Growing Citrus in the North Bay

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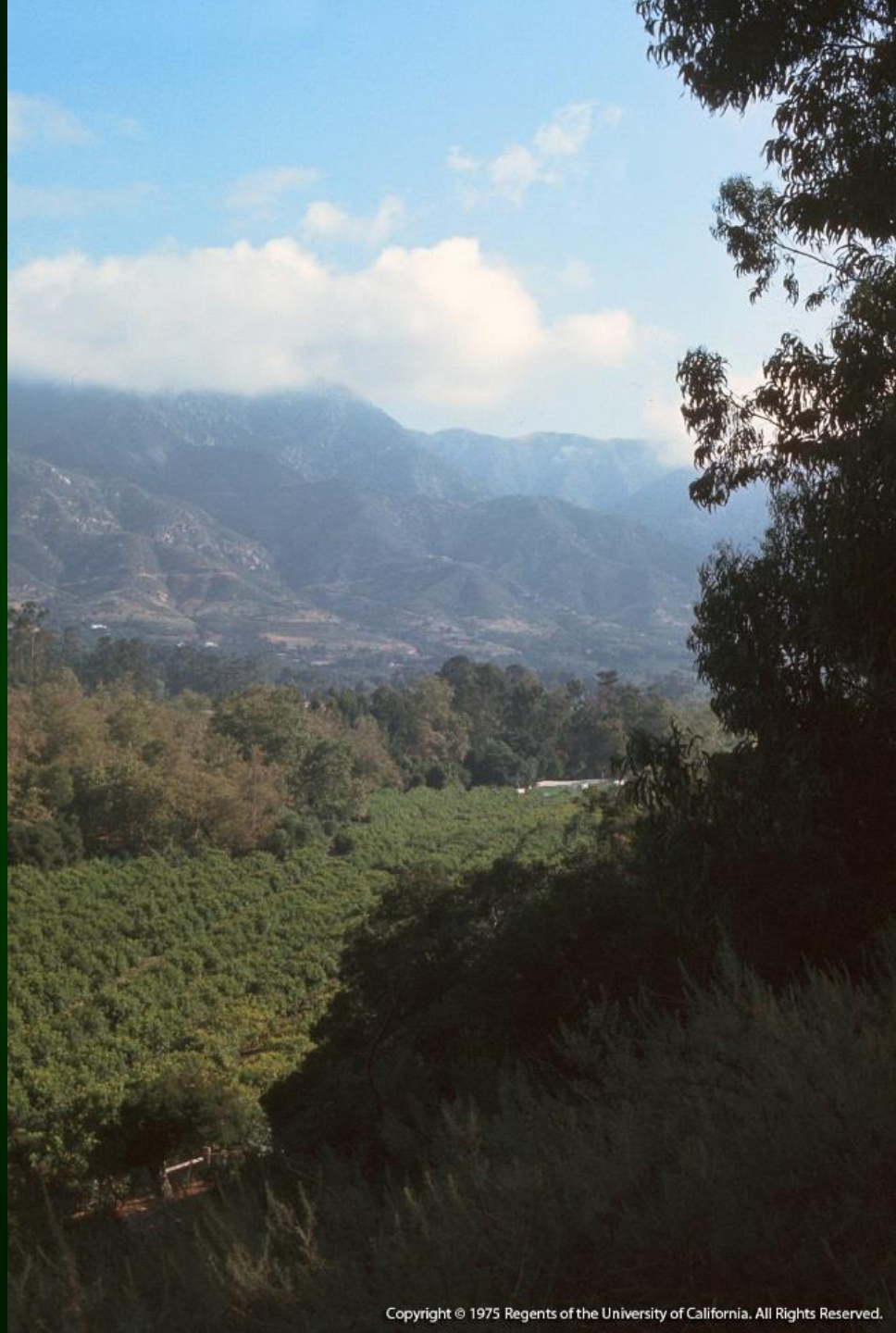
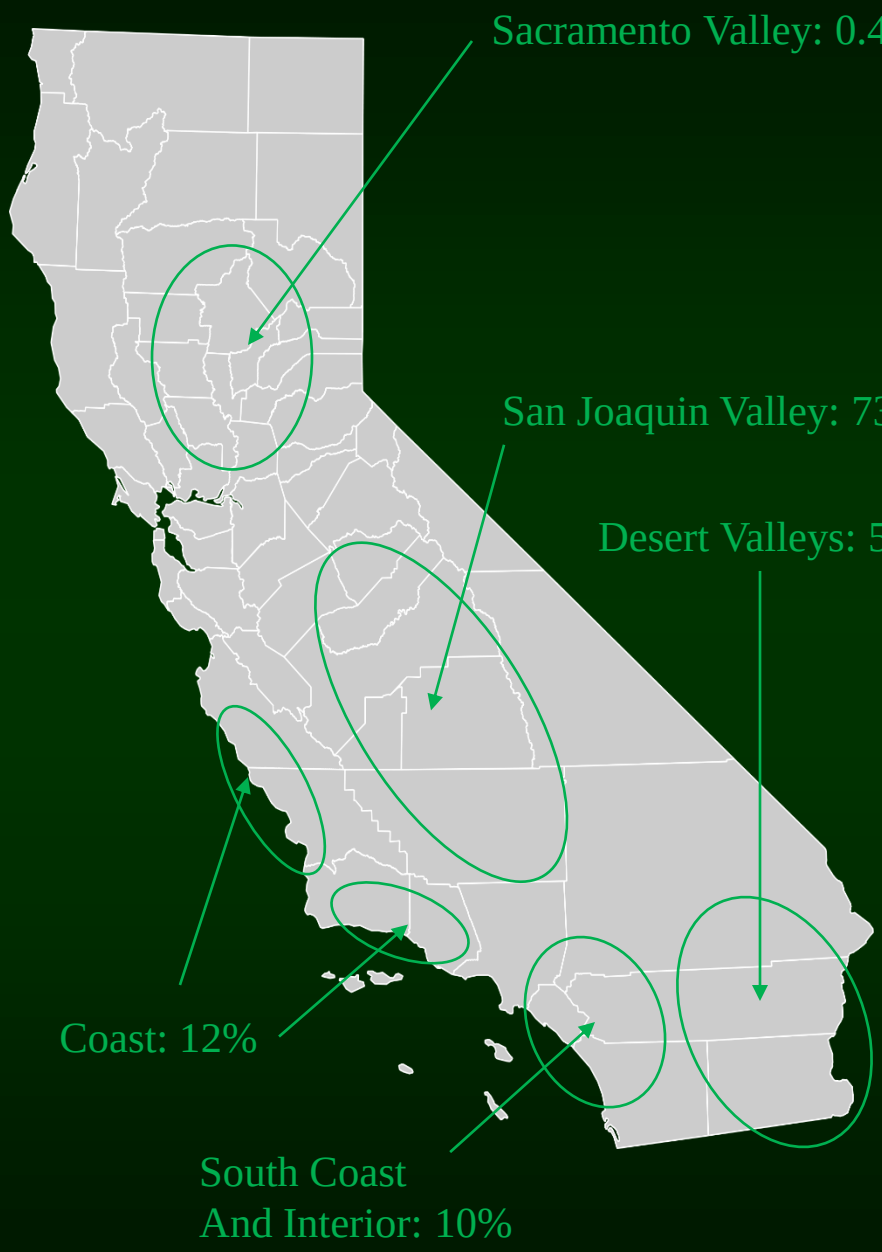
The title is almost an oxymoron

- Where do citrus trees come from?
  - Southeast Asia
  - Burma (Myanmar)
  - Yunnan province of China
  - Northeast India
- In California, we're used to being able to grow anything
  - But California's famous for lots of climates in a small area

