Pistachio Orchard Establishment

Craig Kallsen, Bob Beede and Louise Ferguson
University of California Davis
LFerguson@UCDavis.edu

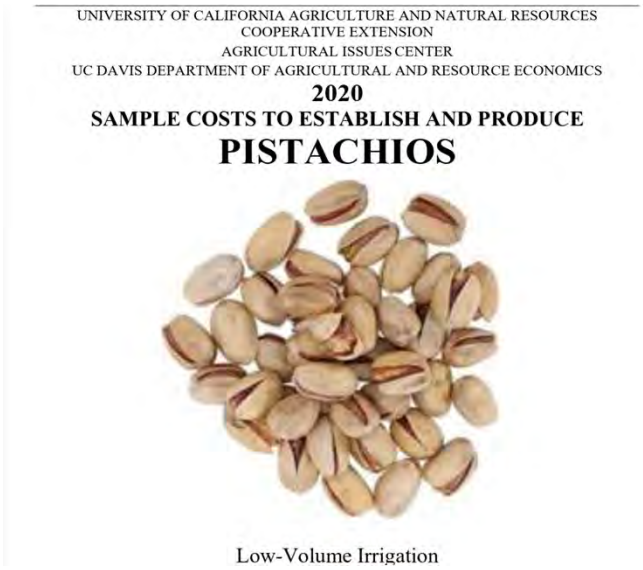
UCDAVIS
DEPARTMENT OF PLANT SCIENCES
College of Agricultural and Environmental Sciences

Pistachio Production Requires:

- Climate
- Soils
- Water
- Infrastructure
- Markets

UC CE University of California Agriculture and Natural Resources

Ask yourself!


UNIVERSITY OF CALIFORNIA AGRICULTURE AND NATURAL RESOURCES
COOPERATIVE EXTENSION
AGRICULTURAL ISSUES CENTER
UC DAVIS DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS

2020

SAMPLE COSTS TO ESTABLISH AND PRODUCE

PISTACHIOS

Low-Volume Irrigation

Pre-planting issues to investigate before designing the orchard
www.coststudies.ucdavis.edu

Does the farm have a suitable climate: enough heat units,

low summer and fall rainfall, sufficient chilling, no late frosts and early fall freezes?

Does the farm have suitable soils?

Is suitable and sufficient water available and what type of irrigation system will you choose?

How long will it take to receive trees from the nursery?

Which rootstock and scion cultivar will you select and why?

Does the farm have power for irrigation pumps?

How soon can you get it?

Where is the money for the farm and, at least, 5 or 6 years of a negative balance sheet coming from?

Who will farm them?

Where is the processor?

Who will buy the nuts?

UC CE University of California Agriculture and Natural Resources

Climate: Freeze Damage

- Scion Death:
  - fall freeze
  - young tree dieback

Climate: Bloom and Size

- < 1000 meters
- Chill: May - September
  - 900 hours < 7.5*C
  - 69 chill portions
- October – April
  - 3000 heat units > 7.5*C
  - < 50% relative humidity
  - No in-season rain

Climate: Rain or Humidity

- **Fungal Diseases:**
  - **< 50% RH**

Soils: Widely Adaptable

- Want:
  - pH 7:00 – 8.5
  - 1.5 - 2m even alluvial soils
  - good drainage
- Do not tolerate:
  - Saturated soils
  - High water table
  - Saline, alkaline soils
    - sodium, chloride, boron
- Adapt irrigation to bulk density, dS/m :
  - method
  - schedule

Water Quality and Quantity:

- **Will live in rainfed conditions:**
  - **Need water for commercial production**
- **Varies by region: California**
  - **43-acre inches/year = 10,922 M^3/hectare**
    - **~ 200 liters/tree/day @ mature peak**
- **Source:**
  - **Groundwater wells, bores**
  - **Snow-melt canals**
  - **Rivers**


