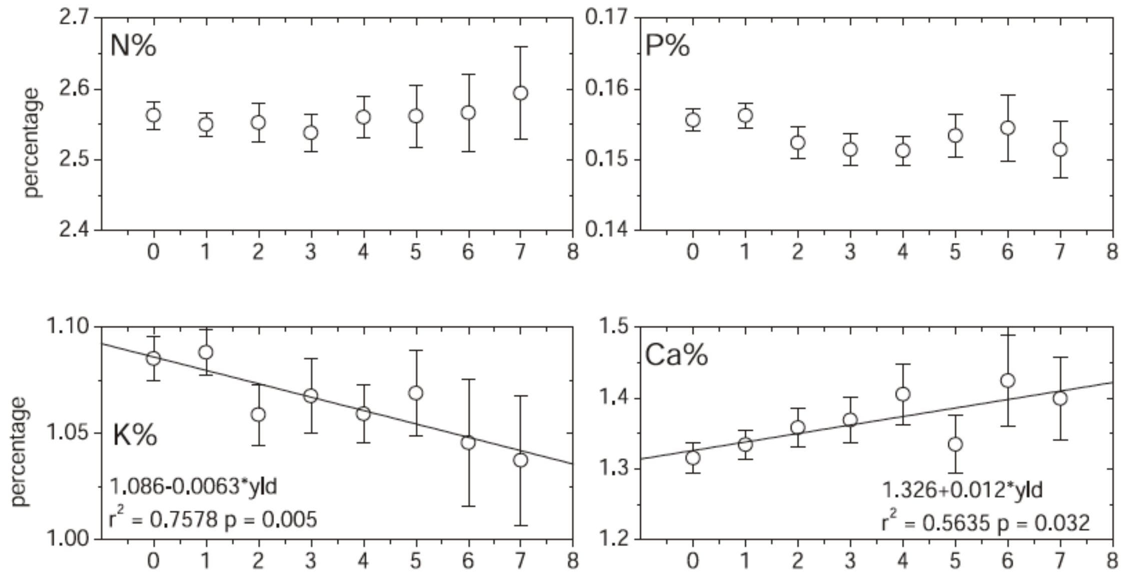
poor root development
leaf necrosis and curling,
bitter pit, fruit cracking,
poor fruit storage
water soaking



While avocado requires fertilization, it is difficult to show a fertilizer response for any nutrient!

Table 2. Range of leaf mineral values (average plus or minus one standard deviation) of 'Hass' avocado trees with different yields taken from leaf tests in the same year as the harvest.

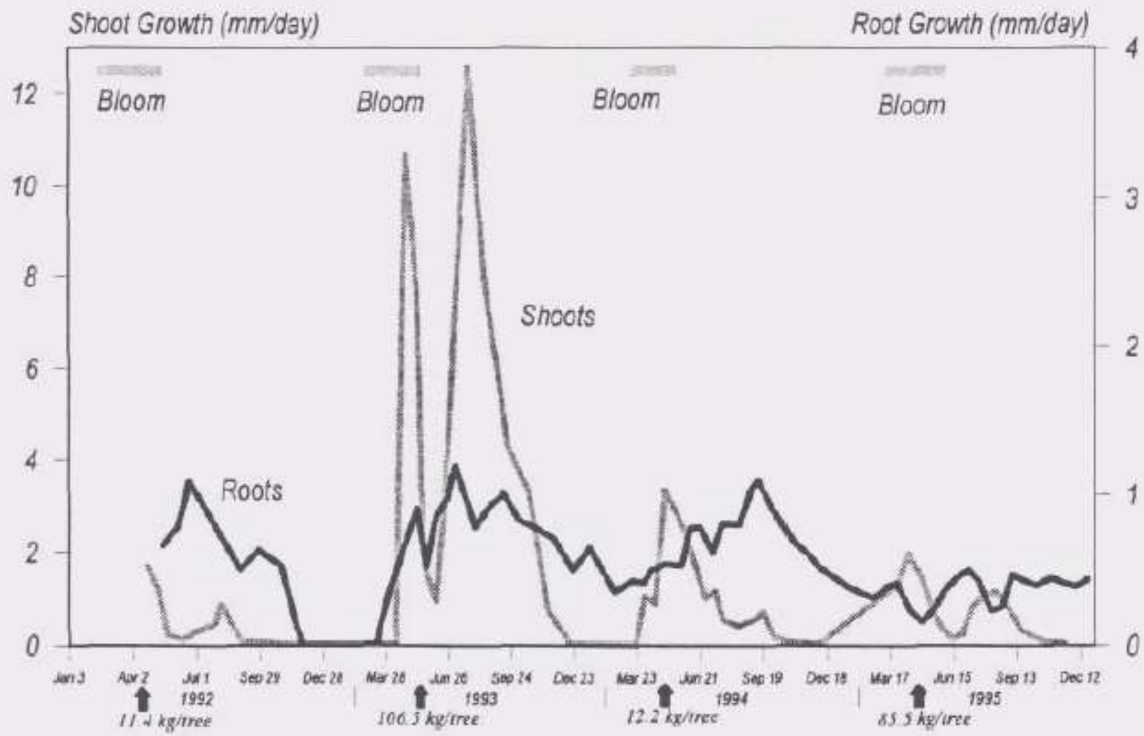
	Yield class (t/ha)						
Element	0-5	5-10	10-15	15-20	20-25	25-30	>30
N%	2.5-2.6	2.4-2.6	2.4-2.7	2.4-2.7	2.4-2.6	2.4-2.7	2.2-2.8
P%	0.15-0.16	0.14-0.16	0.14-0.16	0.14-0.16	0.13-0.16	0.15-0.18	0.13-0.16
K%	1.0-1.1	1.0-1.1	1.0-1.1	1.0-1.1	0.9-1.2	0.9-1.1	0.9-1.1
Ca%	1.3-1.4	1.3-1.5	1.4-1.6	1.3-1.7	1.2-1.8	1.6-1.7	1.1-1.7
Mg%	0.34-0.38	0.35-0.41	0.38-0.43	0.38-0.44	0.35-0.44	0.41-0.48	0.30-0.48
S%	0.24-0.27	0.24-0.27	0.26-0.29	0.25-0.28	0.22-0.31	0.25-0.28	0.21-0.29
Fe ppm	48-69	50-65	54-68	51-57	44-99	52-71	54-74
Mn ppm	146-192	140-237	117-234	127-196	124-233	120-192	73-186
Zn ppm	33-39	31-43	35-48	35-43	35-68	37-53	34-53
B ppm	29-33	25-35	30-39	26-42	21-44	28-39	29-49



Dixon et al.

Timing of fertilizer applications to meet nutrient demand during flowering and fruit set

Figure 1. Vegetative and root growth cycles of 'Hass' avocado at the South Coast Research and Extension Center.



Arpaia et al

Spring (April) applied fertilizer increases avocado yields

Table 1. Effect of time and amount of soil-applied N across 4 years on yield of 'Hass' avocado.

	Yield/tree			
	All fruit		Fruit packing carton sizes 40–60	
Month extra N applied	Total wt (kg)	No.	Total wt (kg)	No.
None[z] (control)	58.5 bc[y]	306 ab	38.4 b	166 b
January	56.1 bc	284 b	34.9 b	152 b
February	56.1 bc	280 b	31.7 b	140 b
April	71.8 ab	349 ab	55.1 a	234 a
June	53.2 c	272 b	38.1 b	162 b
November	76.5 a	384 a	54.9 a	235 a
Significance of F test[x]				
N	*	*	**	***
Year	****	****	****	****
N × year	*	NS	NS	NS

[z]Standard grower practice.
[y]Mean separation within the columns by Duncan's multiple range test, $P \leq 0.05$.
[x]Data analyzed using repeated measures model with year as the repeated measures factor.
[NS,*,**,***,****]Nonsignificant or significant at $P = 0.05, 0.01, 0.001$, or 0.0001, respectively.

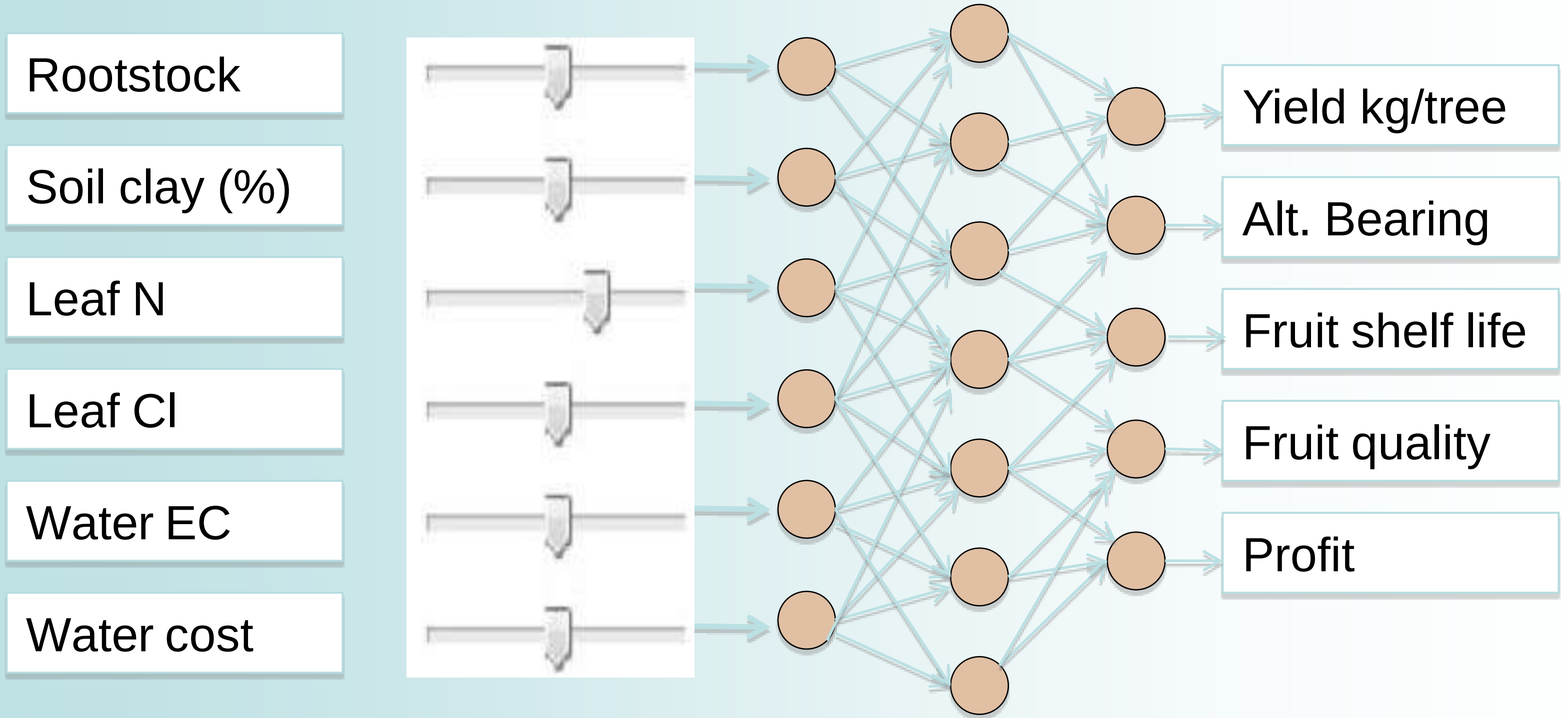
Lovatt 2001

Decision Support Tools for Avocado Production and Fruit Quality

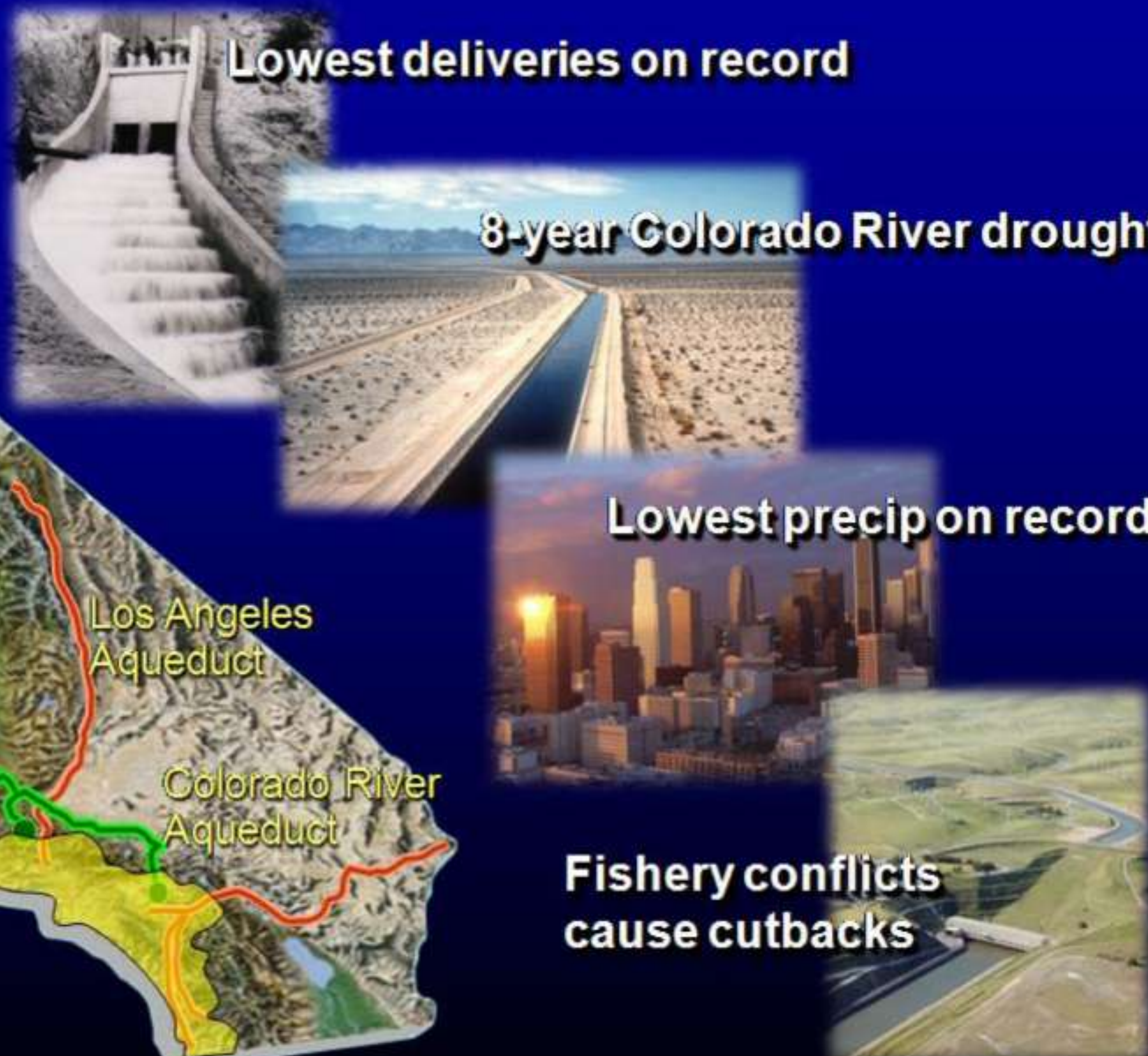
David Crowley, Mary Lu Arpaia, and Ariel Dinar

Objectives: Develop an internet based set of decision support tools that can be used to predict fruit yields, fruit quality, alternate bearing patterns, and profit.