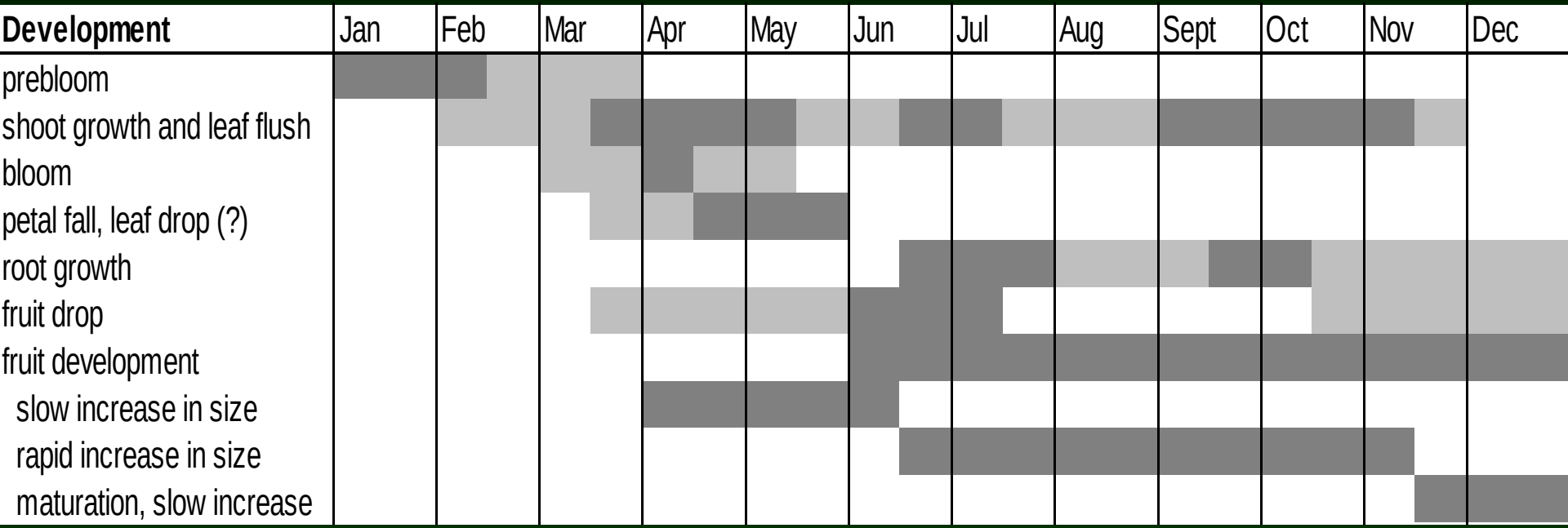


Where is citrus commercially grown?

- Not here …
  - There's probably more than one reason for that
  - Commercial citrus in Sacramento Valley is restricted to hot spots
  - Commercial grapefruit restricted to inland locations with water
    - Why?
  - Citrus is a subtropical plant
    - It needs heat to produce sugar



Citrus development periods



- … for navel oranges grown in San Joaquin County
- The average time of year for each development stage is shown in dark gray, less vigorous development is shown in light gray
- Note *early drop* (light gray), *June drop* (dark gray), and *preharvest drop* (light gray)
- Prebloom: All citrus except lemon essentially stop growing in California's climate (variable due to weather)
- Note that maturation can extend into early May in some citrus varietals in some regions
- Table adapted from *IPM for Citrus, 3rd ed.*, in turn from *Lovatt, in prep*

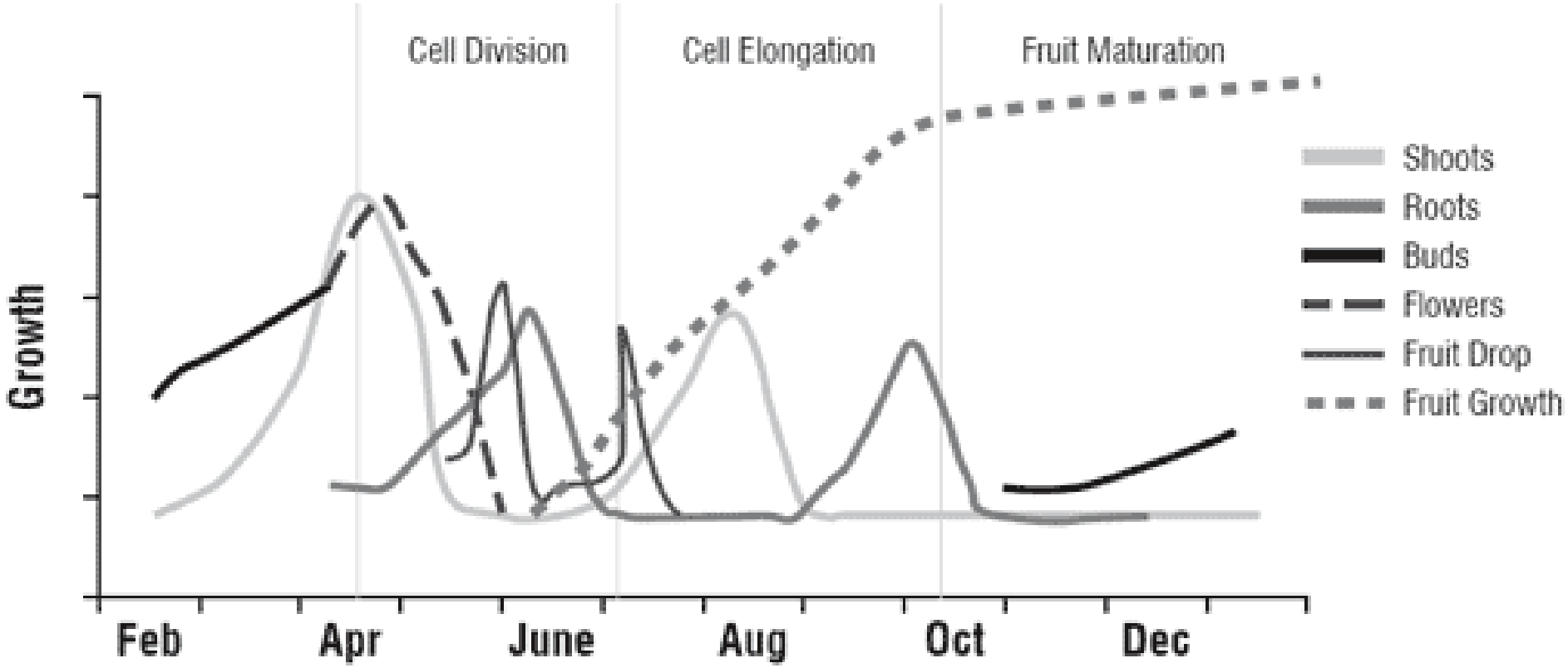


Figure 1. Schematic phenological cycle for citrus in the northern hemisphere.