Tolerate
saline soils:
< 6.00 dS.m

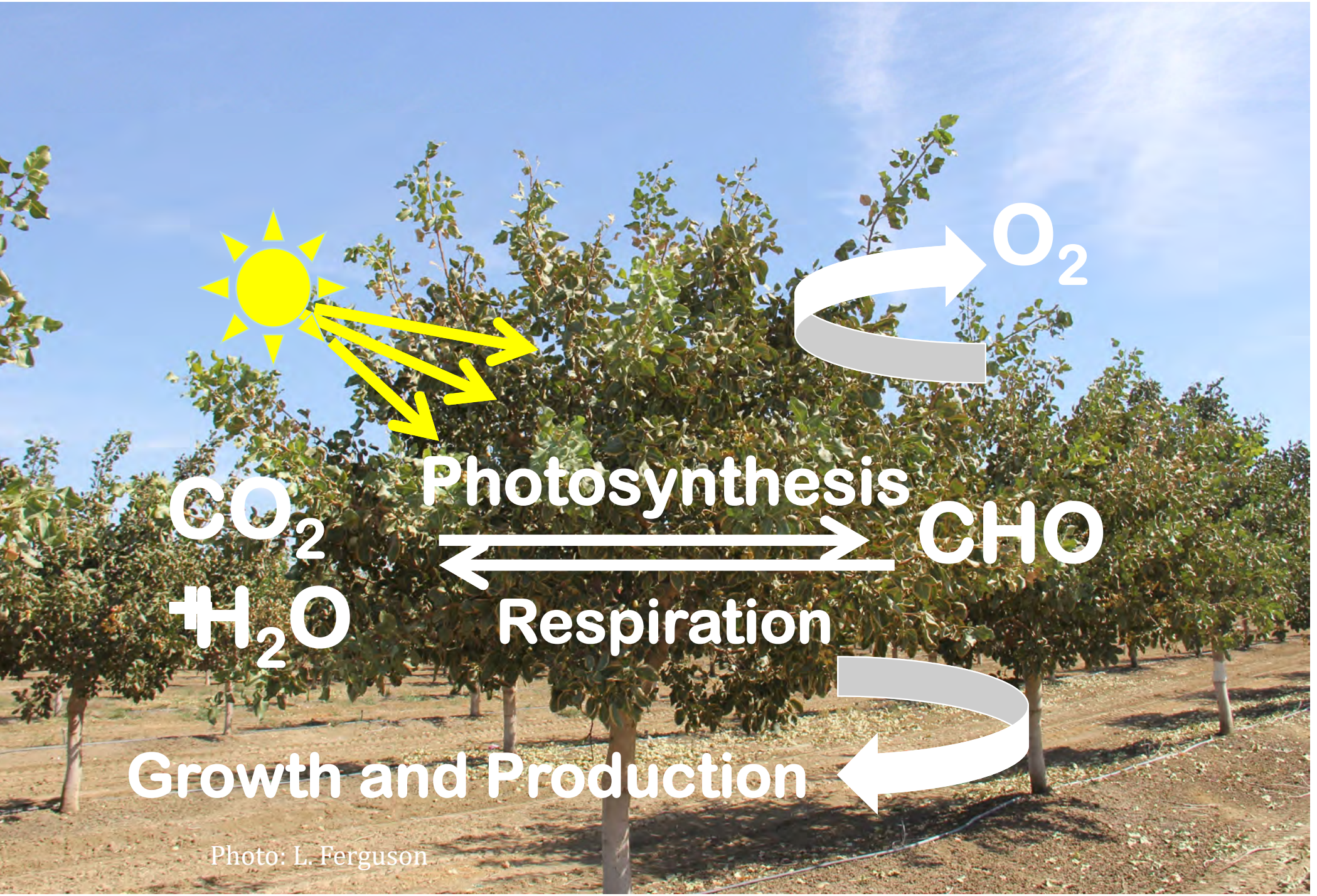
Major Orchard Design Considerations:

Tree Density
Tree Design
Pollinizer Placement
Orchard Floor Management System

The well-designed orchard should create an orchard that ensures:

- **Earliest economic return per hectare**
- **Maximum kilogram per hectare at tree maturity**
- **Least management cost**

<u>Sometimes these goals may be mutually exclusive!</u>


O_2
CO_2
+
H_2O
Photosynthesis
CHO
Respiration
Growth and Production
Photo: L. Ferguson

Logic of Orchard Design:

The leaf canopy is what catches the energy from the sun to produce nuts. The more energy caught – the more nuts to harvest.