Research Plan: Construct artificial neural network and economic models that are trained and validated using data collected from a transect of avocado orchards across S. California having different rootstocks, irrigation water quality, fertilization practices, soil types, and climate.



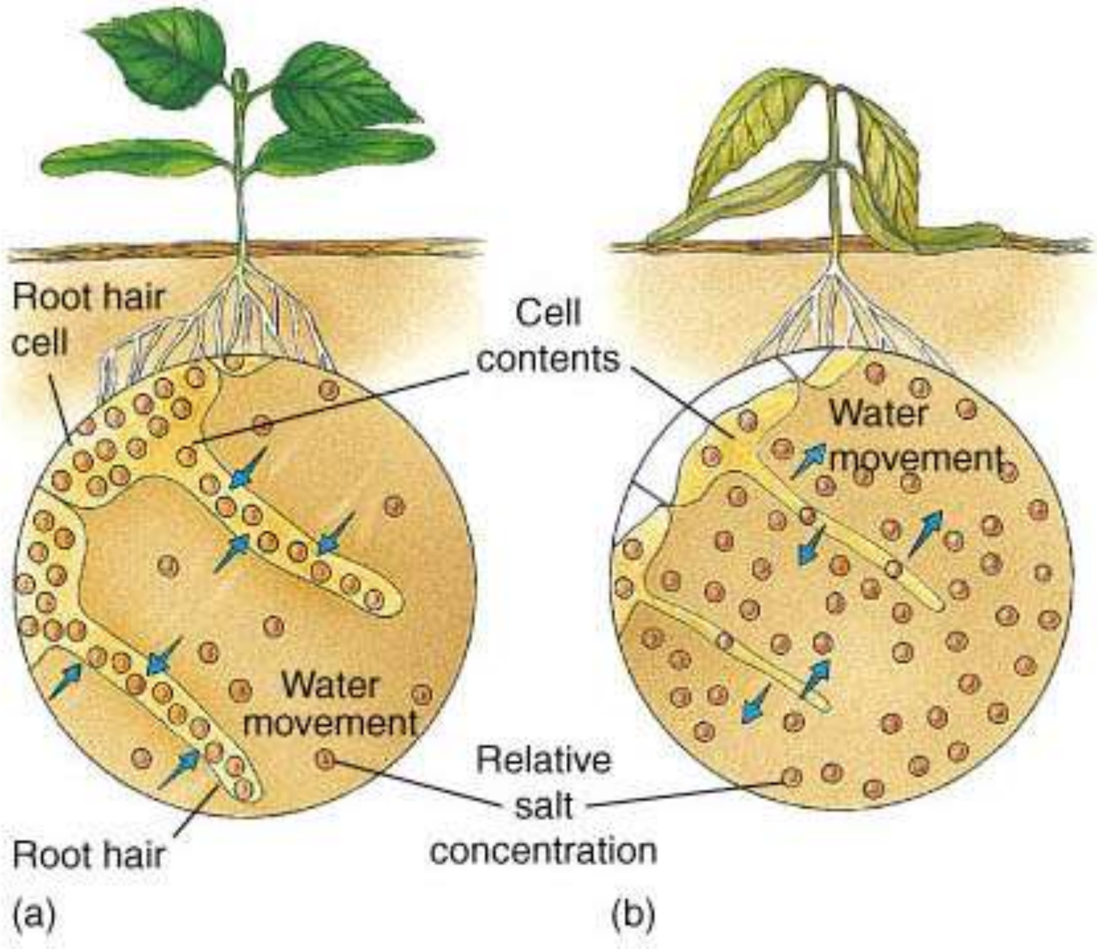
California Water Today



Suitability of Water for Irrigation

Quality	Electrical Conductivity (millimhos/cm)	Total Salts (ppm)	Sodium (% of total salts)	SAR	pH
Excellent	0.25	175	20	3	6.5
Good	0.25-0.75	175-525	20-40	3-5	6.5-6.8
Permissible	0.74-2.0	525-1400	40-60	5-10	6.8-7.0
Doubtful	2.0-3.0	1400-2100	60-80	10-15	7.0-8.0
Unsuitable	>3.0	>2100	>80	>15	>8.0

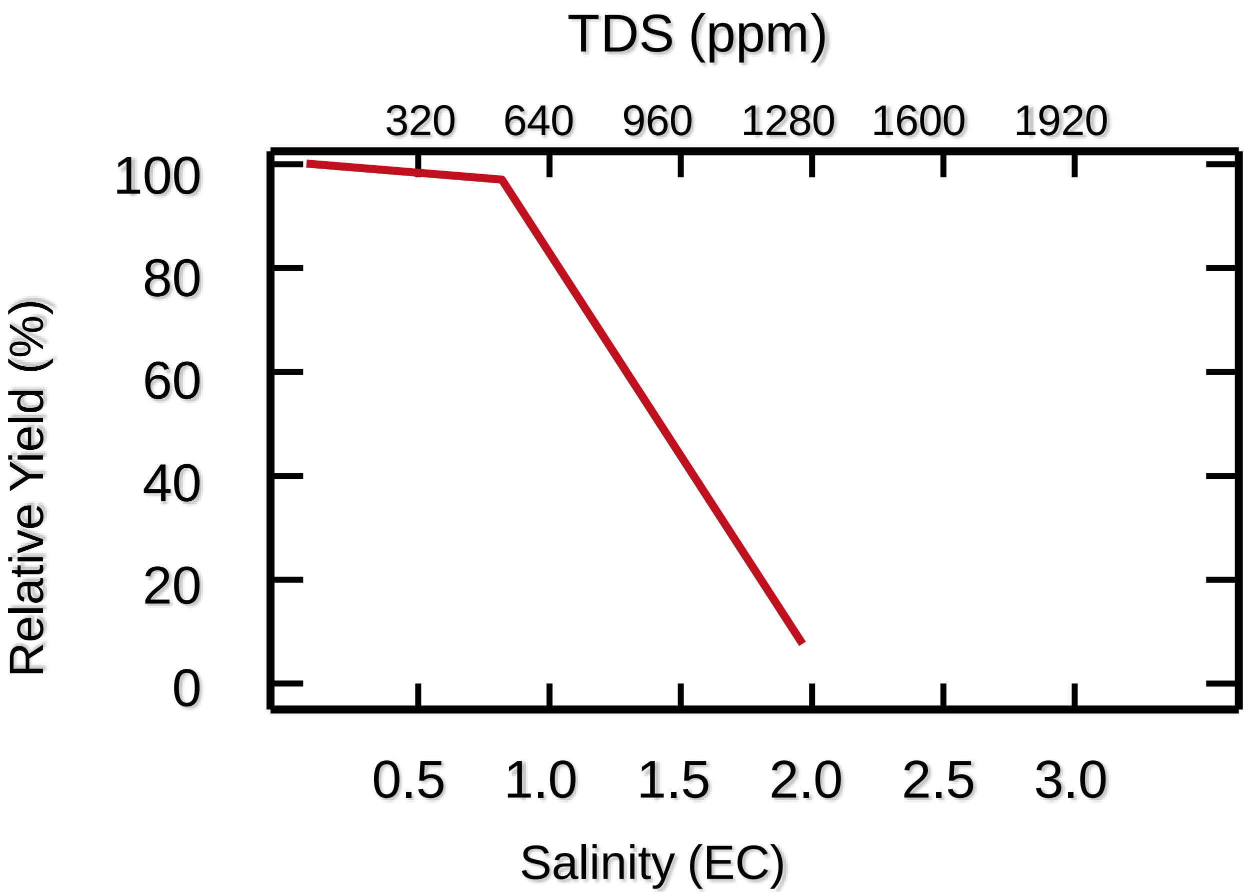
The Problem with Total Dissolved Salt: High Salt Inhibits Plant Water Uptake