From: Bower JP (2004) The pre- and postharvest application potential for CropSet and ISR2000 on citrus. Conference paper.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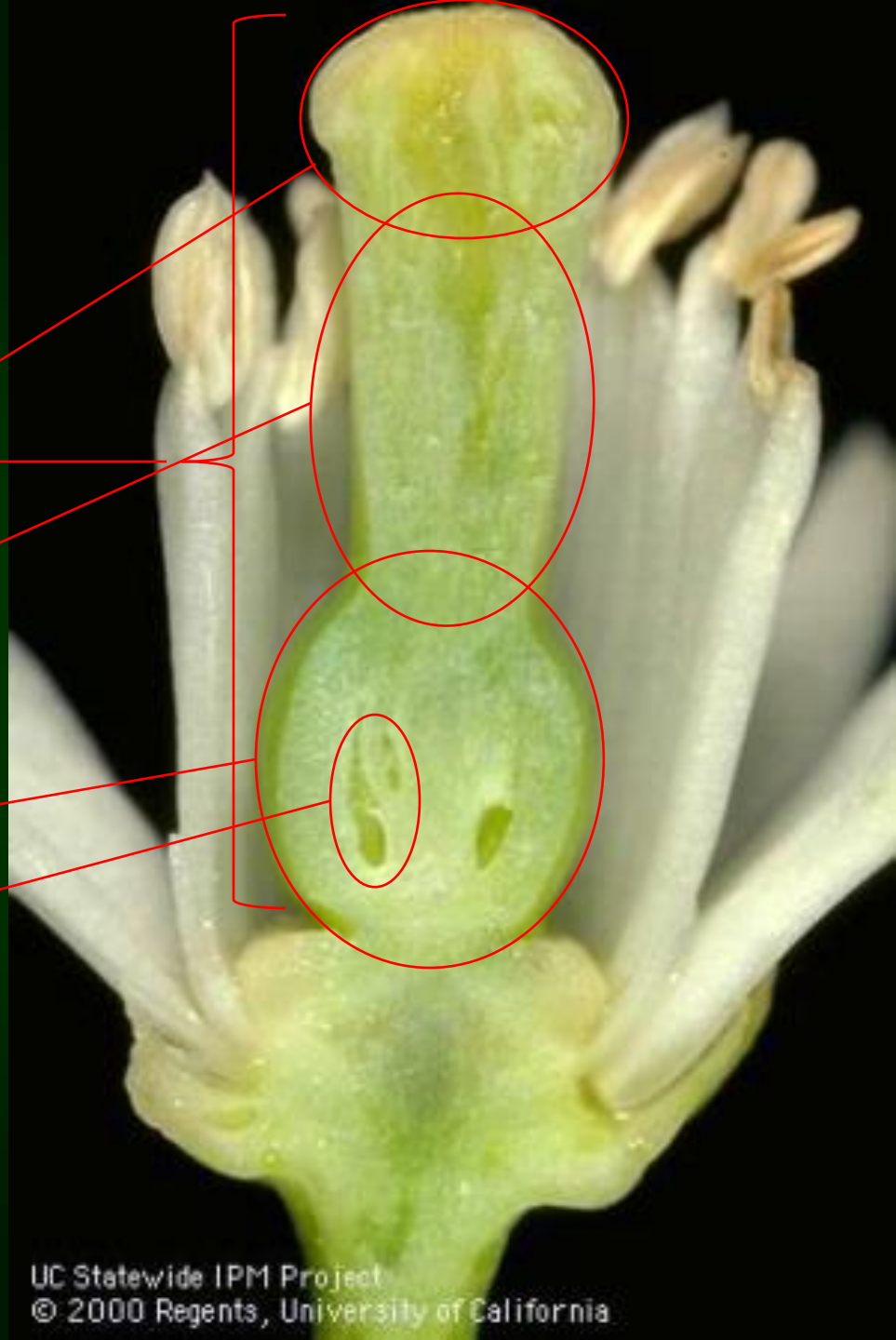
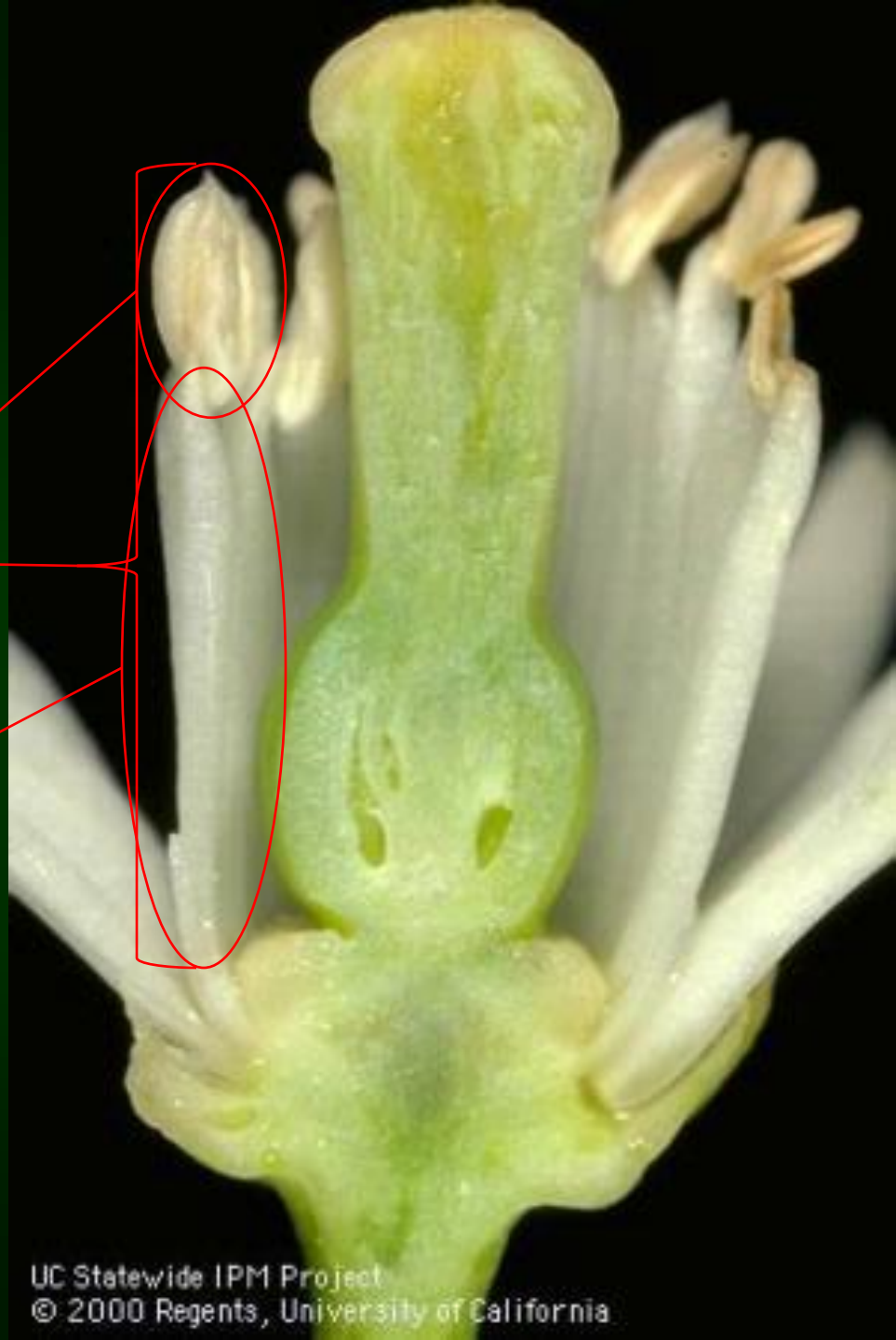
Citrus flower



Citrus flower



Citrus flower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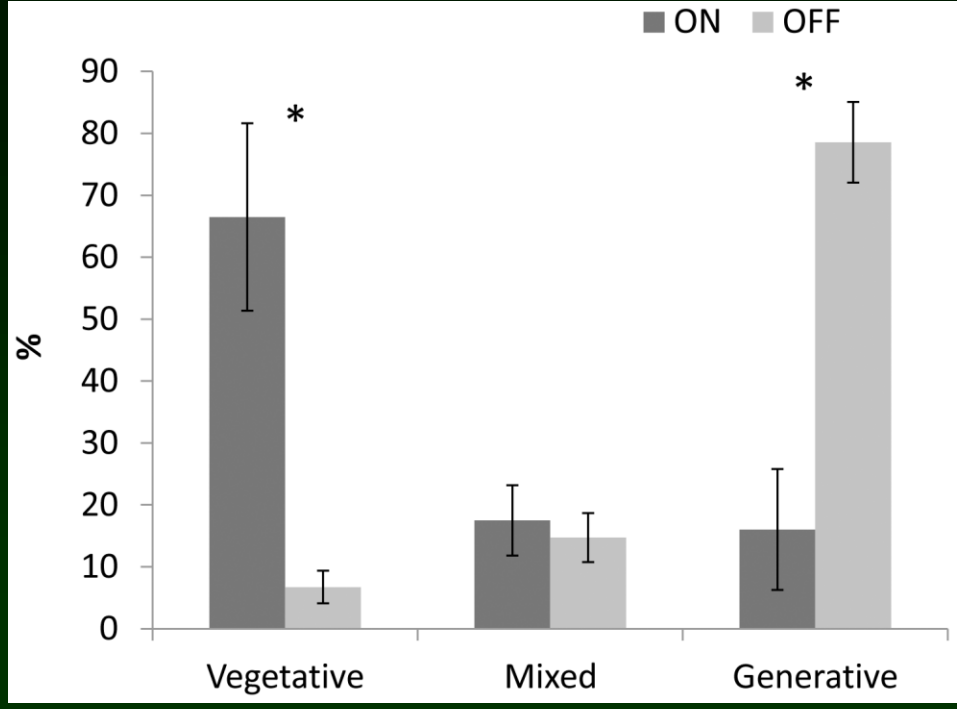
Alternate bearing

- Setting of heavy fruit load one year, followed by a light load the next
- Valencia & Mandarin oranges
- Don’t hold fruit, harvest as soon as ripe
- If necessary, thin fruit in early summer in heavy years



Source: Shalom et al, 2012

- Heavy fruit loads (ON years) suppresses generative primordia, and enhances vegetative primordia.
- Light fruit loads (OFF years) do the opposite

Fruit Thinning
Total yield vs. fruit size

Citrus Types

- Standard – to 20 or more feet!
- Dwarf – to 6-10 ft.
- Meyer lemon (*Citrus meyeri*) is not a true lemon (*Citrus limon*)
  - Was discovered in China in 1908 by Frank Meyer
- Mandarins (tangerines) do well here
  - Satsuma (early enough to miss frost)
  - Pixie (small, hangs well)
- Tangelos and Grapefruit don’t do well

Pollination of Citrus Trees

- Pollenizer: A tree of one variety used to provide pollen to a nearby tree of a different variety to produce fruit

- Pollinator: An insect (usually a bee) that carries pollen from one tree or flower to another

Pollination of Citrus Trees

- Most varieties are self-fruitful (no pollinizer required)
- Navel oranges and some mandarin varietals do not produce viable pollen
  - Some mandarins fruit better when a pollinizer is available
  - Seed production in mandarins is variable
    - See IPM for Citrus, p.8, or Kahn 2007
  - Navel oranges don’t require fertilization

Citrus needs heat

- Cool weather can inhibit nutrient uptake
  - Winter and spring
  - Shows as nutrient deficiency
  - Soil tests okay
  - Disappears with the onset of warmer weather
  - In Marin, the chlorosis may be less marked along the veins
- Sunlight is related to heat …

Sunlight Requirement

Minimum of

6 hours per day in February

Citrus Frost Hazard

Frost damage

- Susceptibility varies with species
- Always a risk in inland areas
- Foliar symptoms:
  - Scorching of upper, lower, or exposed leaves
  - Newer growth may be more susceptible
- Worse if tree is drought stressed
  - Water in November?