The questions are:

- **How long will it take an orchard to achieve full leaf canopy and still leave room for machinery access to shake and catch the nuts?**
- **How many tree trunks do you need to hold up a full orchard leaf canopy at maturity?**
- **Ideally, 80% canopy cover at noon on a N-S axis.**

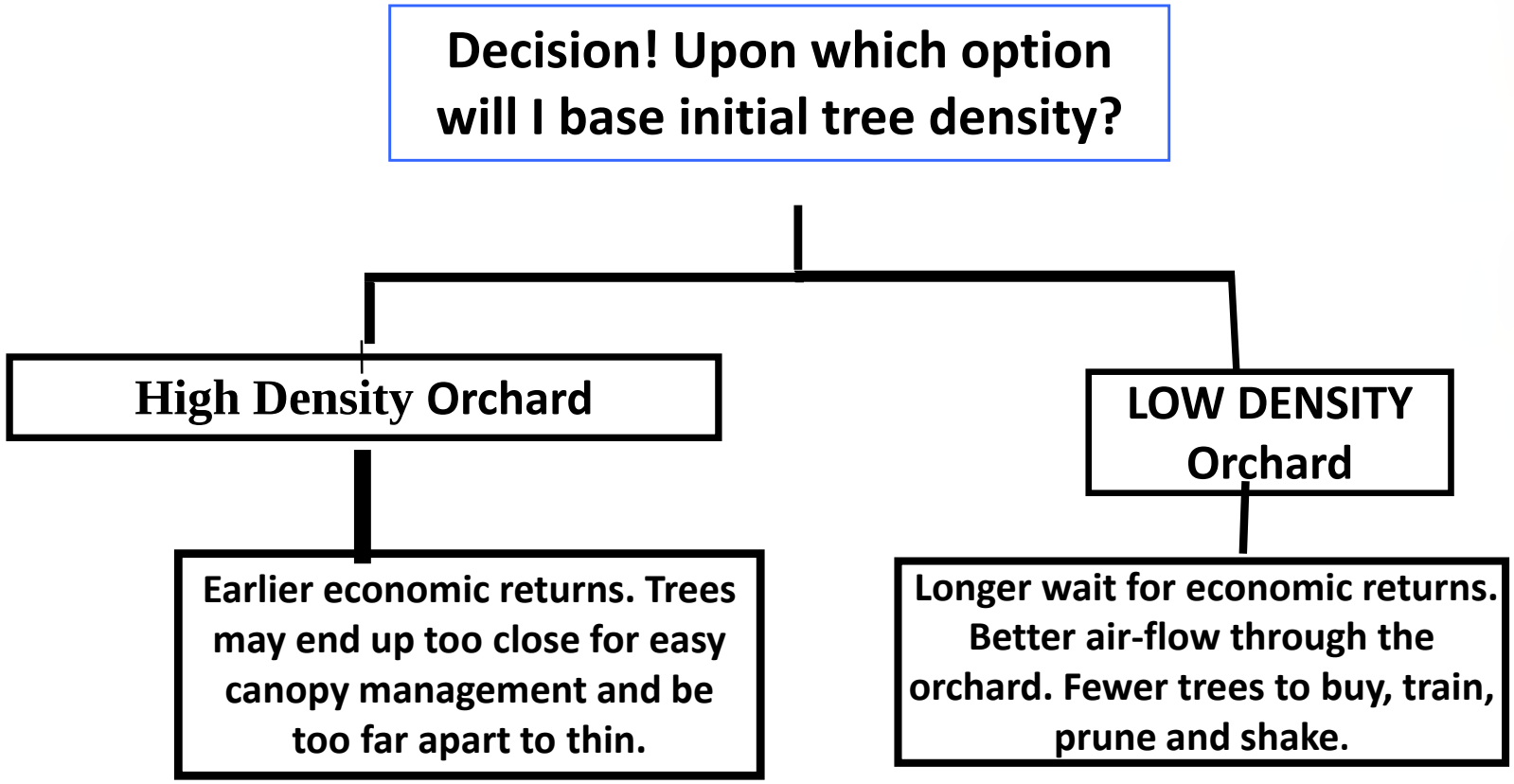
If trees are too close..