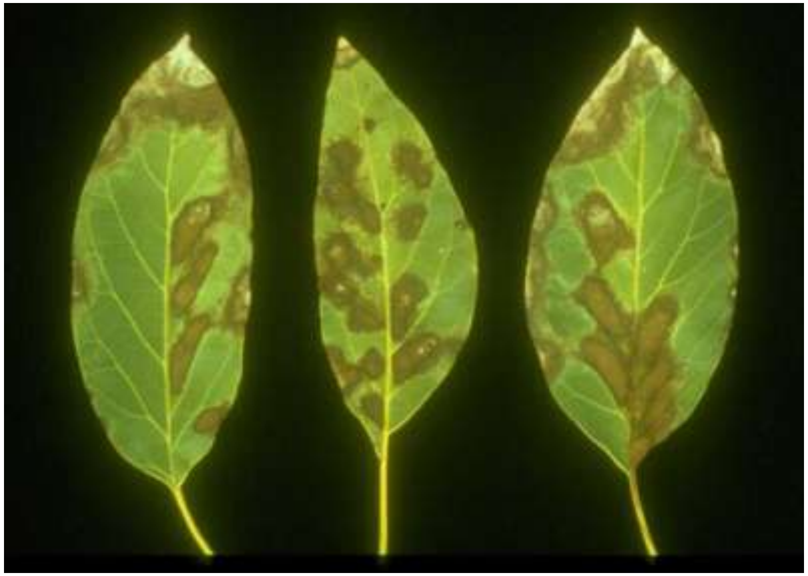
For avocado, this occurs at EC = 4 dS/m

Avocado Yield Function for Irrigation Water Salinity

Oster and Arpaia, J. Am Soc. Hort Sci. 2007



Combined Effects of Chloride and Sodium Toxicity on Avocado Trees

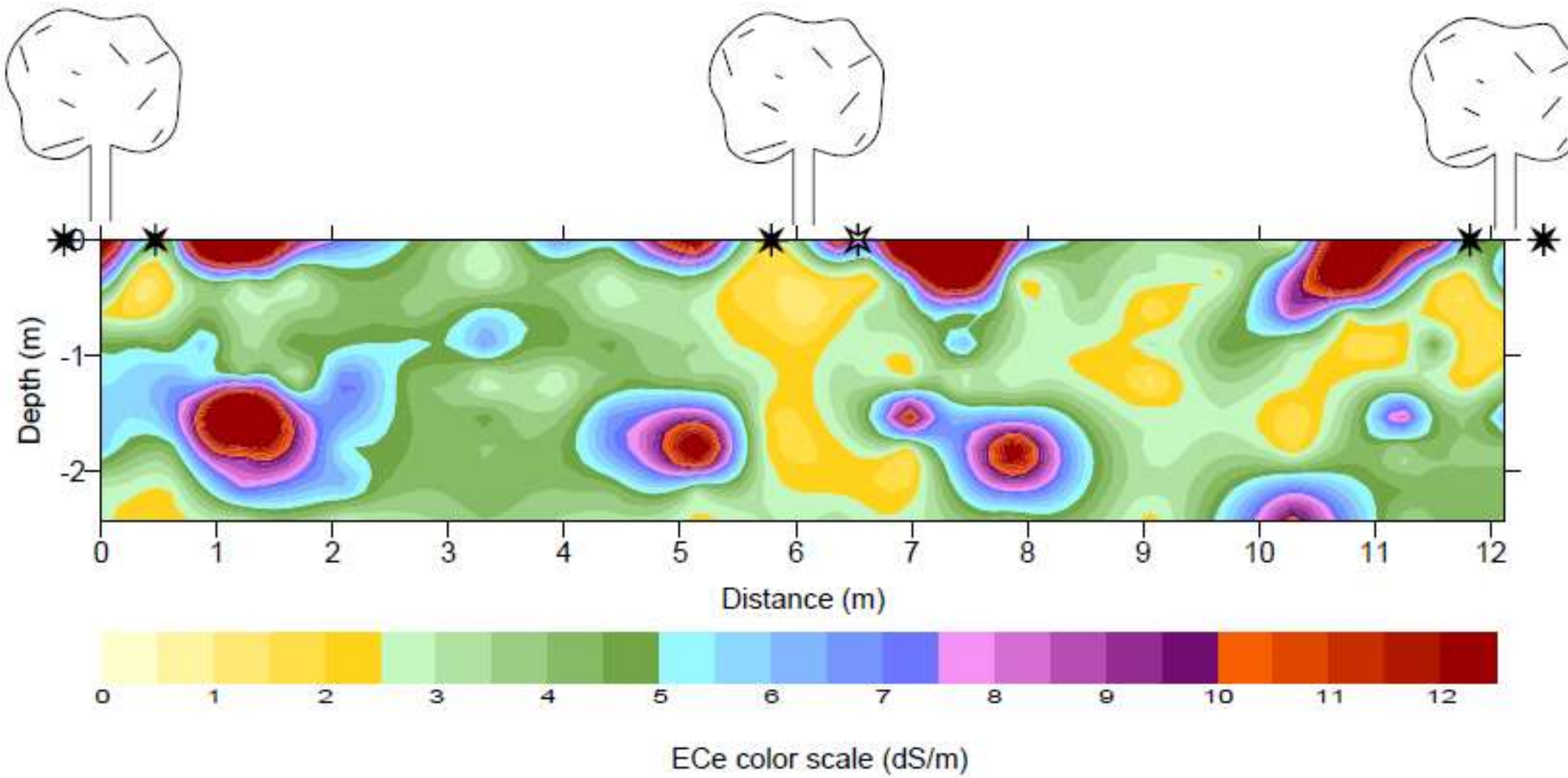


Chloride 0.58%
Sodium 0.35%

Chloride 0.61%

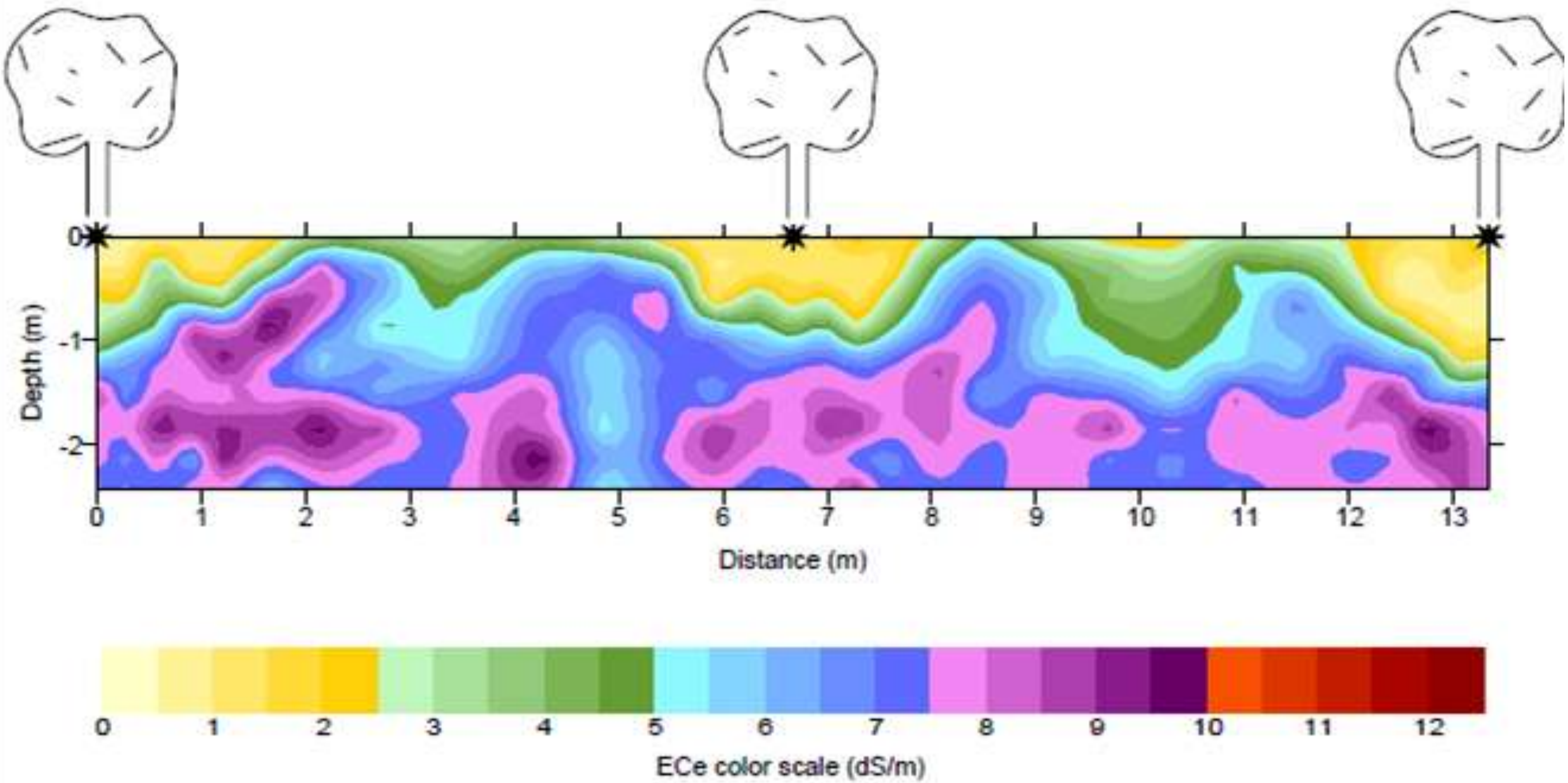
Kadman (Avocadosource.com)

Salt Accumulation in Tree Crop Orchards Using Drip Irrigation



Soil Salinity Accumulation in Orchards with Drip and Micro-spray Irrigation in Arid Areas of California
http://www.itrc.org/reports/salinity/treecropsalinity.pdf ITRC Report No. R 03-005

Salt Accumulation in Tree Crop Orchards Using Micro-Spray Irrigation



CDWR 2003

Soil Salinity Accumulation in Orchards with Drip and Micro-spray Irrigation in Arid Areas of California
http://www.itrc.org/reports/salinity/treecropsalinity.pdf ITRC Report No. R 03-005


Soil Leaching: Pushing Salt Down

TDS/Conductivity/Salinity Pen

Collect Soil Cores

0-6", 6-12", 12-18"

Prepare 2:1 Water:Soil Extracts

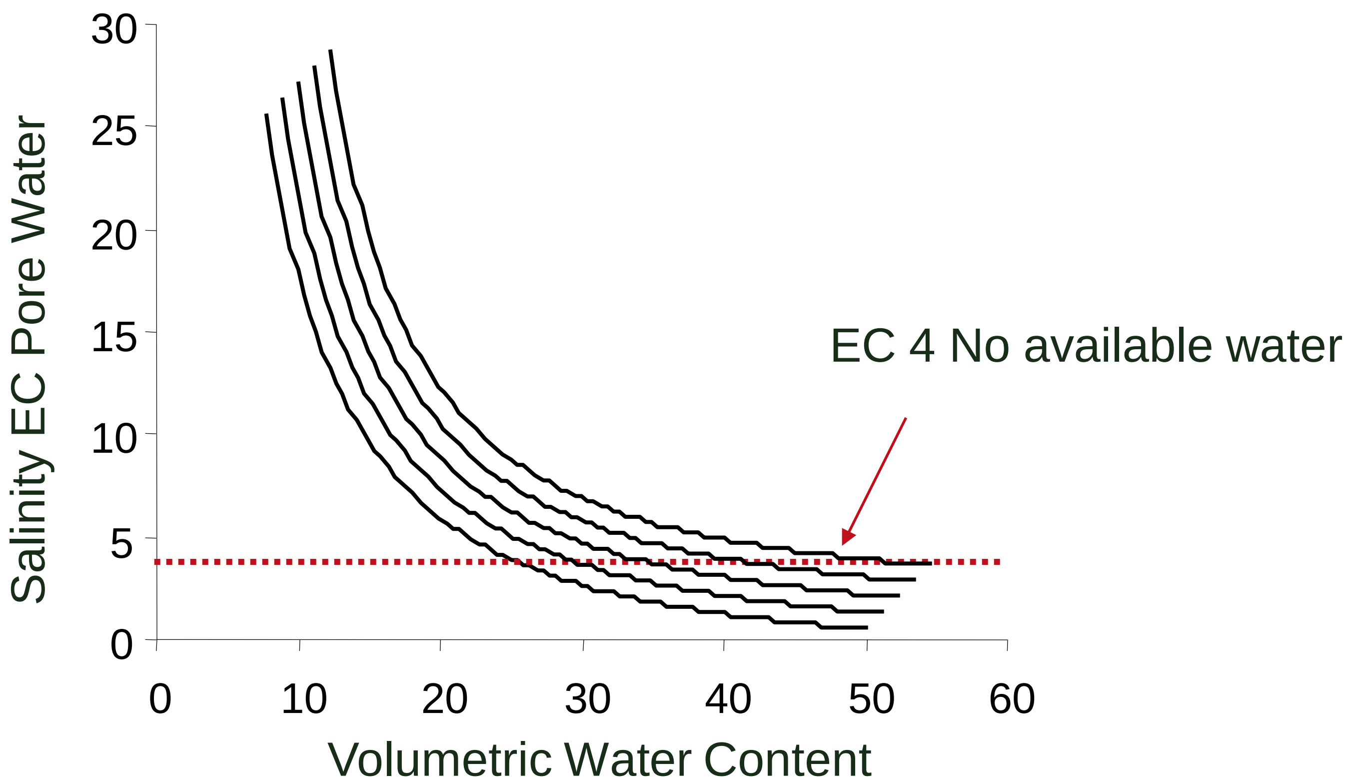
Distilled Water

Measure EC

Multiply x 8 (to estimate soil ECw)

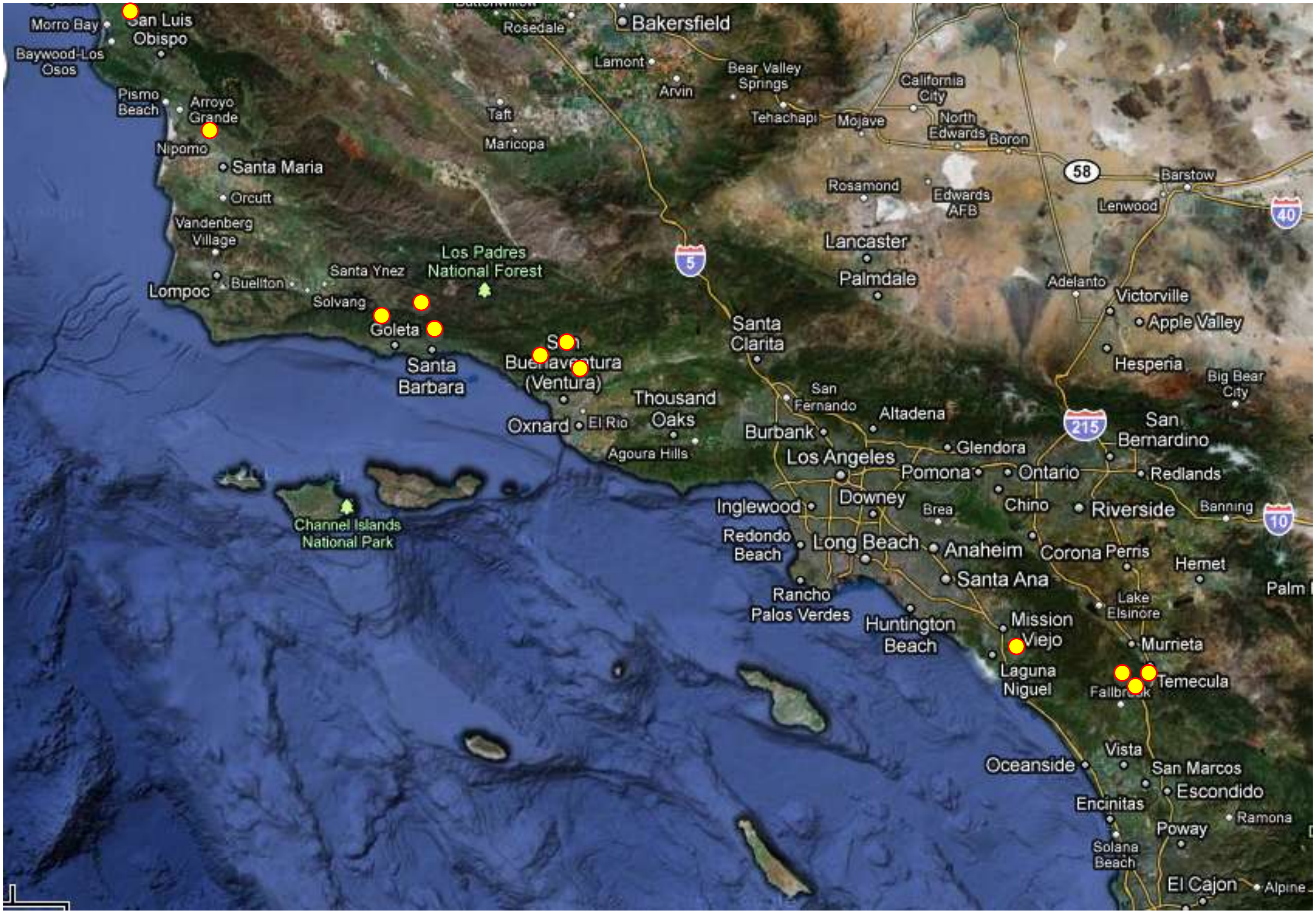
If EC > 0.25 dS m^{-1} for 2:1 water extract then it is time to leach (equivalent to an ECw of 2.0 at field capacity)

water water everywhere, but nothing ….