Frost damage to fruit

- Typically appears after leaf symptoms
  - No leaf symptoms? Not likely frost damage
- Can mask internal damage
- Note: this slide shows two fruits with frost damage symptoms
- The next slide shows one healthy fruit, and one with frost damage

Frost damage to fruit

- Severe enough frost damage resuts in dry fruit
  - (Bottom)
  - Remember what we said about water?
- Note: can also result from under-watering
  - Drought makes frost damage much more severe
  - Citrus trees will sacrifice the kids if they have to
    - Look for the “I’m spending my children’s inheritance” bumperstickers on the RV

“Holiday” Tree Lights for Warmth

Cold Hardiness of Citrus Varieties
(Temp. below which tree damage occurs)

- Mexican Lime 29
- Bearss Lime 28
- Regular Lemon 26
- Grapefruit 25
- Meyer Lemon 22
- Sweet Orange 21
- Mandarin / Tangerine 20
- Kumquat 19

Citrus *needs* cold?

- Well, sort of …
  - More like “chill”
- Rind color depends primarily on:
  - Nutritional status of the tree
  - Sufficiently low night-time temperatures (below 55 deg F)
    - Oranges grown in the tropics often have green skin

What else does it need?

- Water: citrus likely needs some summer irrigation
  - Climate dependent
  - Overwatering leads to root rots
- Soil: well-drained soil is imperative
- pH: 6.5-7 (slightly acidic)
  - If soil pH is off, plants will exhibit nutrient deficiencies

Soil Considerations for Citrus

- Roots are generally shallow (1-2 ft.)
- Good drainage essential
- Avoid heavy clay soils
  - Raised beds or containers?
  - Plant high
- Tolerant of sandy soils with less nutrient capacity
  - Better with some fertilization
  - Loams best

Serpentine Soils

- Green rocks
  - Break down into red clays
  - Not all red clays are serpentine
- California's state soil
  - Common in Marin
  - Esp. around Belvedere
- Calcium vs Magnesium
  - Most soils 4 or 5:1
  - Serpentine: 2 or 3:1
  - Result: Calcium deficiency

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1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 16-238-123 **CLIENT NO:** 99999

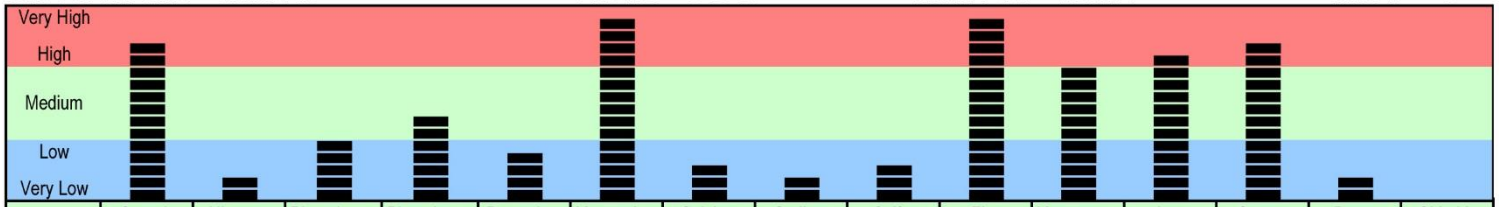
SEND TO: PETER NORTON
2060 CENTRO EAST
TIBURON, CA 94920-

GROWER:

SUBMITTED BY:

Graphical Soil Analysis Report

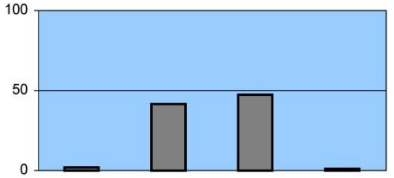
DATE OF REPORT: 09/07/16 **LAB NO:** 51813 **SAMPLE ID:** HOME **PAGE:** 1



Analyte	Organic Matter %	Nitrogen NO_3-N ppm	Phosphorus Weak Bray ppm	Phosphorus $NaHCO_3$-P ppm	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Chloride Cl ppm
Results	7.0	4	17	21	163	1094	2054	64	6	14.8	22	24	3.3	0.4	

LOW AVERAGE HIGH

Percent Cation Saturation (computed)



Potassium K %	Magnesium Mg %	Calcium Ca %	Sodium Na %
1.9	41.7	47.5	1.3

ACIDIC BASIC

ECe dS/m	CEC meq/100g	Ex. Lime	pH
0.5	21.6	L	6.5

INCREASING SALINITY →

← INCREASING NEED FOR LIME

Buffer pH:

Soil Fertility Guidelines

CROP: **RATE:** lb/1000 sq ft **NOTES:**

Dolomite (70 score)	Lime (70 score)	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B	
		90		3.0	2.0	4.5								

COMMENTS

SOIL SALINITY REPORT indicates that sodic or saline conditions do not exist and that pH is satisfactory. Therefore, gypsum or other chemical amendments may not be necessary at this time.

MAGNESIUM: If levels are very high (generally, they increase with depth), one may encounter drainage problems and potassium uptake may be hindered. Extra calcium may provide some benefit.

MAINTENANCE: Split the above amount over the year at a time according to local conditions and requirements. Choose a source that best fits this combination and avoid applications in winter.

MICRONUTRIENTS: Where levels appear to be high, avoid any further applications for the time being. Very high (VH) levels may not necessarily be toxic, but avoid. Maintain correct soil pH.