- **Trees eventually crowd together shading the lower tree canopy (nuts borne higher in tree and air flow restricted which may mean more fungal problems).**
- **Pruning costs increase to maintain equipment access to the orchard and tree isolation for shaking.**
- **You paid for too many rootstocks, budded/trained too many trees and now must prune too many trees.**
- **Trees should be at least 3.6m apart so that the mechanical shaker frame (typically 6.7m long) will be able to access the tree trunk.**

If trees are too far apart

- **Potential per acre yield may be permanently reduced or delayed for many years.**
- **If trees are too far apart and grow too large, nuts will fall outside of the catching frame at harvest.**
- **How big a trunk circumference can we shake efficiently? All else being equal, closely spaced trees will grow slower, due to inter-tree competition for light and nutrients.**

ORCHARD TREE DESIGN

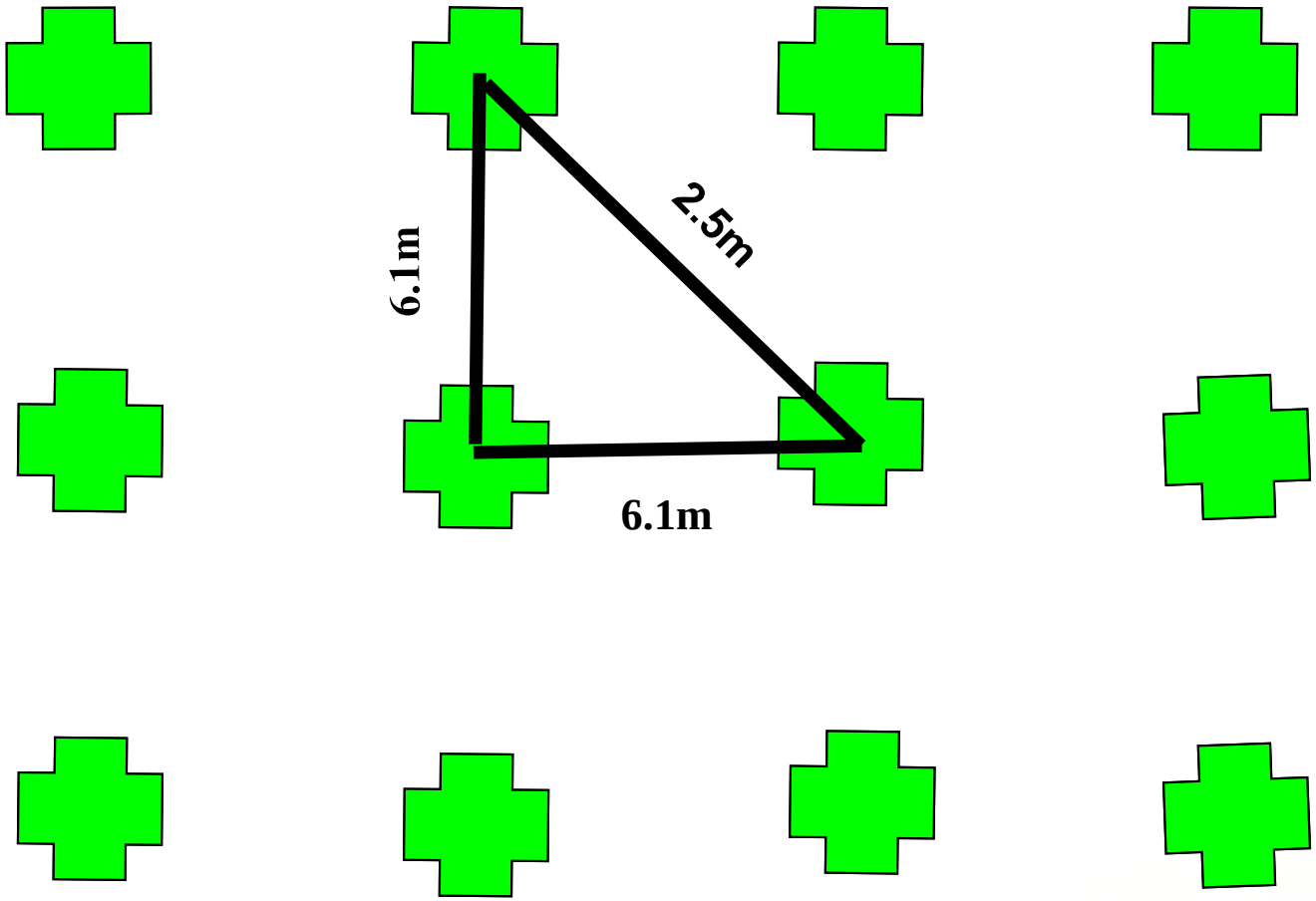


Pistachio harvesting equipment is large: between tree rows width > 6.1m.

UC CE University of California Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

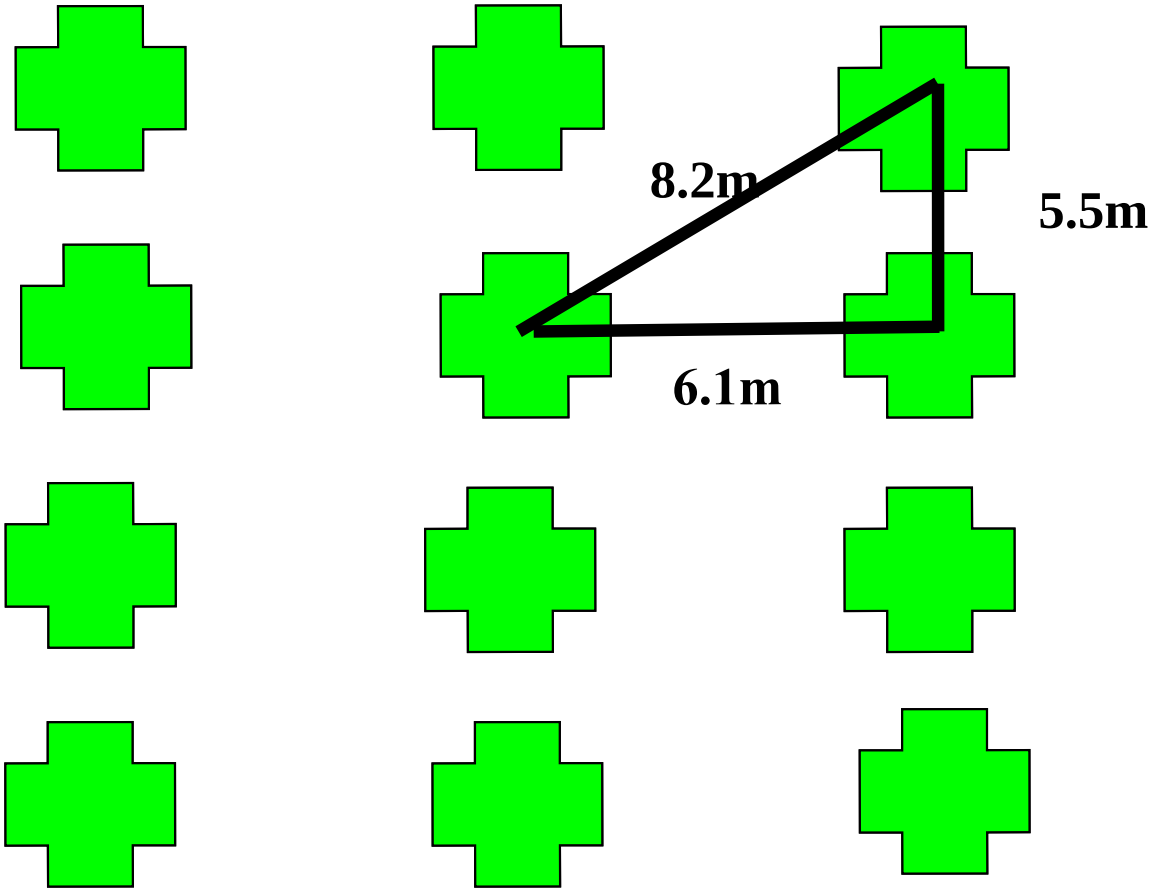
Square design: 270 trees/hectare:



Spacing the trees closer together in the row may pay off where trees grow slower due to hardpans, high salt, excessively high boron, or for other reasons.

Trees in poor growing environments will take longer to provide full canopy leaf cover, so yield will benefit by higher tree numbers for a longer period of time after planting.

The variety 'Golden Hills' appears to be a smaller tree and can be spaced closer together down the tree row, than for example 'Kerman'.



Rectangular planting

- Most common design in California but spacing varies.

(299 trees/hectare)

Mechanical cross-hedging possible with trees 5.2m apart in row.

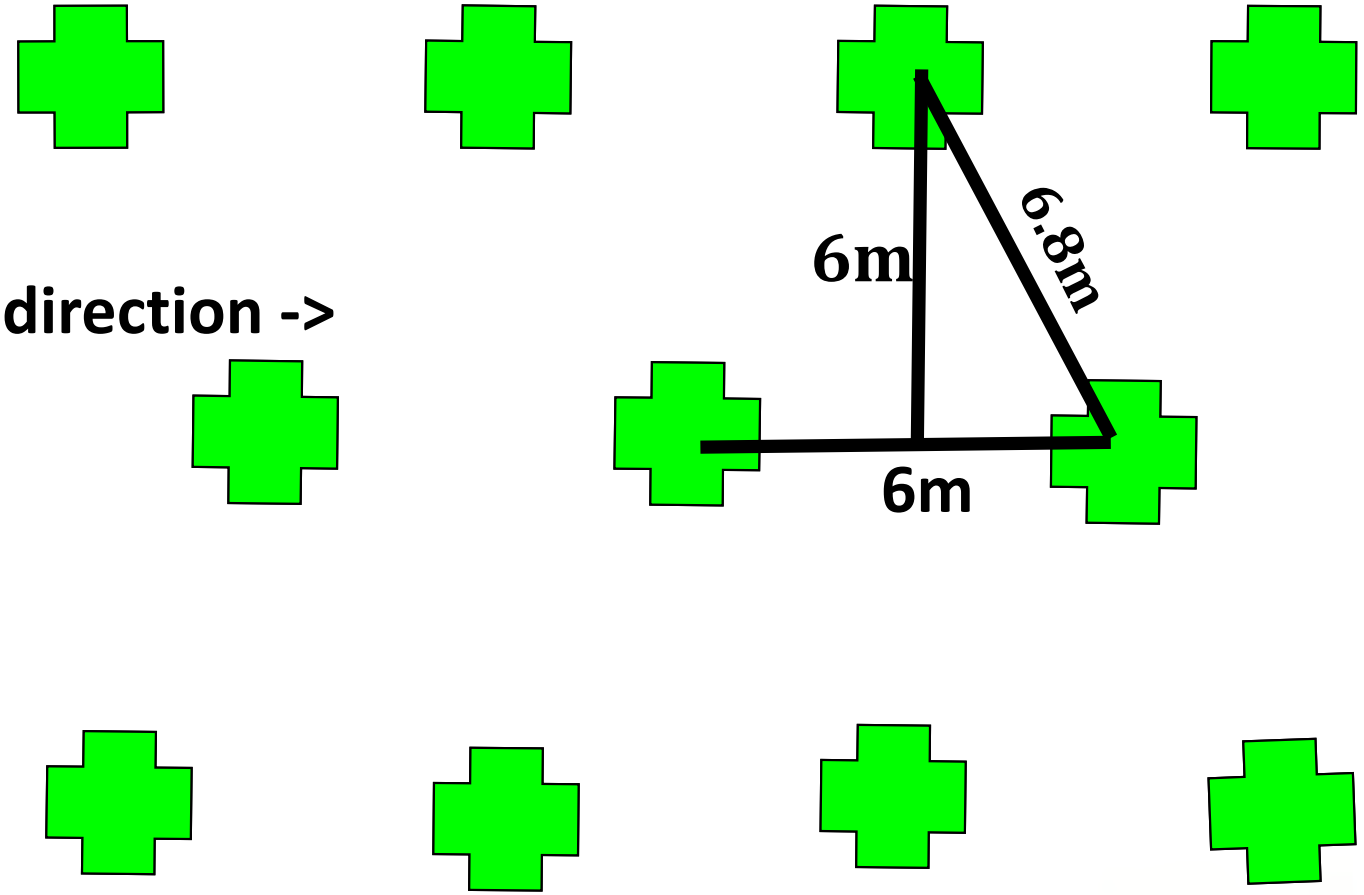
It may be particularly advantageous for organic growers with square or rectangular plantings to leave enough room between trees in the row to cross-cultivate for weed control in orchards.