Avocado Production Transect Network

12 Locations
450 Total trees



Rootstocks: Duke 7, Toro Canyon, Dusa, Thomas, Mexican


Steve Smith, Rancho Mupu
Ventura


Lyle Snow Orchard
Ventura


Derek Knobel, Rancho Mission Viejo
Orange


Pete Miller Orchard
Santa Barbara


Deardorff Orchard
Riverside

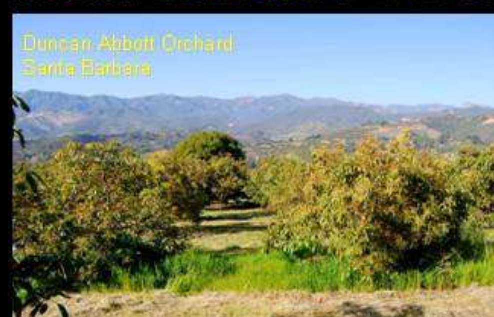

Ed McFadden, Rancho Simpatica
Ventura


Rick Carey Orchard
San Diego


Van der Kar Orchard
Santa Barbara


Tyson Davis Orchard
San Luis Obispo


Woodworth Orchard
Riverside


Duncan Abbott Orchard
Santa Barbara


Staller Orchard
San Luis Obispo

ENVIRONMENTAL FGL AGRICULTURAL
Analytical Chemists

December 4, 2012

Fruit Growers Laboratory, Inc.
853 Corporation Street
Santa Paula, CA 93060

PLANT ANALYSIS SPM12Y730A:1-15
Customer ID : 2-22872
Sampled On : November 6, 2012
Sampled By : Stephen Qi
Received On : November 8, 2012
Depth : Yes

Hass Plant Tissue Analysis

Sample Area	% Nitrogen	% Phosphorus	% Potassium	% Calcium	% Magnesium	ppm Zinc	ppm Manganese	ppm Iron	ppm Copper	ppm Boron	% Sodiu	% Chloride
Tree # 01	2.00	0.134	1.14	1.33	0.690	121	127	114	20	25.1	0.010	0.903
Tree # 02	2.34	0.157	1.02	1.81	0.627	98.8	124	75	18	20.9	0.01	0.815
Tree # 03	2.57	0.143	1.13	1.79	0.509	76.6	79	62	15	28.4	0.010	0.606
Tree # 04	2.21	0.153	1.26	1.49	0.502	114	118	68	18	24.3	0.009	1.09
Tree # 05	2.21	0.157	1.37	1.64	0.532	126	209	86	19	29.9	0.012	1.04
Tree # 06	2.36	0.176	1.50	1.54	0.440	105	93	58	18	30.8	0.01	0.980
Tree # 07	2.47	0.185	1.32	1.87	0.523	122	114	66	18	35.1	0.011	0.612
Tree # 08	2.25	0.161	1.02	2.30	0.578	75.7	147	62	16	27.1	0.008	0.565
Tree # 09	2.20	0.133	1.57	1.53	0.395	118	123	64	19	34.6	0.012	0.745
Tree # 10	2.02	0.178	1.40	1.51	0.453	195	119	84	31	29.1	0.012	1.01
Tree # 11	2.14	0.179	1.84	1.71	0.503	132	72	66	19	50.0	0.009	0.983
Tree # 12	2.23	0.151	1.27	1.38	0.584	104	120	70	17	38.9	0.011	0.706
Tree # 13	2.66	0.173	1.74	1.35	0.468	76.1	79	54	13	47.3	0.01	0.942
Tree # 14	2.14	0.133	1.36	2.08	0.491	97.7	140	62	15	32.2	0.011	0.626
Tree # 15	1.89	0.143	1.02	2.64	0.659	137	228	111	22	43.6	0.011	0.548
Optimum Range - Average	2.2 - 2.4	0.080 - 0.44	1.0 - 3.0	1.0 - 4.5	0.25 - 1.0	30 - 250	30 - 700	50 - 300	5 - 65	12 - 100	0.0 - 0	0.0 - 0.25

Good Problem Low High Indicates physical conditions and/or phenological and amendment requirements.

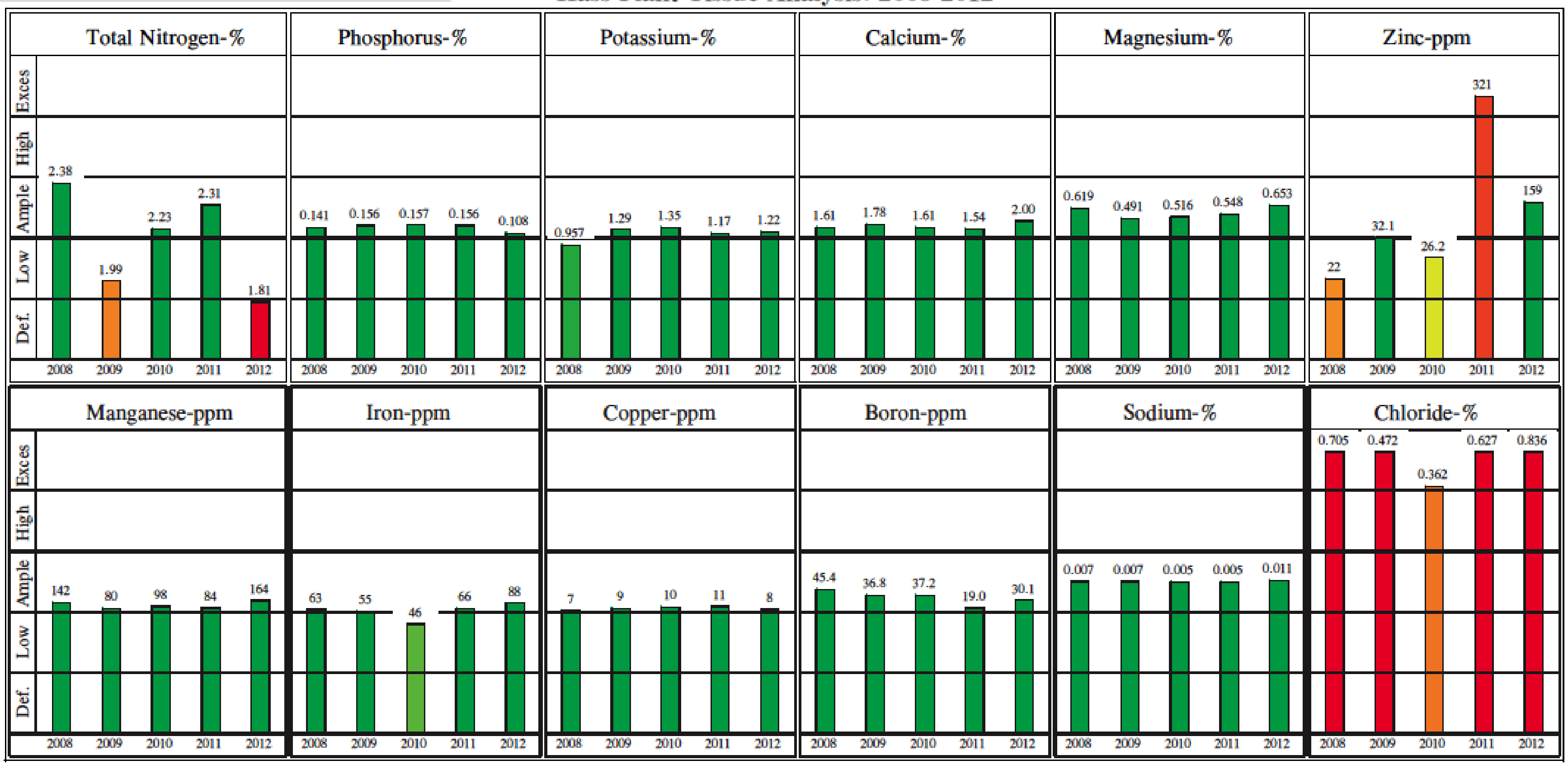
Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.

ENVIRONMENTAL FGL AGRICULTURAL
Analytical Chemists

December 4, 2012
Fruit Growers Laboratory, Inc.
Sample: Tree # 03

Lab ID : SPM12Y725A-003
Sampled By : Stephen Qi
Sampled On : November 6, 2012

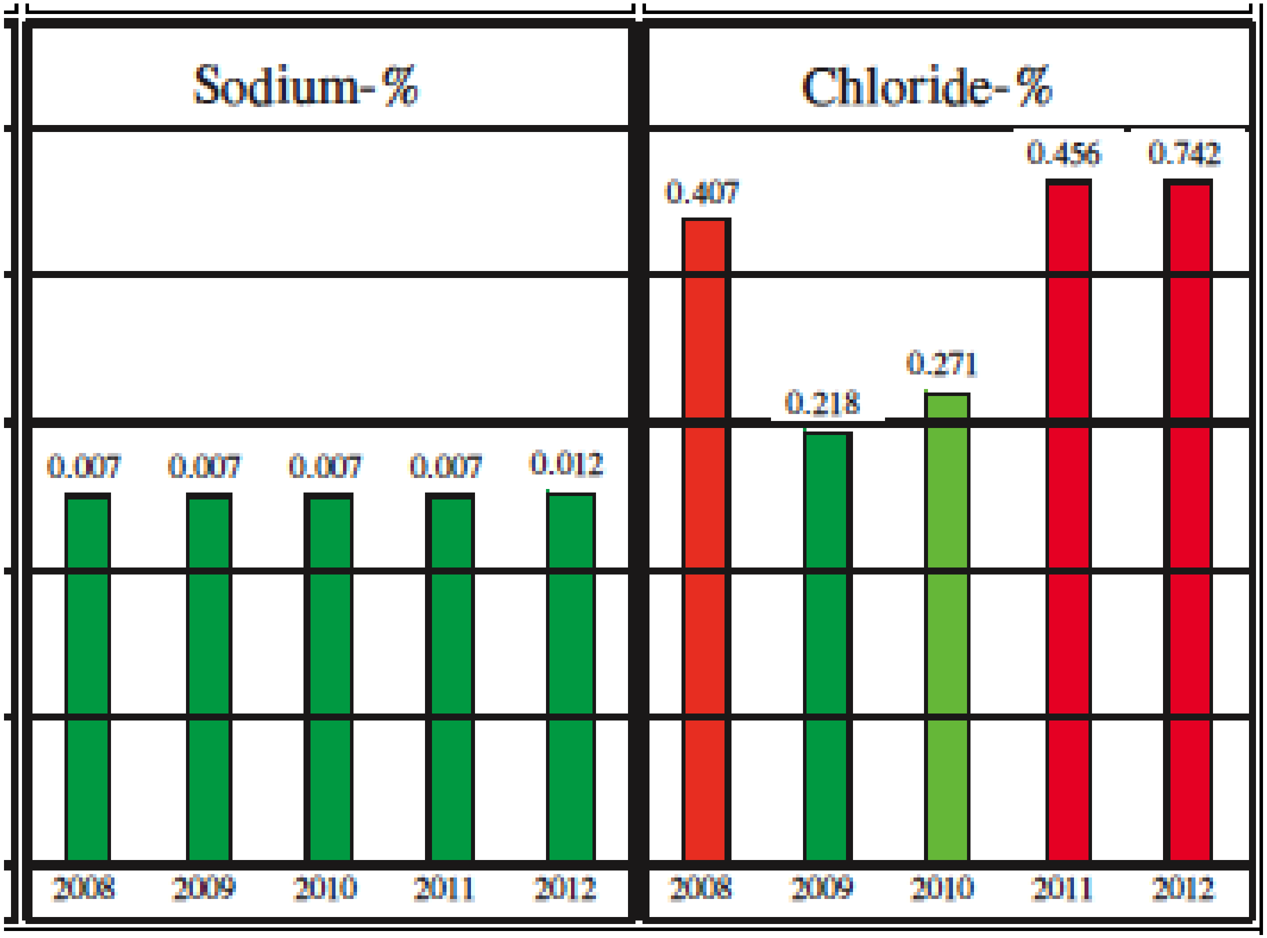
Hass Plant Tissue Analysis: 2008-2012



Good — Problem — Indicates physical conditions and/or phenological and amendment requirements.

Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.