Phoebe Gordon, PhD
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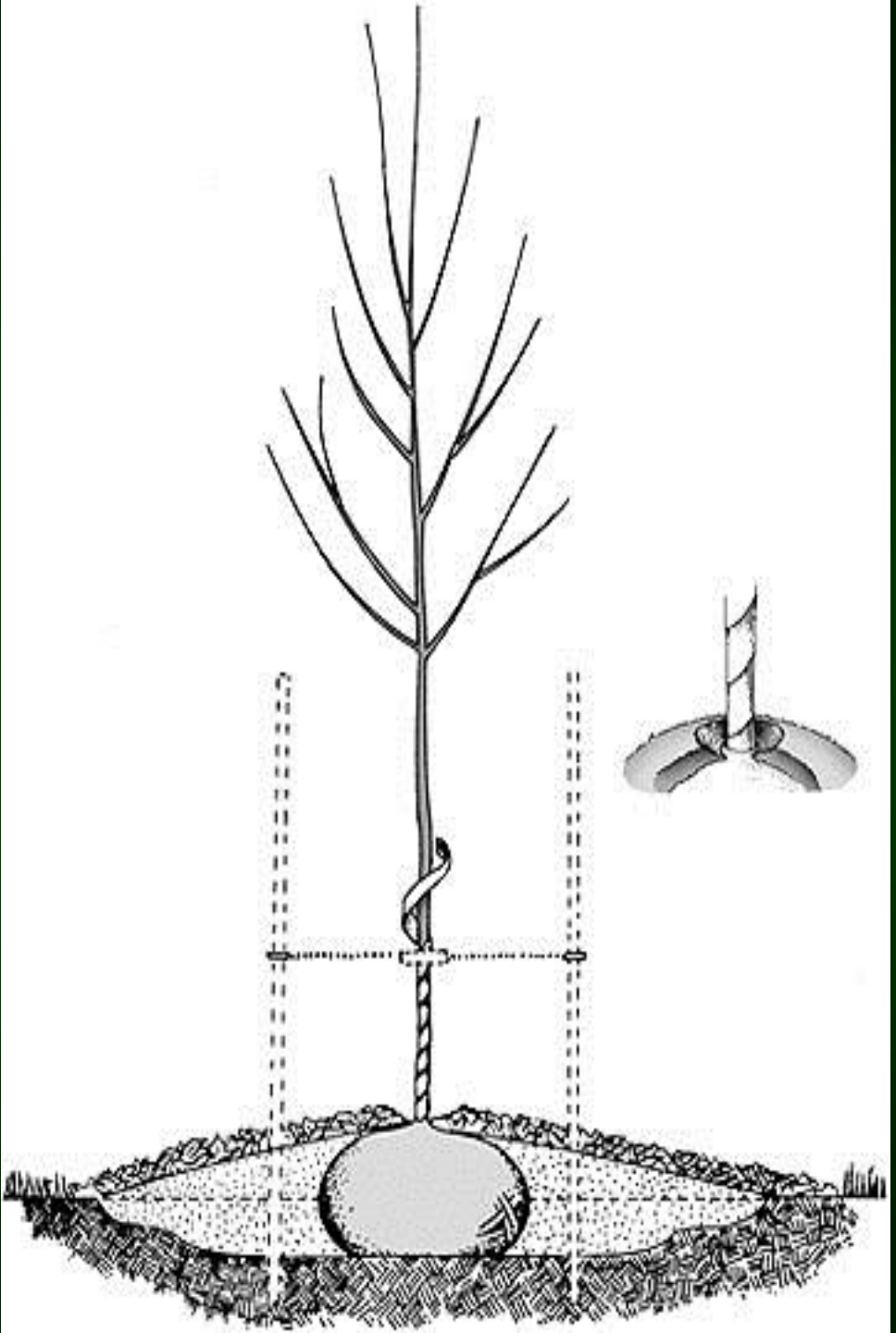
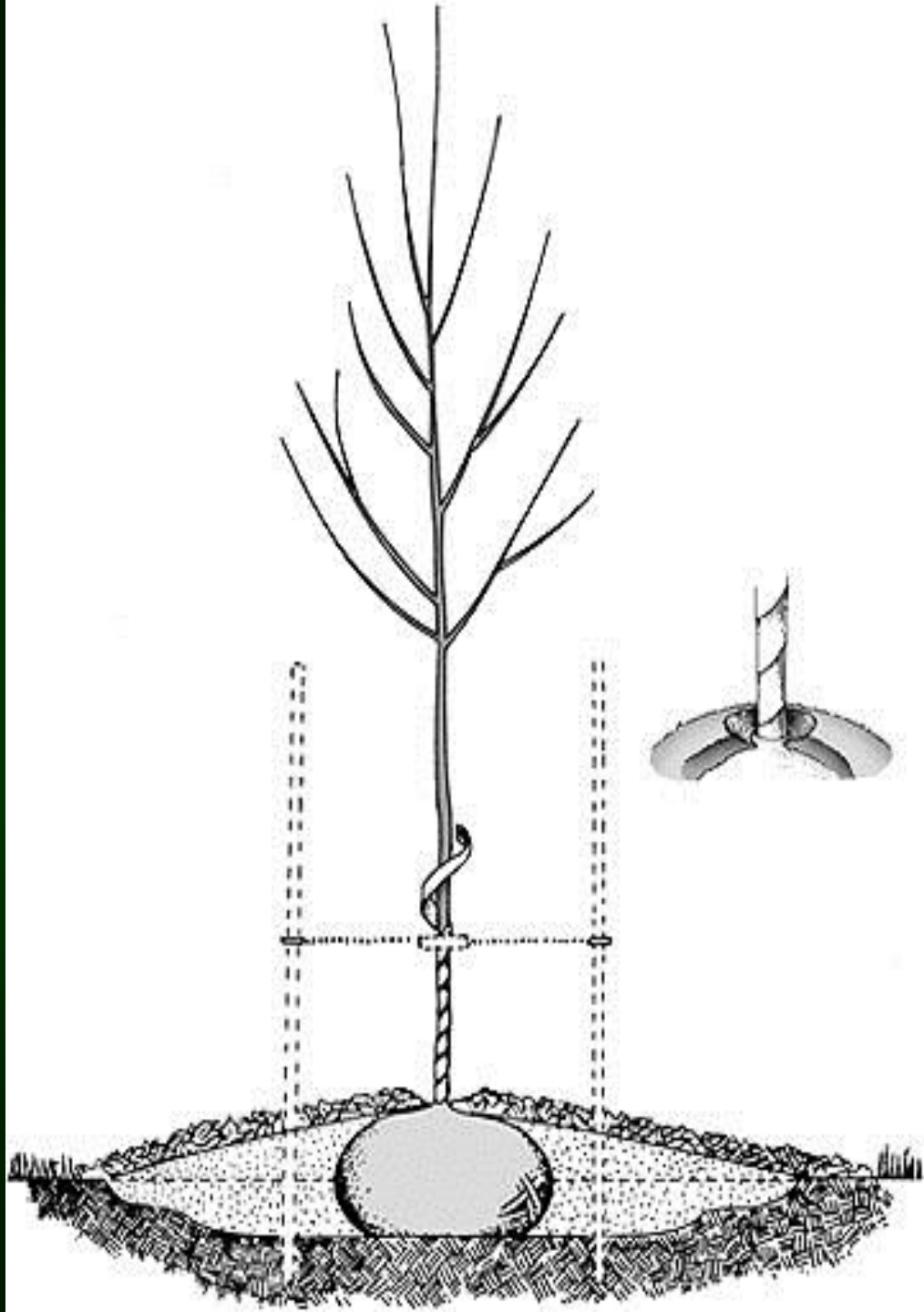


Planting Trees

- Check roots, cut off dead or damaged
- Hole size: Wide & shallow. Deep only if compacted
- Plant on mound to keep crown dry
- Plant high! – Reduces chances of crown & root rot
  - Upper roots just below ground, graft union well above soil
  - Allow for soil settling

Soil Amendments

- None in planting hole
- Compost can be incorporated into soil above grade if you wish
- Un-composted amendments should be incorporated months before planting
- Avoid pockets of undecomposed organic matter in heavy soils
- Add mulch or compost to surface



A deep hole is a grave

Dig a wide hole

Planting a Bare Root Tree

Or one you've rinsed of soil

Dig wide, shallow hole

Backfill and lightly tamp soil

Emitters: ~1 ft. away
Next year: move to dripline

Planting a Containerized Tree

Water in

Don’t cover soil in pot

Pull out circling roots

Post-Planting Irrigation

- Water in after planting
- In heavy soil, do not water in if soil wet
  - Anaerobic conditions → dead roots
- Drip emitters ~1 ft. away from trunk, or doughnut basin around tree

Irrigation

- Best = drip and microsprinkler irrigation
- Also, furrow, doughnut ring, sprinkler
- Worst = in a lawn
- Water should reach >1 foot deep
- A 2-year-old tree can use about 2 gal./day
- A mature tree can use >50 gal./day

Drip Irrigation

Mulch pulled back


Microsprinkler

Irrigating mature citrus

- Water required to make sugar
  - Up to 50gal on a hot July day
  - Mostly used for cooling / transport
- Soil should remain moist 1 foot down
  - This can be a challenge in clay soils

Irrigating mature citrus

- Chronic drought and/or frost cycles can induce decline
- Often takes the form of diseases
  - But the disease is just a symptoms of underlying problems

Citrus in Pots?

- It can work for a long time if you:
  - Have a warm, sunny location that isn't too exposed
  - Use a dwarf variety
  - Remove the tree from the container every year
  - Prune the roots
  - Replant with fresh soil
  - Water consistently
  - Fertilize as needed
  - Banzai! <sic>

Image: growingfruit.org

Citrus in Pots?

- Root-binding
  - Hormones that regulate bud growth are made in the roots
  - Vise versa
  - Small shoot growth suggests root problems
  - Leaf scorch *in potted citrus* suggests the plant is going from too wet to too dry on a routine basis
    - This can cause calcium deficiencies
    - Chlorosis