For all growers, allowing sufficient space between trees for cross-hedging, will provide an additional means of canopy control, especially so if labor costs continue to rise.

Obviously, if you plan to cross-cultivate or eventually cross-hedge the orchard, trees should *not* be planted on a berm.

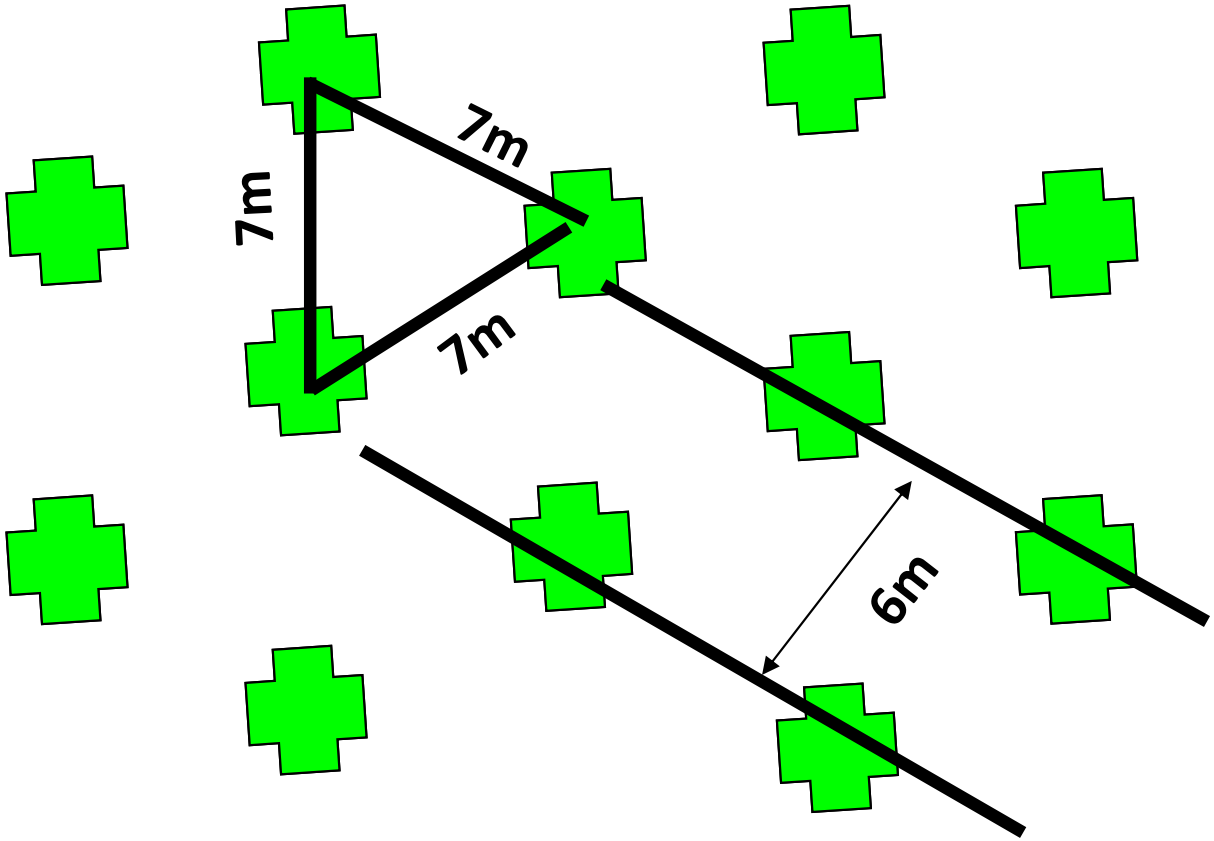
Offset square design: 270 trees/hectare

Cross hedging not possible with this design



Row direction ->

Hexagonal planting: 240 trees/hectare



Theoretically, with trees spaced equidistant from each other, mutual shading should be minimized.

System	Row Spacing	Tree Spacing	Estimated Trees per Hectare	Notes
High-Density	5.5m	2.5m	~727	Requires good tree management.
Standard	6–7.3m	3–3.6m	~380–555	Common for many fruit varieties.
Vase Pruning	~3m (tree spacing)	~3m (tree spacing)	~1111	Less control is harder to maintain with older trees.
Central Leader (Tight Spaces)	~1.5–2.0m (tree spacing)	~1.5–2.0m (tree spacing)	~2,500–4,444	Best for tight spaces.

Calculating trees per hectare

To calculate the number of trees for your specific spacing:

1. **Measure your desired row spacing and tree spacing in meters.**
2. **Multiply the two numbers to find the area each tree occupies.**
3. **Divide 10,000 (the number of square meters in one hectare) by the result from step 2.**

Planting density is a function of soil/water quality and cultivar.

In pistachio, male and female flowers are borne on different cultivars: male trees and female trees which bear nuts.

Pollen is blown to female trees by the wind….

Male trees are dispersed throughout the orchard to pollinate females.