Year to Year Variation in Chloride Toxicity for Same Tree, Same Soil, Same Irrigation Water and Same Management



Effects of Waterlogging on Leaf Chloride Uptake

Plant Species	Days	Leaf Cl % Drained	Leaf Cl % Waterlogged	% Cl Increase
Atriplex	14	4.12	8.53	210
Casuarina	84	0.27	0.72	270
Eucalyptus	77	0.49	1.37	280
Lycopersicum	15	0.92	2.68	290
Nicotiana	10	0.93	1.87	200
Triticum	7	0.59	0.91	160
Vitis vinifera	7	0.19	0.68	306

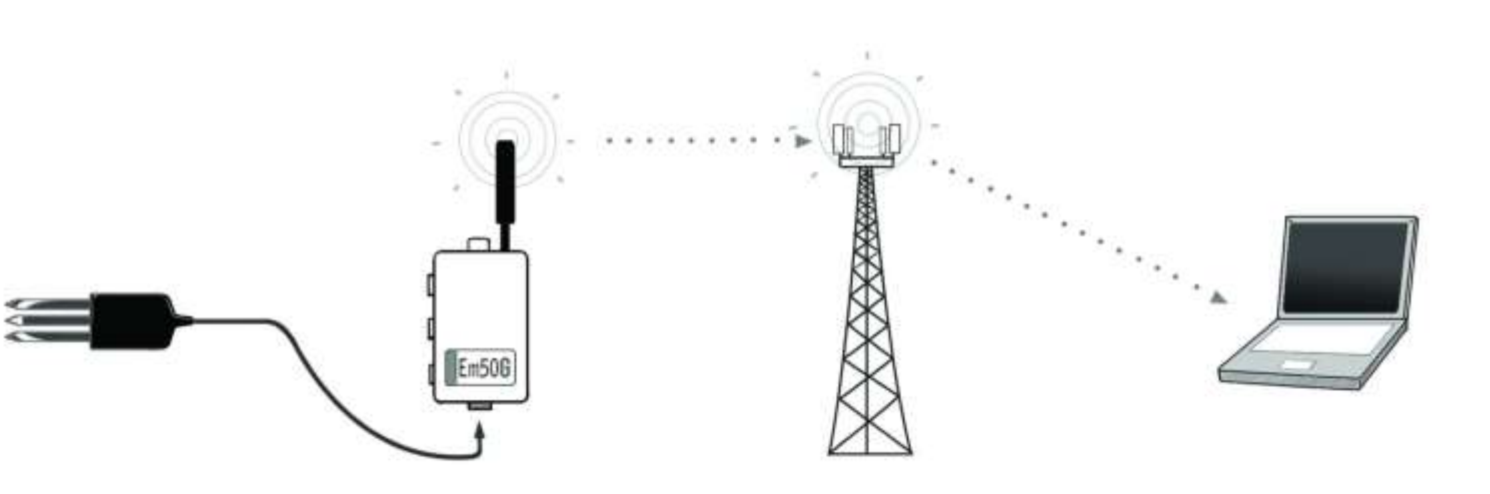
Review Paper: Barrett-Lennard. 2003. The interaction between waterlogging and salinity in higher plants: causes, consequences and implications. Plant and Soil 253:35-54

Research Focus: Soil Water Management

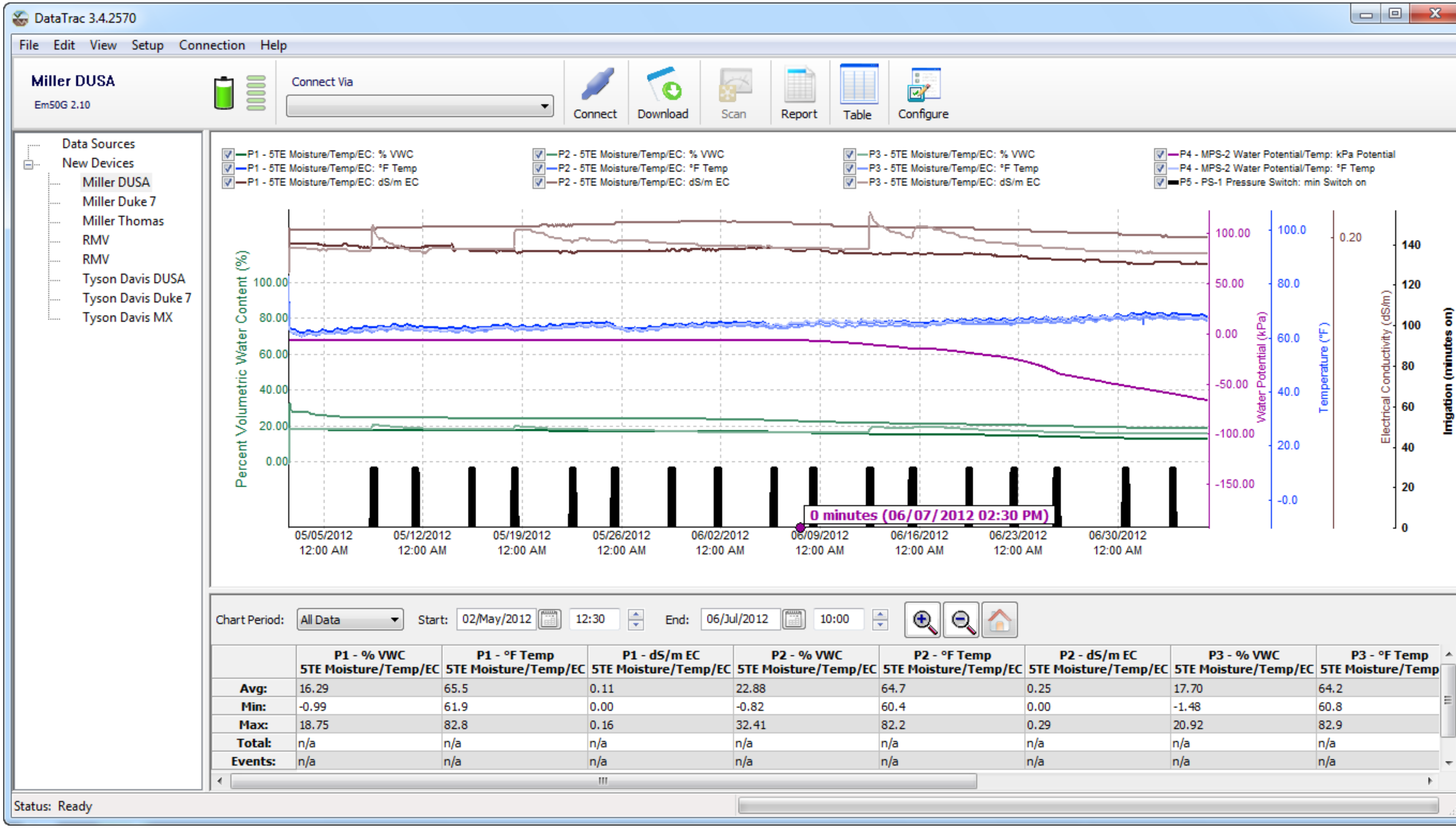
Salinity
Volumetric water content
Temperature

Soil water potential

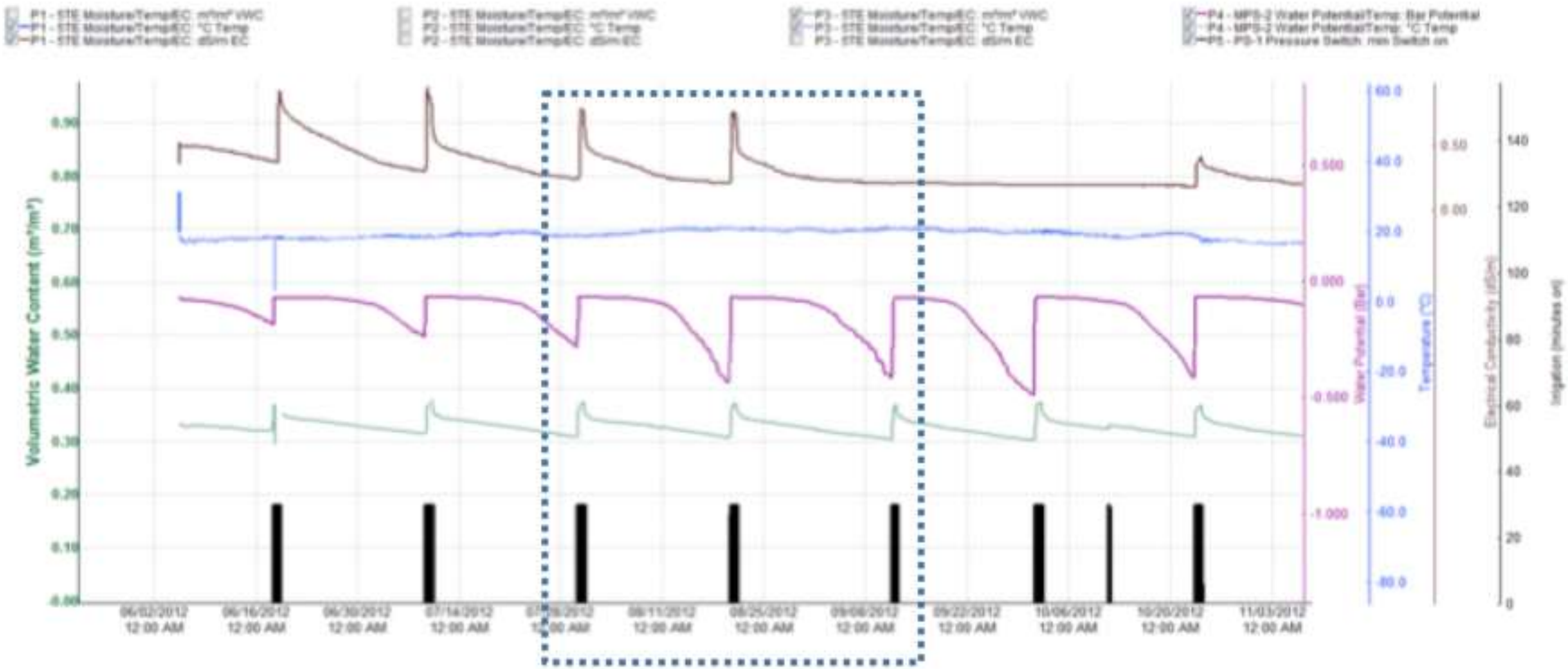
Data logger

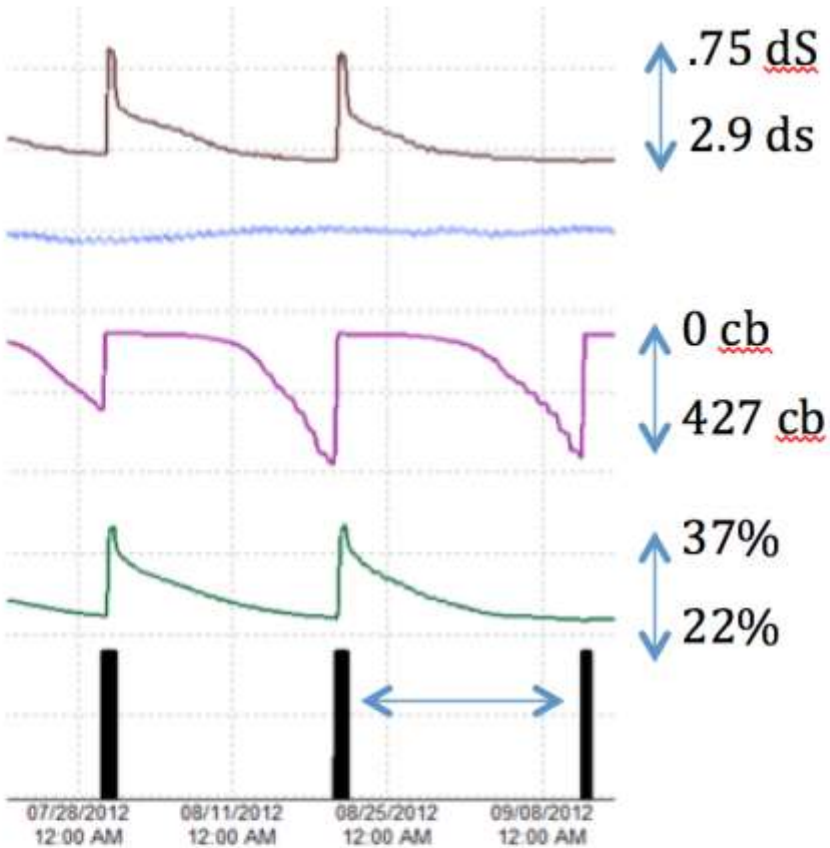


Real time monitoring of soil water availability and salinity status



Interpreting Soil Water Status / Irrigation Reports





Salt flush at beginning of each irrigation set. EC range between leaching is .75 to 2.9 dS/m.

Soil water potential (plant available water decreases from 0 to -427 cbars between irrigation sets.

Soil volumetric water content at saturation is 37% decreasing to 22% as soil water potential reaches wilting point. Total available water ~40%.

Irrigation timer indicates that trees are being watered every 3 weeks.