Citrus Pruning

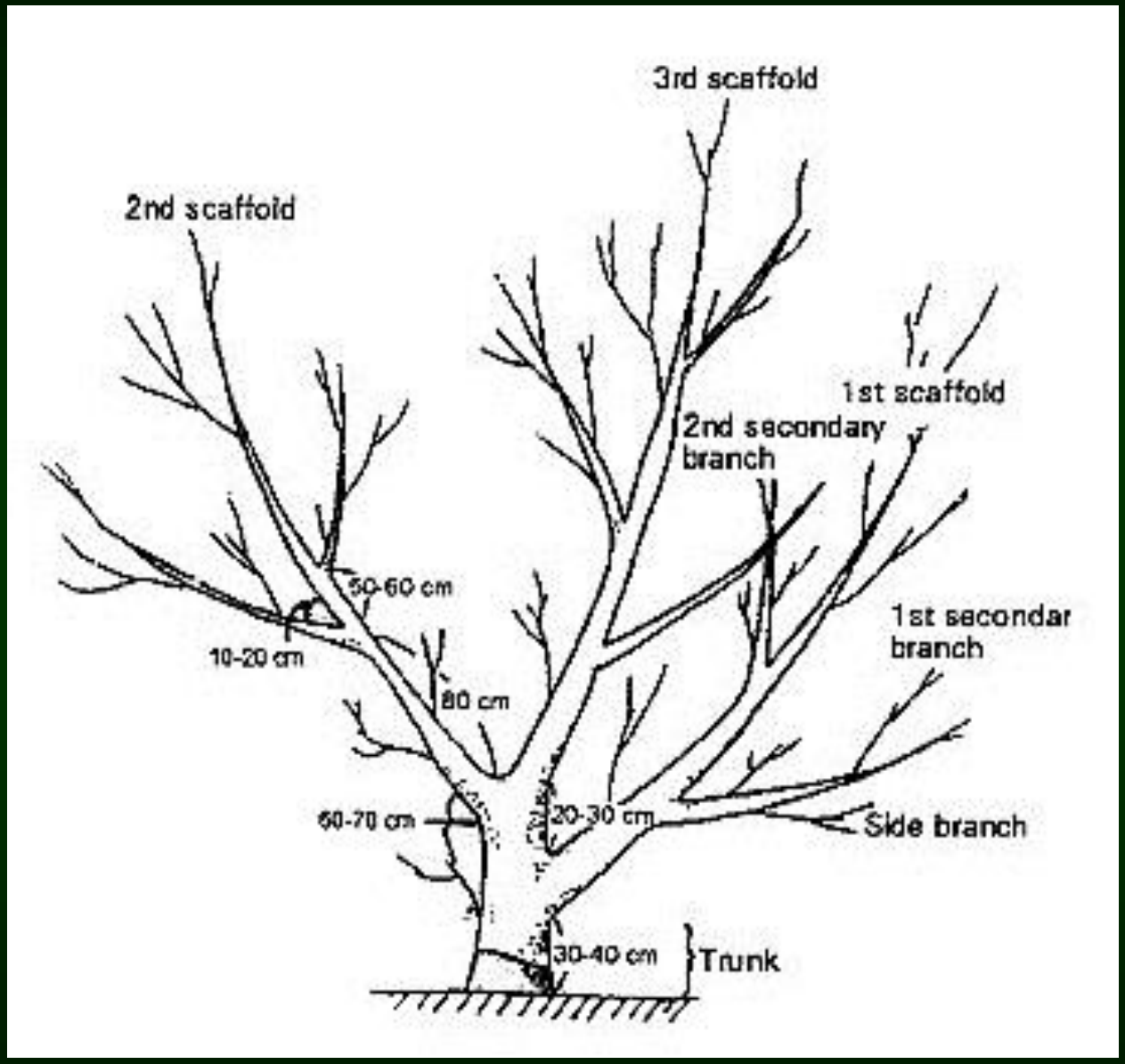
- Little required – shaping, dead wood
- Timing – early spring after frost is best
- Head or remove strong upright shoots
- Keep “skirts” pruned up off ground
- Tall trees: reduce height over 3-years, whitewash exposed limbs
- Can prune fairly severely to reshape and reinvigorate tree

Open Center

- Most common method for citrus (and olive)
- Best sunlight penetration
- Easiest harvesting
- Not strongest structure
  - There are better styles for big trees
- Select scaffolds
  - first 2 growing seasons
  - touch up in dormant season
- Keep center open during summer <u>from the start</u>

Ideal open center structure

- Radial balance
- Vertical separation
- Strong enough if done right



Must have both radial and vertical branch separation, with wide crotch angles

Good radial separation but poor vertical separation … leads to this

Pruning response

- Wild citrus have thorns
  - Bred out of cultivars
- Stressed plants tend to revert toward wild type
- Pruned citrus may therefore develop thorns
  - Cultivar specific
  - Reversion tends to stay with the plant (like drought stress)
  - Don’t prune too severely!
  - You can prune thorns …

Suckers…

vs.

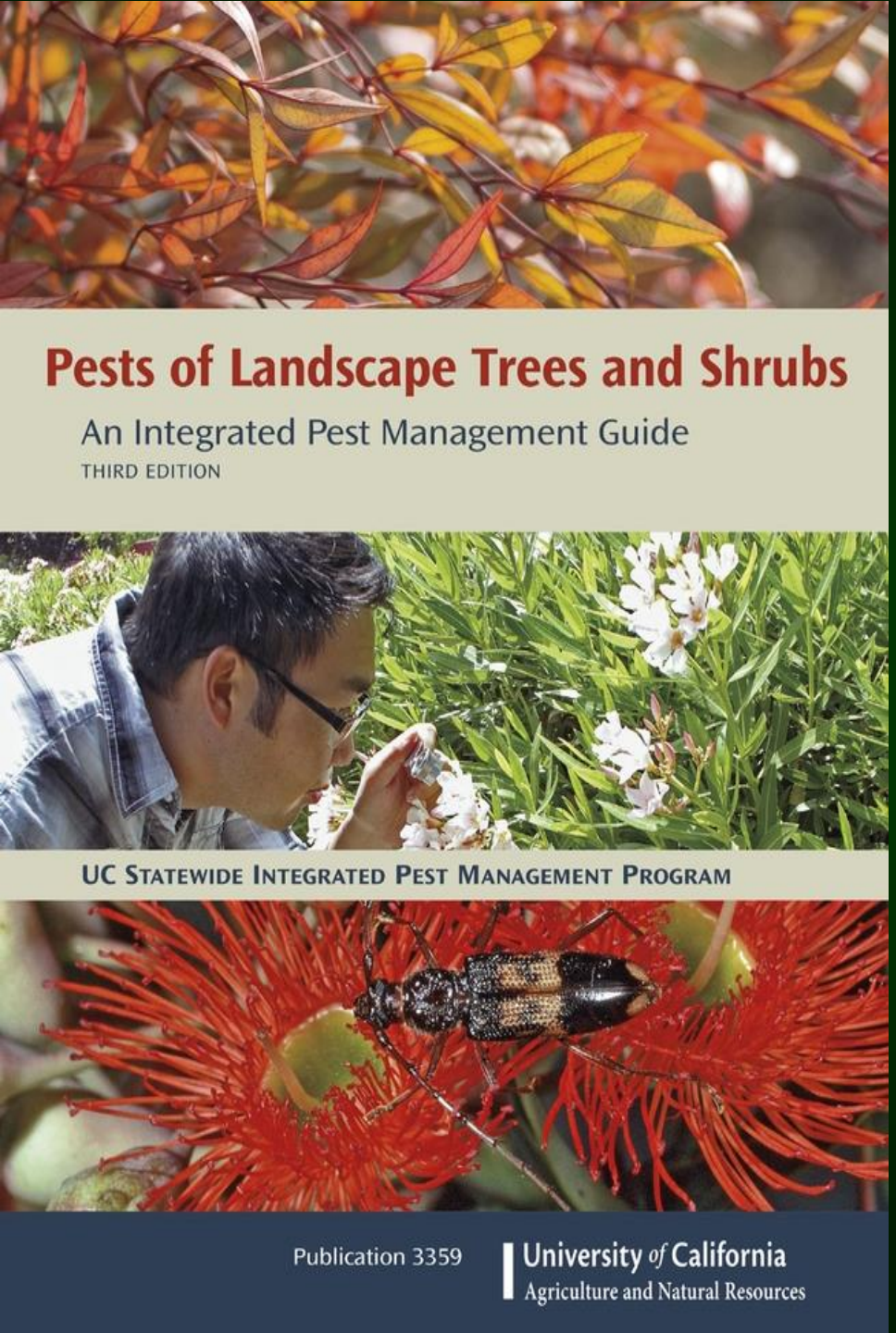
… water sprouts

The problem with suckers

- Grafts are never as compatible with the rootstock as its own leaves are
- If allowed to remain, the rootstock will outcompete the scion
- Lousy fruit
  - Pumelo
  - Sour orange