Statistical Analysis and Pattern Recognition Using Artificial Neural Networks

EC

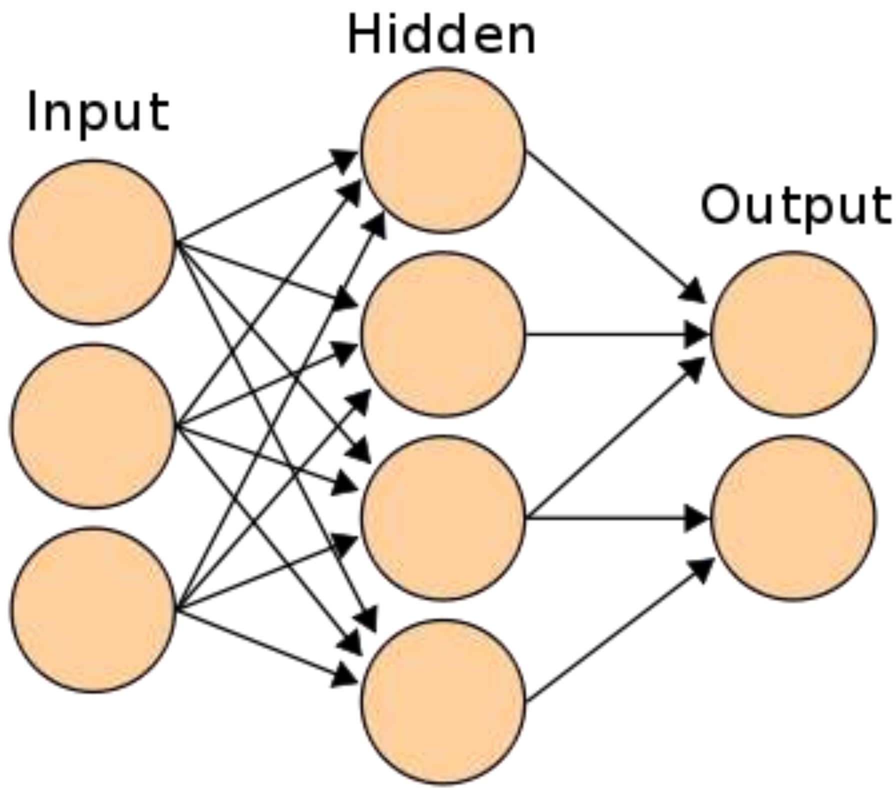
Chloride

% Clay

Rootstock

Fertilization

……

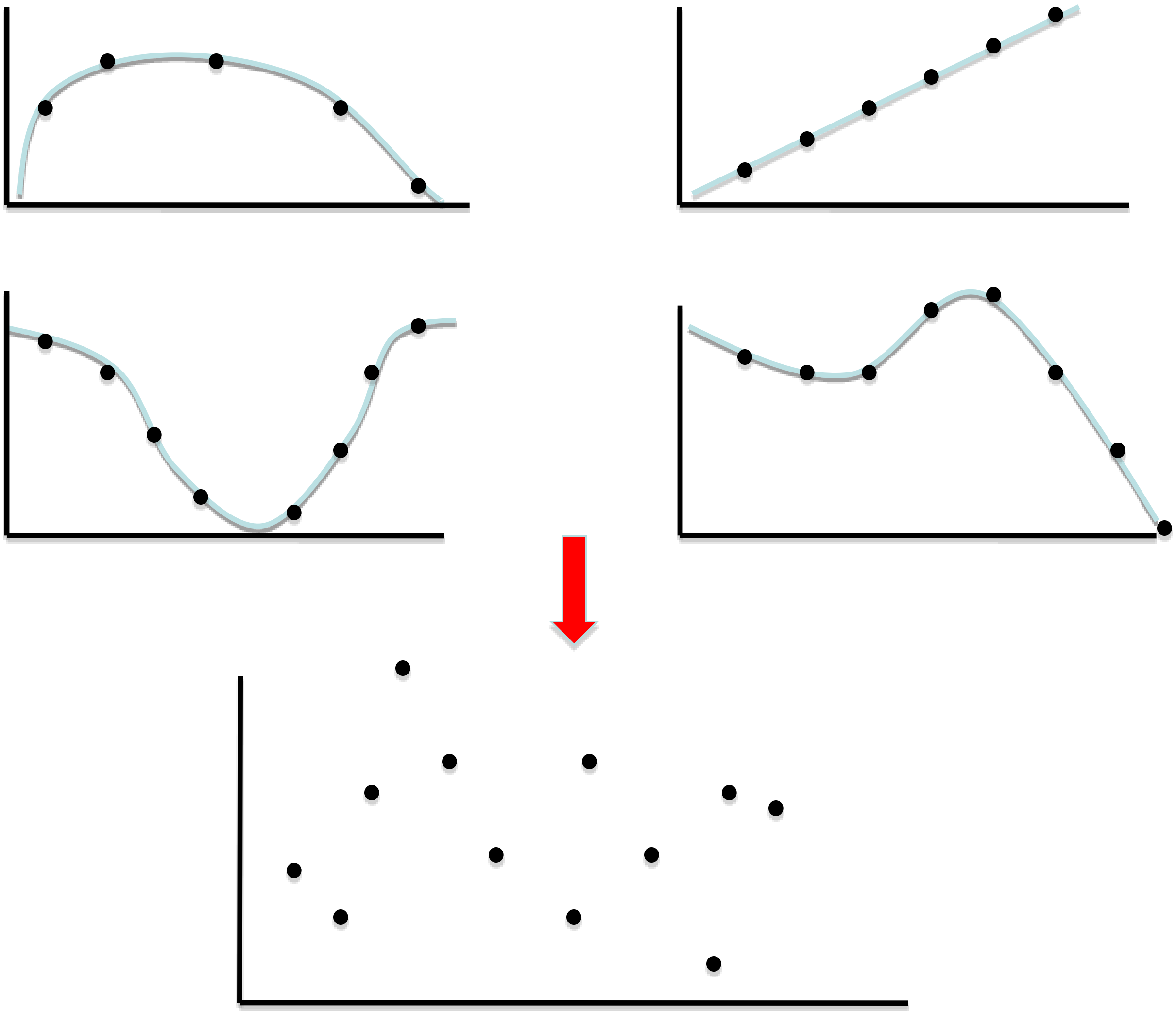


Root Growth

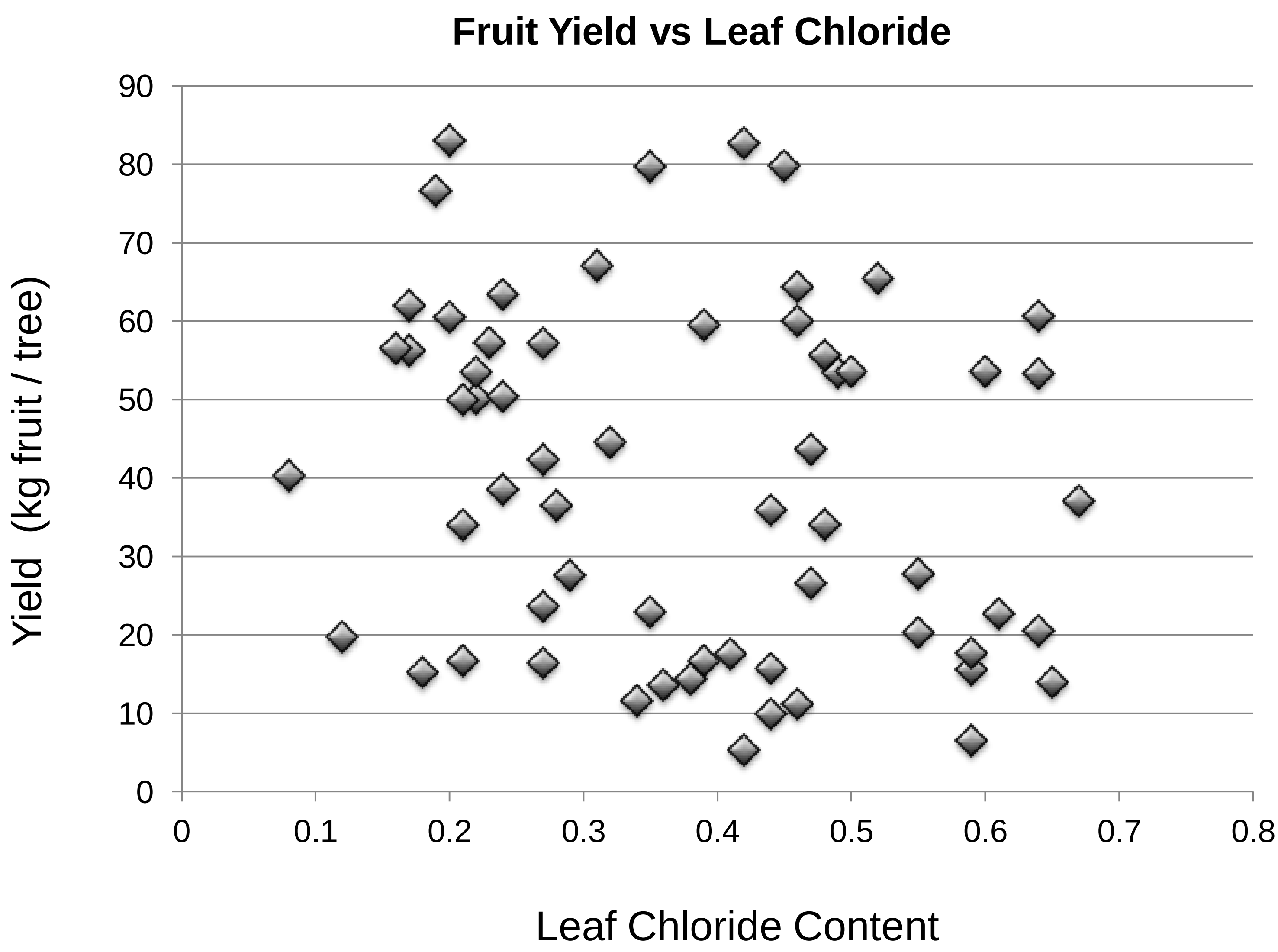
Fruit Yields

http://www.answers.com/topic/artificial-neural-network

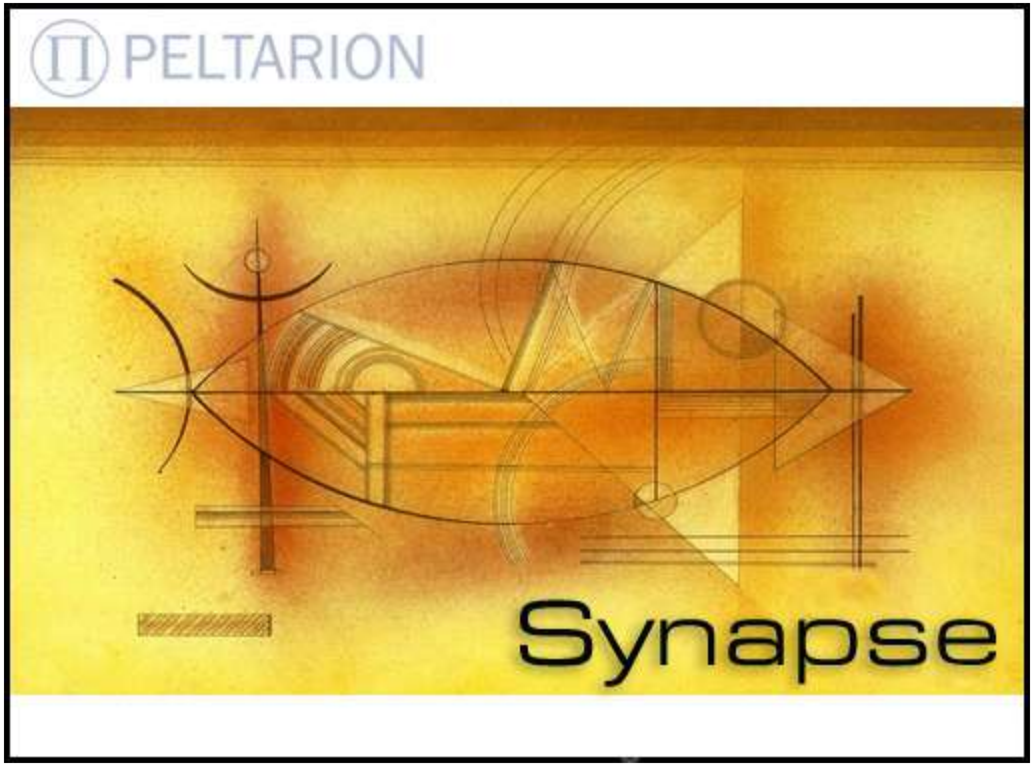
When there are many interacting factors that affect plant yields, it is often difficult or impossible to separate out the effects of individual variables using traditional statistical procedures.



Due to nutrient interactions that affect yield, scatter plots show no apparent relationship Between chloride toxicity and fruit yields.

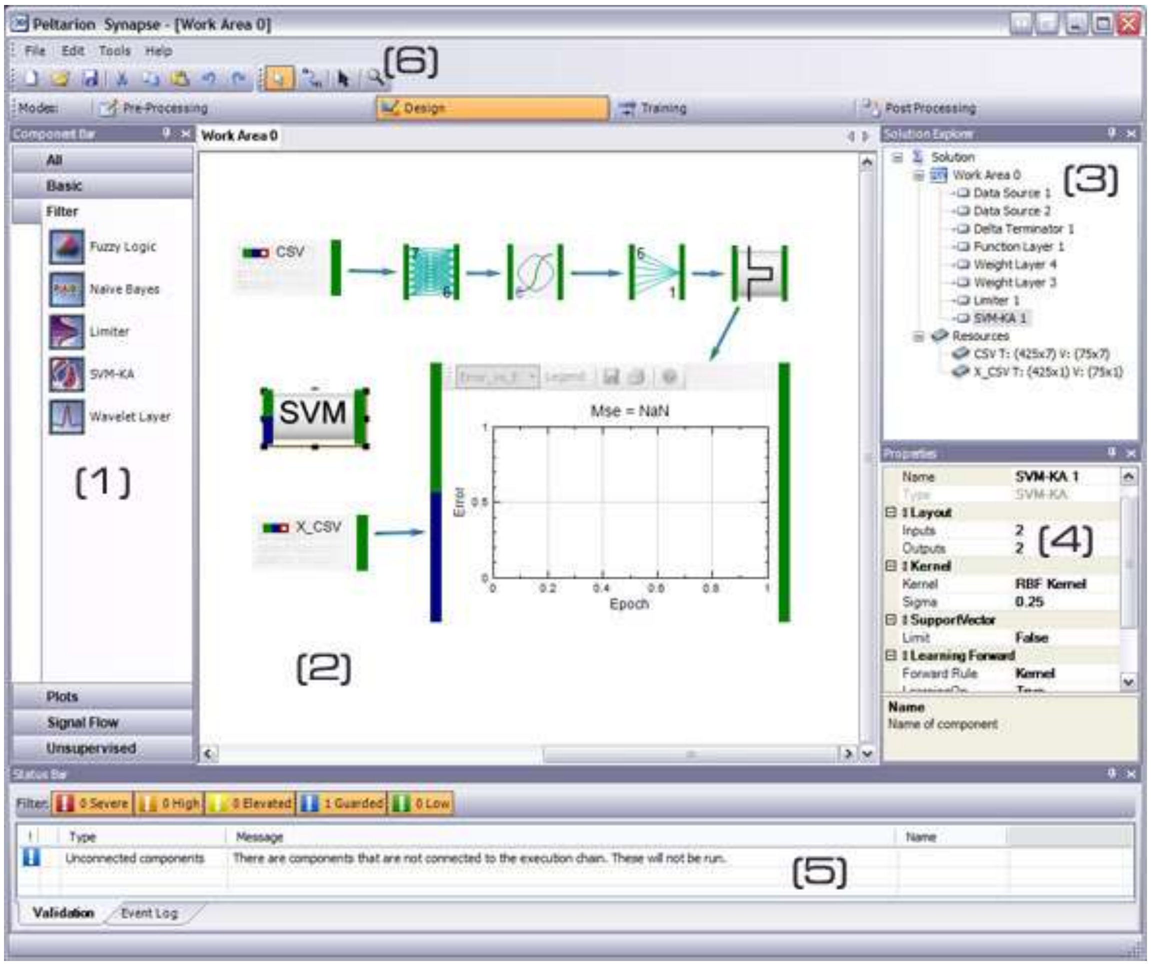


Neural Net Software and Programs



http://www.peltarion.com/WebDoc/index.html

Software for Running Artificial Neural Networks



Model design page for Peltarion Synapse software

ANN Applications

Business
Market analysis

Voice recognition
Image analysis

Medical
EKG, EEG

Defense

Environment

Experimental Variables for Production Function Model

Soil

- Texture (clay, silt, sand)
- pH, salinity (EC), chloride
- ave soil water content (Watermark data)
- organic matter, mulch