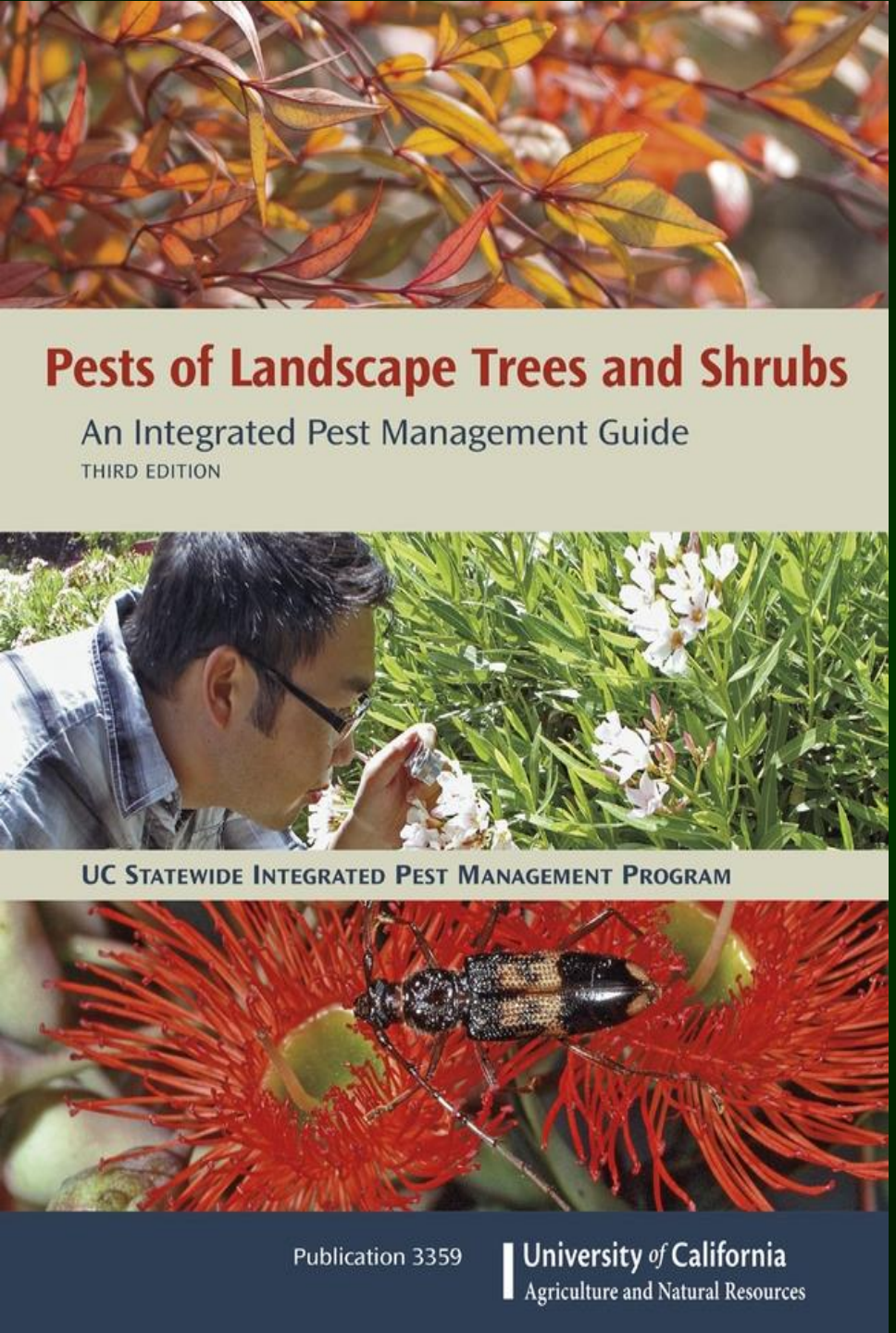
Watersprouts

- Frequently a response to overpruning
  - The tree wants to be bigger
  - Sometimes a response to release (removal of factors limiting growth)
    - Transplanting
    - Removal of shade
    - New sources of water & nutrients
- Will bear good fruit
- Leave if they have decent structure and space?



A word about IPM

- An integrated approach to least toxic pest management
  - This means using more than one technique
  - Spend time in your garden
  - Get to know your
    - Plants, both good and bad
    - Pests
    - Beneficials
    - Understand how your management decisions affect balances
    - Consider giving up some control
- http://ipm.ucanr.edu



… and about today

- Citrus subject to many pests and diseases
  - Like most trees grown world-wide
- We can't cover them all
  - Today we focus on stuff we don't see on everything else
  - So while citrus get both Armillaria and Phytophtora root rots, we'll focus on other things
- http://ipm.ucanr.edu

Slugs and snails

- What they need:
  - Water (humidity)
    - Subsurface drip
  - Day-time shelter
    - Boards, free pavers, etc.
- Modify habitat
- Bait and trap
  - Iron Phosphate

Slugs and snails

- Sharp-tailed snake
  - *Contia tenuis*
  - Rust to brown top
  - B&W striped belly
  - Few other markings
- Hides where slugs hide
  - Because it eats them
  - Easily mistaken for an earthworm or slender salamander
  - Shy and totally harmless to people
  - Take care when landscaping
- Cover your pool

Slugs and snails

- Other predators
  - Predatory ground beetles
  - Rove beetles
    - These also hide where slugs hide
  - Chickens!

Leafrollers

- Tortricidae
  - Small, bell-shaped moths
  - Many species here
    - Orange tortrix
    - LBAM
    - Fruit tree leafroller, etc.
- Management:
  - Diverse flowers
    - Small flowers throughout year
    - Xerces society
  - Clean gardens
    - Damaged fruit harbors pests
    - Remove tied / damaged leaves
    - Many weeds harbor leafrollers
  - Sprays?
    - Horticultural or neem oil in winter
    - Bt

Scale

- Small insects
  - Immobile
  - Sucking mouthparts
  - “Mine” trees for nitrogen
  - Excrete pure sugar (honeydew)
  - Black sooty mold grows on the honeydew, making leaves and fruit look like …

Scale

- … this.
- Management:
  - Control ants
  - Check for signs of parasitism

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Scale

- … this.
- Management:
  - Control ants
  - Check for signs of parasitism
    - If you find parasitism, don't spray!
  - This usually does the trick, but if it doesn't
  - Check UC IPM before spraying
    - Bees!
    - Best products and timing may be species specific

Citrus leafminer

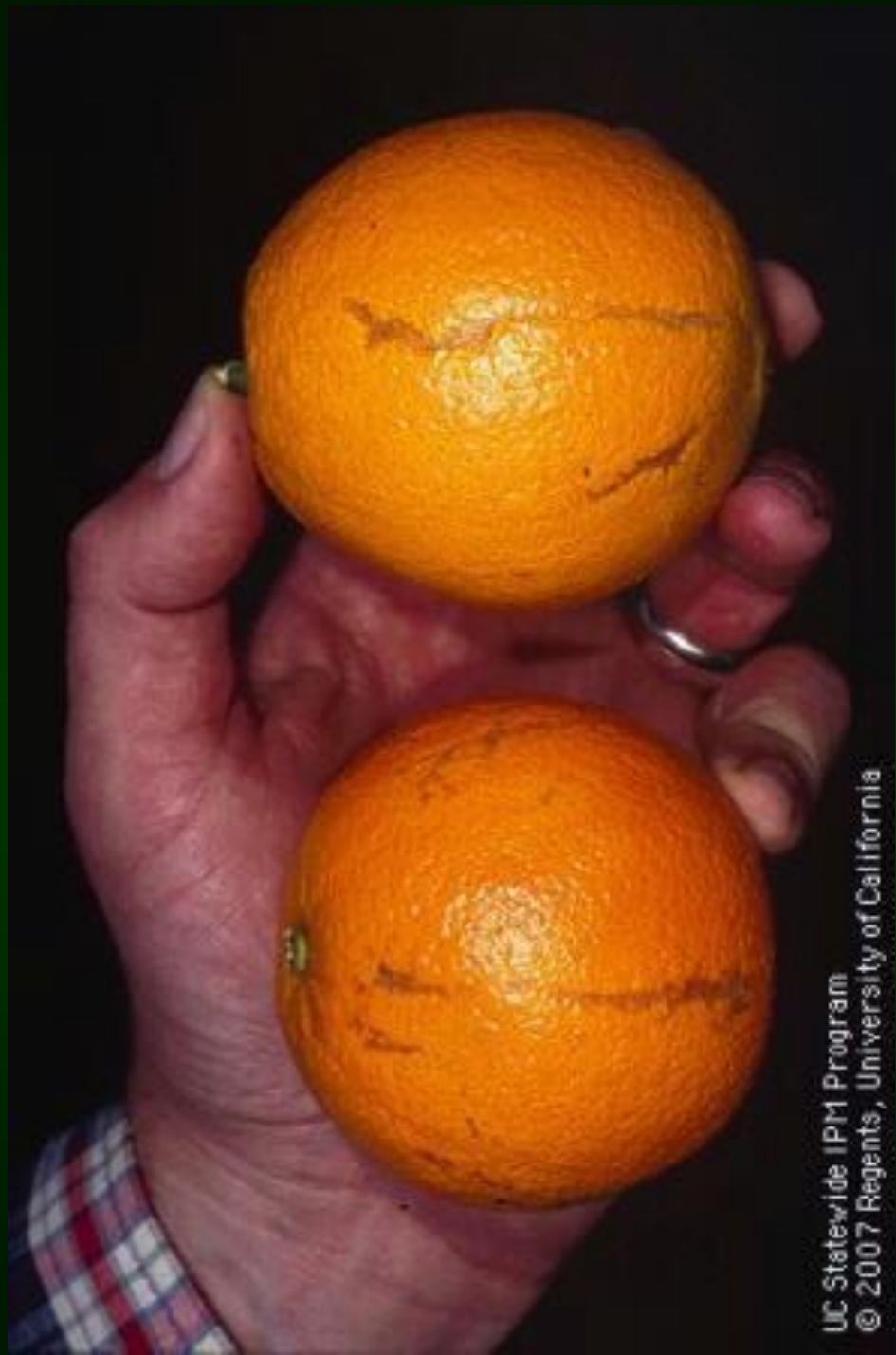
- *Phyllocnistis citrella*
  - A tiny moth
- Arrived in Marin Co. in summer of 2015
- Larvae tunnel inside leaf
  - Very small & translucent green
    - Wasps parasitize larvae
    - Wasps are black or opaque tan
  - Leave a trail of mucus and excrement in tunnel center
  - Only infests NEW leaves

Citrus leafminer

- Don’t prune infested leaves right away
  - Increases damage
  - Some leaves still work
- Management
  - Diverse garden
    - Tiny wasps in Marin effectively control the problem
  - If parasites present:
    - Keep infested leaves
    - If pruned off, let them sit at base of tree so larvae can hatch
  - No parasites?
    - Spinosad if trees aren’t in bloom

Septoria / Anthracnose

- *Colletotrichum gleosporioides* and *Septoria citri*
- Chiefly in areas with cool wet weather
- Cultivars vary in susceptibility
- Mostly affects rinds of fruit
  - Some leaf damage in prolonged cool wet weather
- Management generally not required



Botrytis

- *Botrytis cinerea*
  - A fungal pathogen
  - Thrives in cool, wet conditions
  - Mostly affects lemon and Valencia oranges
  - Worst near the coast
  - Symptoms variable
    - Dead buds
    - Twig and branch gummosis
    - Scarring of fruit

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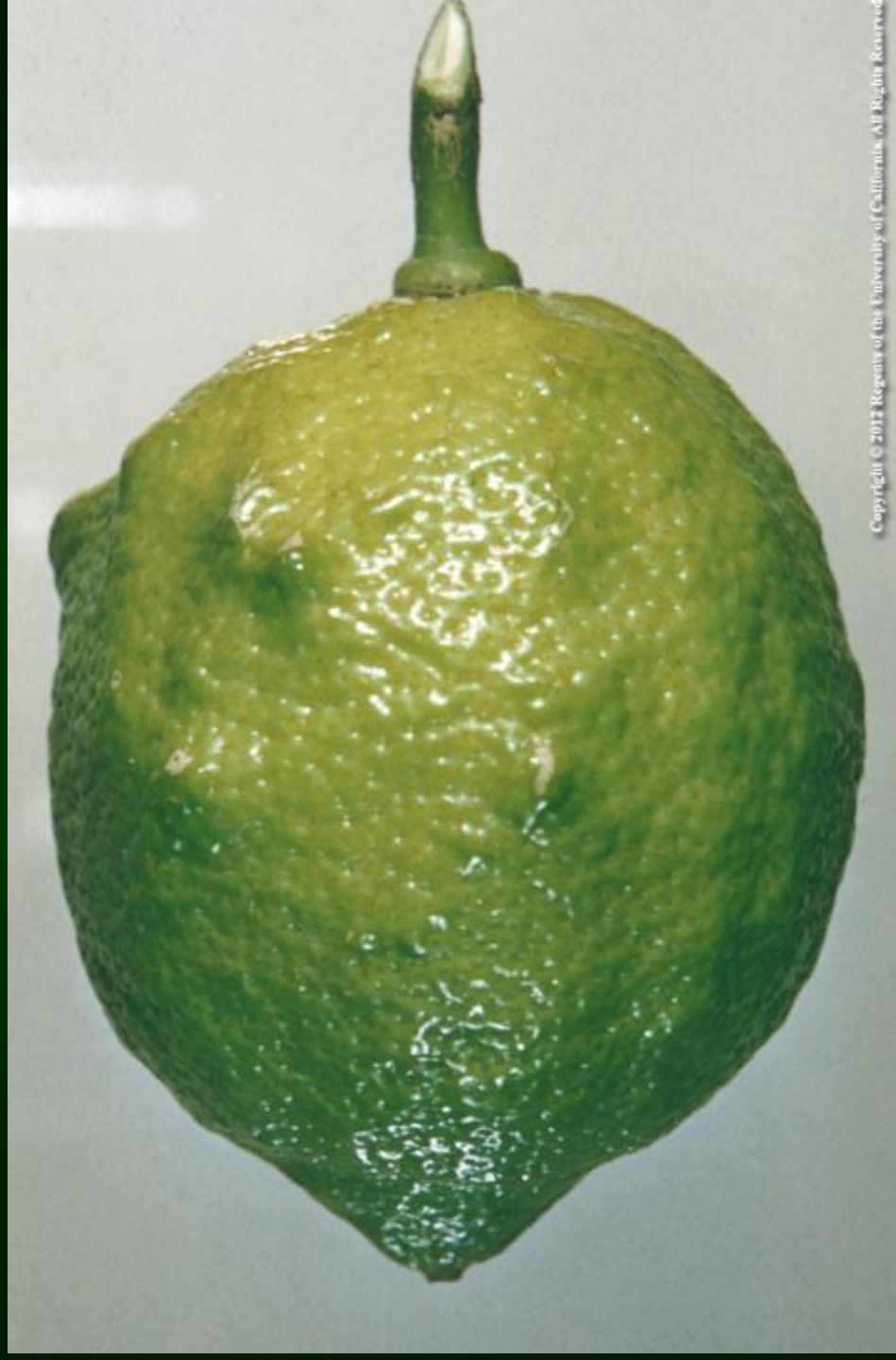

Botrytis

- Management
  - Right tree, right place
  - Focus on tree health
    - Reduce frost injury
    - Proper water and nutrition
    - Sanitation
      - Prune out dead branches
      - Remove damaged fruit
      - Harvest fruit promptly, but NOT when it's wet

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Deformed fruit

- This is a genetic deformity on citron
- No citron grown in Marin
- This can also be caused by an eriophyid mite
  - Microscopic
  - Damage usually less severe

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Deformed fruit

- Eriophyid mites
  - Little clear Jalapeno peppers with 4 legs out of the thick end
  - Once fruit is set, damage is done
- Management
  - Usually managed by predatory mites
    - Predatory mites prefer fairly cool, moist climates
  - If repeated problem, consider augmentive release (see references)
  - Hort. oil before bloom?

Huanglongbing

- *Candidatus liberibacter*
  - A bacterium
  - Fatal to citrus trees
  - More than $5Bn damage to Florida economy
  - Vectored by Asian Citrus Psyllid (ACP)
  - Symptoms:
    - Pale green, asymmetric blotches in leaves
    - Deformed fruit often stays partly green (fruit unmarketable)
    - Slow decline of trees over several years
    - Contagious trees may be asymptomatic for months to years


Michael E. Rogers

What's being done?

- ACP quarantine
  - Don't move citrus!
  - Currently in Modesto, Pacifica, San Jose
  - HLB only found in Los Angeles area
    - But trees may be asymptomatic for years
- *Tamarixia radiate*
  - Tiny parasitic wasp has shown efficacy in Florida

Flowering and Fruiting Problems

- Few or no flowers
  - Overcropping, severe pruning, too young. Re-graft (?)
- Fruit drop
  - Some is normal, especially in citrus
  - Lack of pollination
  - Pests, diseases, drought, fruit load
- Small fruit
  - Overcropping, rootstock sucker (?)

Flowering and Fruiting Problems (Cont.)

- Lack of flavor
  - Over-irrigation (insipid fruit)
  - Variety (no sweetness)
    - If you want good fruit, don't try grapefruit or tangelos
    - Stick with lemons (incl. Meyer), limes, and mandarins
    - If you live in Novato, you might get away with Valencias or other oranges
- Split fruit
  - Variety; inconsistent irrigation, potbinding, nutrient deficiency

Summary

- Citrus needs
  - 6 hours sun
  - 1-2 feet of well-drained topsoil
  - Some water
  - Heat
  - Drainage
  - Hard frost protection
  - Occasional fertilizer on poorer soils
- Not needed
  - Much pruning

Citations

- Bower JP (2004) The pre- and postharvest application potential for CropSet and ISR2000 on citrus. *Nutritional biotechnology in the feed and food industries;* Proceedings of Alltech's annual symposium: Reimagining the feed industry. Lexington, KY. pp. 361-367 fig 31
- Kahn TL (2007) Birds do it, bees do it, even citrus with seeds do (did) it: Part 1 – The biology behind seedlessness in mandarins. *Topics in subtropics* 5(1):3-5
- Lovatt CJ (in prep) Citrus physiology and phenology. In *Citrus Production Manual,* L. Ferguson et al., eds. UC ANR Publications, Oakland, CA.
- Shalom L, Samuels S, Naftali Z, Sadka A (2012) Alternate bearing in citrus: changes in the expression of flowering control genes and in global gene expression in ON versus OFF crop trees. *PLoS ONE* 7(10):e46930

References

- Providers of beneficial insects and mites:
  - Beneficial Insectary: http://www.insectary.com/
  - Rincon Vitova: http://www.rinconvitova.com/
- UC IPM: http://ipm.ucanr.edu/
- Xerces Society: http://www.xerces.org/

- This presentation on-line: http://ucanr.edu/northbaycitrus