Water Quality

- EC, chloride

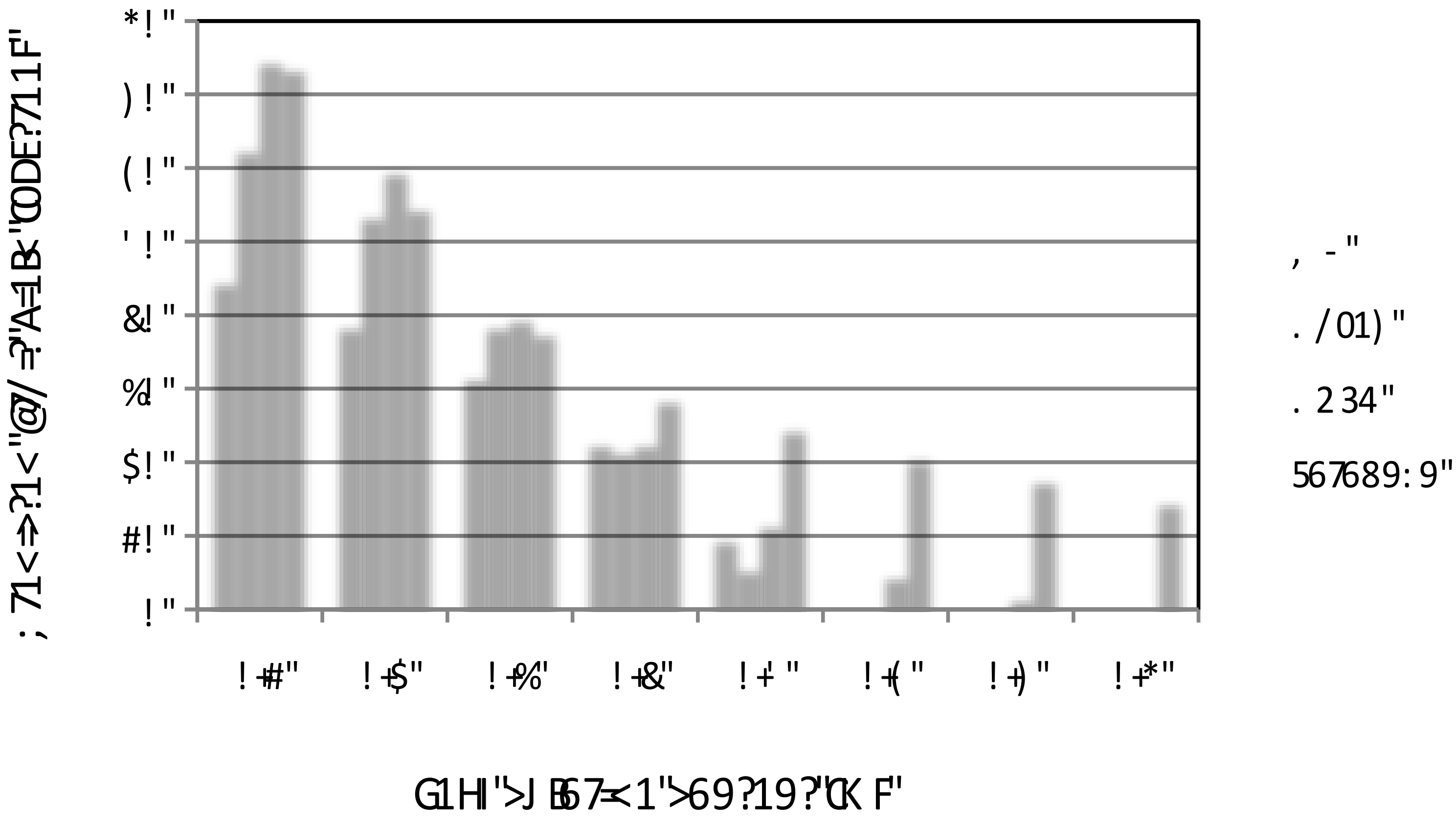
Plant

- rootstock (5 types)
- leaf nutrient contents
- leaf chloride

Output

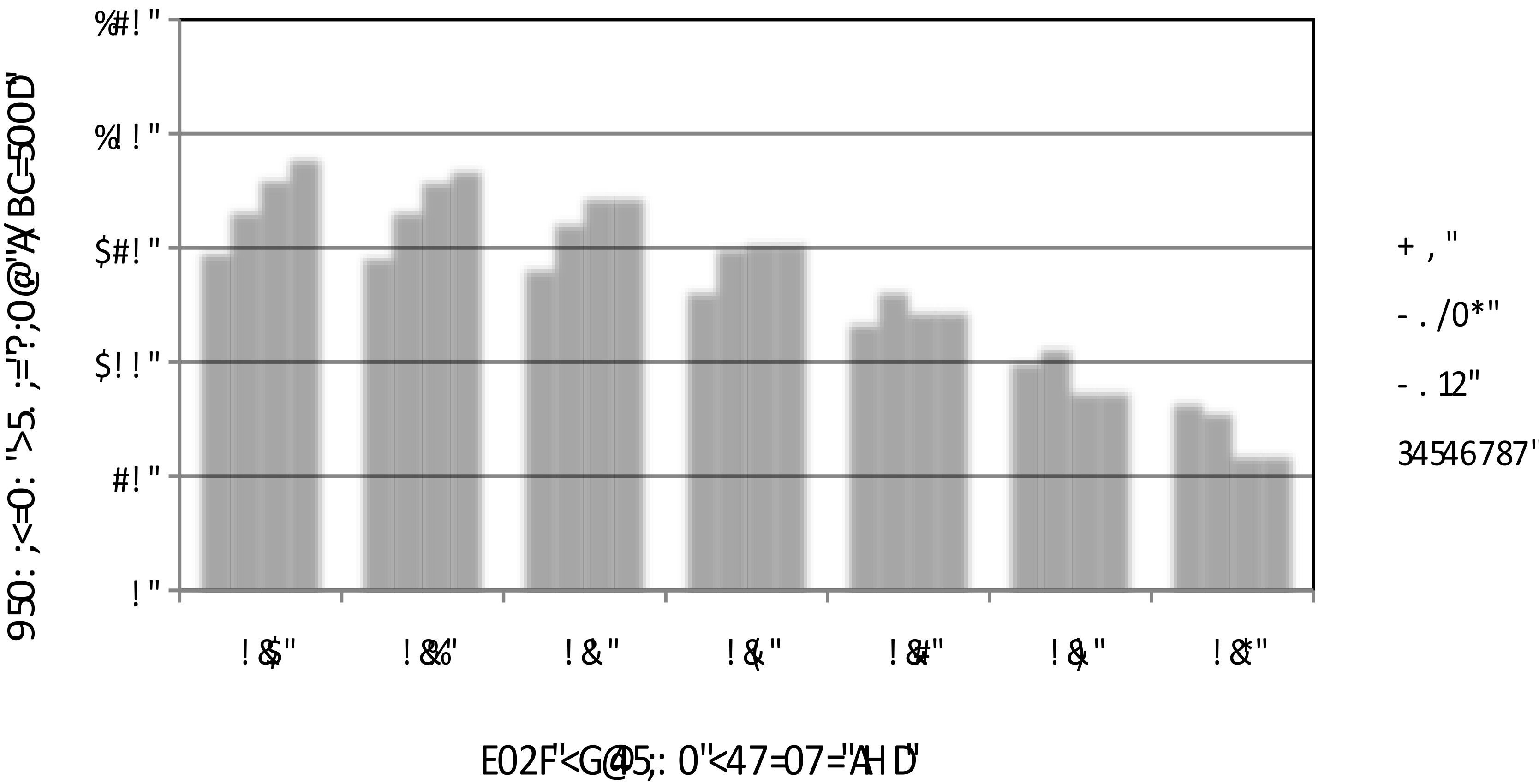
- Root health (root mass, PGPR bacterial densities)
- Fruit yields
- Alternate bearing index
- Water use efficiency (fruit yield/ unit of water)

ANN predicted fruit yields as affected by leaf chloride content for Hass avocado grafted on to different rootstocks under “average” nutrient conditions.



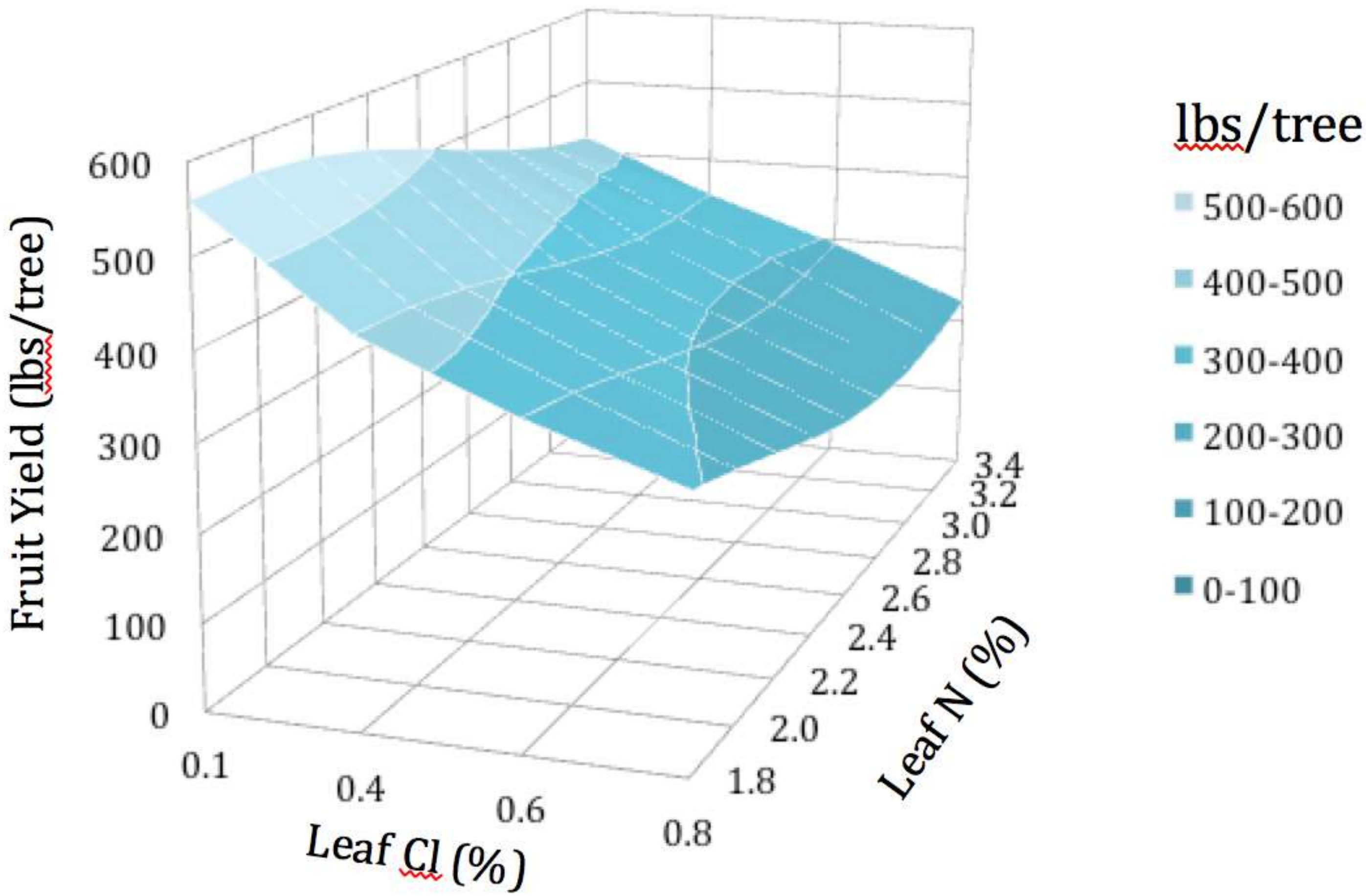
Yield values predicted from an artificial neural network model using fixed values for all nutrients except chloride (values fixed at average levels for entire orchard: N 2.4%, P 0.18%, K 1.2%, Ca 1.5%, Mg 0.4%, Na 0.015%, Zn 30 ppm, Fe 84 ppm, B 40 ppm.

Fruit yield as affected by leaf chloride content for Hass avocado grafted on to different rootstocks under “optimal” nutrient conditions.

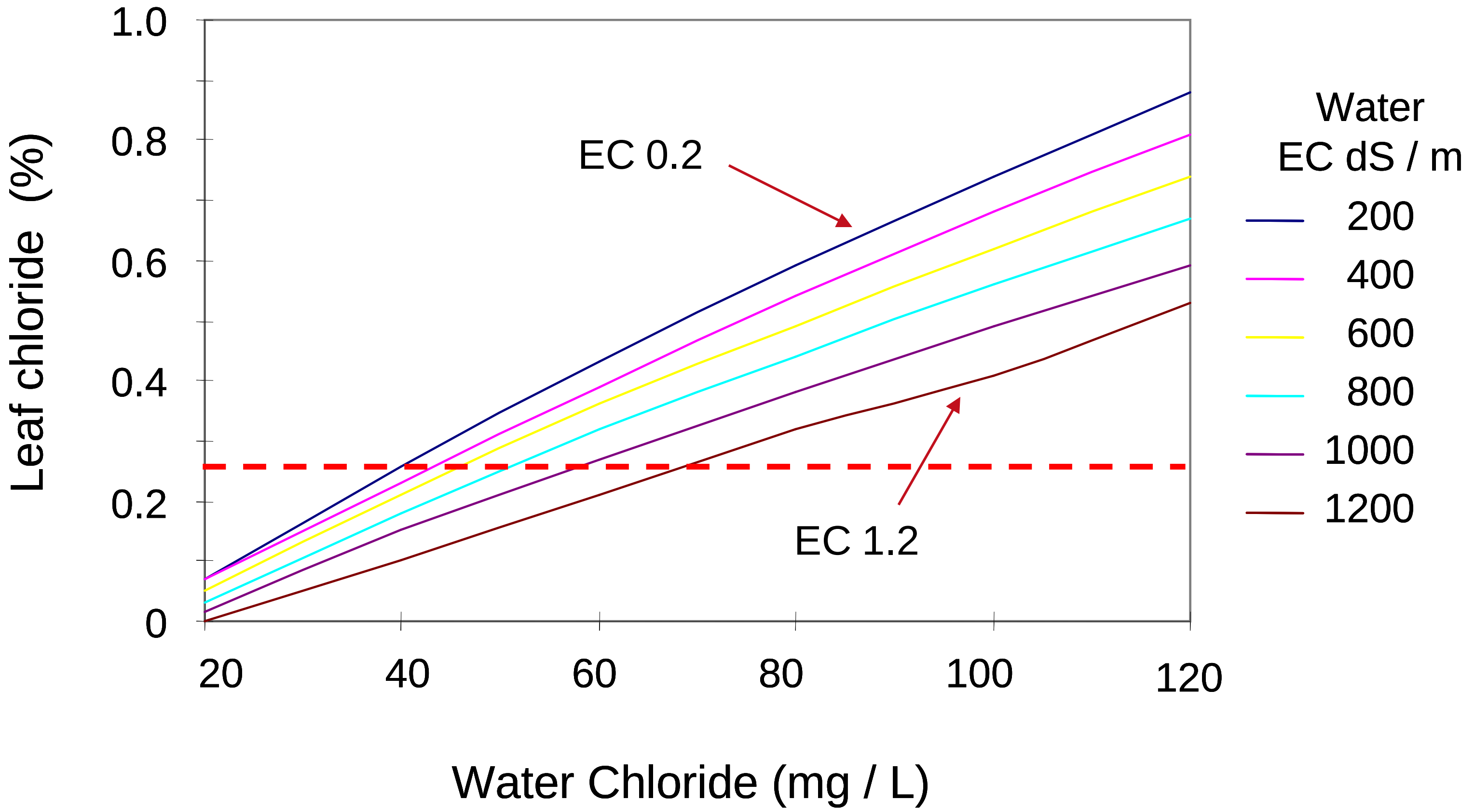


Predicted fruit yield for trees with foliar nutrient values optimized for maximum yields, while varying leaf tissue chloride content for each rootstock. Optimized nutrient levels were N 1.7%, P 0.26%, K 1.3%, Ca 1.14%, Mg 0.28%, Na 0.015%, Zn 31ppm, Fe 100 ppm, B 40 ppm.

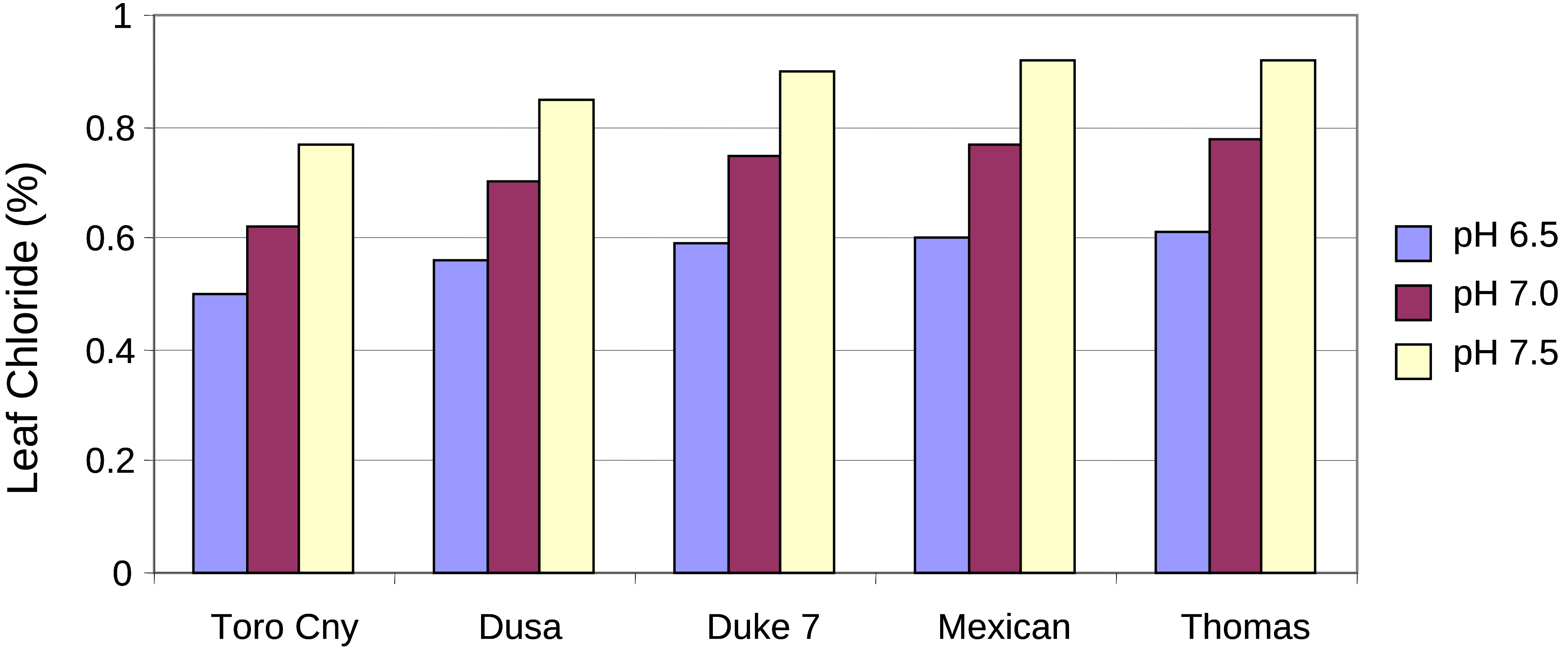
Combined Effects of Increasing Chloride and Excess Nitrogen On Avocado Yields Predicted by ANN Modeling



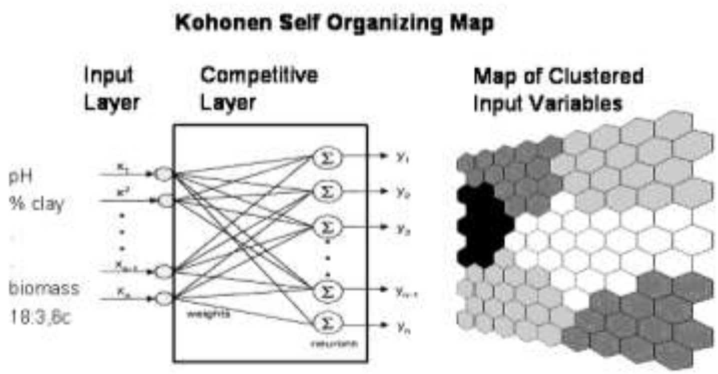
ANN model output illustrating the inverse relationship between irrigation water salinity and chloride concentrations on accumulation of chloride in leaves of Hass on Toro Canyon rootstock. Fixed model values were pH 7, 35% Clay, soil ECe 2.0, and soil Cl at 4 mg/kg

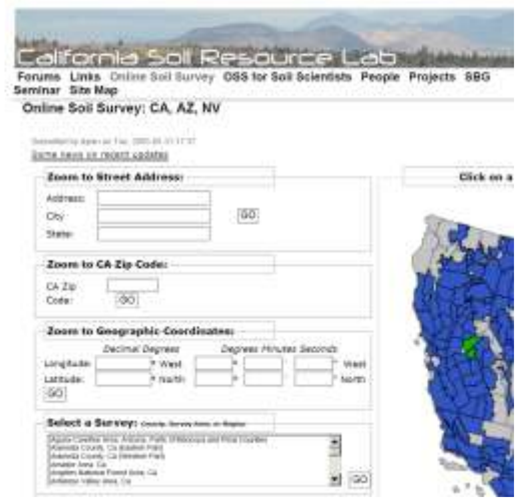


ANN predicted effect of changes in soil pH on leaf chloride content for five avocado rootstocks. Additional parameters were set under relatively harsh conditions that are associated with elevated chloride levels: soil ECe= 4.0 dS/m, soil Cl 8 mg/kg; irrigation water EC 0.8 dS/m; irrigation water chloride = 50 mg/L; soil clay content 50%.



Decision Support Tools for Predicting Yield Based on Soil Chemical and Physical Properties, Fertilization, Root Stock Selection, Fruit Quality, and Optimization of Economic Benefits





Soil and Climate Data

Water Quality Data, Rootstocks Used Yield Data

Questionnaire

Recommendations

Irrigation and Water Use Efficiency

AVOCADOSOURCE.COM | Search | Tools | Site Index: <SELECT PAGE> | Avocado Data

Instructions for the Irrigation Scheduling Calculator

English | Español

Principles of Irrigation | Select a Crop: Avocado

Kc Source: California (New Values) | English Units | Metric Units

Reference Evapotranspiration (ETo): [ ] in./day or period | Data Source: <SELECT SOURCE>

Crop Coefficient (Kc): [ ] Get Kc for a month <SELECT>

Distribution Uniformity (DU): [ ] %

Leaching Requirement (LR): [ ] %

Method: Trees per Acre: [ ] | Tree Spacing [ ] by [ ] ft.

Number of Emitters per Tree: 1

Surface area under tree canopy (ft^2): [ ] (enter only when surface area covered by canopy is less than 65%)

Emitter Output (Gal/Hour): [ ]

Grove Size (acres): 1

All fields with yellow boxes must be filled out, white fields are optional.

Calculate — Click on 'Calculate' after any changes are made to recompute totals.

Water per tree per day or period: [ ] gallons

Watering time per tree per day or period: [ ] hours, [ ] minutes

Total Water Requirements for Grove: [ ] gallons

Allocated Water for Grove: [ ] gallons

Shortfall: [ ] gallons

New Project 2013:

Use of Recycled Water for Irrigation of Avocado

UCR EGAP (Escondido Growers for Agricultural Preservation)

Recycling of gray water for agriculture

- Alternatives: $400 million dollar waste pipeline to ocean
- Recycle and sell water for agriculture

Issues:

- Degree to which water must be treated for avocado?
- Fair pricing
- Subsidies
  - Direct and indirect benefits of agriculture to Escondido

Experiment to Evaluate Recycled Water for Avocado Production

Standard Potable Water
Recycled Water

Vary irrigation water quantities (leaching fraction)
    0.75, 1.0, and 1.25 ET

Measure Cl, B, Na levels in foliage
Measure accumulation of salts in soil

Construct model of toxic element accumulation in relation to irrigation water elemental composition and leaching.

Set threshold levels for water treatment
Determine required leaching fraction.
Build profitability model based on yield losses vs water costs

Summary

Decision support tools are being developed to predict tree fruit crop yields under different salinity, soil fertility, and management practices.

The use of an artificial neural network model allows the separation of nonlinear interactions between variables to examine the relationships between specific individual variables and fruit yield.

The production function model further allows optimization of fertilization programs to maximize production – and suggest that proper fertilization can offset much of the yield loss under mild to intermediate salinity conditions.

Benefits to the Industry

• Cost benefit analysis for irrigation water quality versus fruit yields over the full range of salinity levels that occur in water supplies used by avocado growers.

• Optimization of irrigation regimes for use of saline irrigation waters based on management of chloride versus total dissolved salts.

• Basic information on mechanisms of salinity stress and tolerance in avocado rootstocks. Improved guidance to growers for appropriate rootstock selection.

• Optimization of fertilization and irrigation programs for maximum yields under specific soil, water, and management conditions