In “low chill – warm winter” years, male – female bloom synchrony may be lost as male trees tend to bloom later than their normally synchronous female.

Multiple male varieties are planted: in ‘Kerman’ orchards the late blooming ‘Peters’ and earlier-blooming ‘Famoso’ will better synchronize with Kerman in ‘low-chill/warm winters’

https://fps.ucdavis.edu/pistachioscion.cfm

https://fps.ucdavis.edu/pistachioscion.cfm

Favorites | Bookmarks Menu | Reading List | Acta Horticulturae | Acta Horticulturae... | Phishing Notificati... | louiseferguson47... | Retirement plannin...

Foundation Plant Services Pistachios

UCDAVIS COLLEGE OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES

HOME | GRAPE | PRUNUS | PISTACHIO | UC STRAWBERRY | ROSE | SWEET POTATO | BERRIES | VARIETY ID | VIRUS DIAGNOSTICS | PORTAL | ABOUT FPS

PISTACHIO
- FPS Pistachio Program
- UCB#1 Seed
- Pistachio Scion Varieties
- DNA-ID for Pistachio
- Outside Resources

Pistachio Scion Varieties

The pistachio tree, *Pistacia vera* L., a native to western Asia and Asia Minor, has a long juvenile periods, producing a small crop at 5-6 years, and achieving full bearing at 10-12 years of age. The tree is dioecious, with male and female flowers borne on separate trees. Thus, both male and female trees are required to produce a crop, with pollen being wind-borne; typically male/female trees are planted in a ratio of 1 to 19-24; the tree is deciduous, becoming dormant in the winter, and alternate bearing, which means the crop is larger in alternate years. Edible nuts are borne laterally on year-old wood.

Pistachio Scion Cutting Order Information

Price per cutting: - $100.00

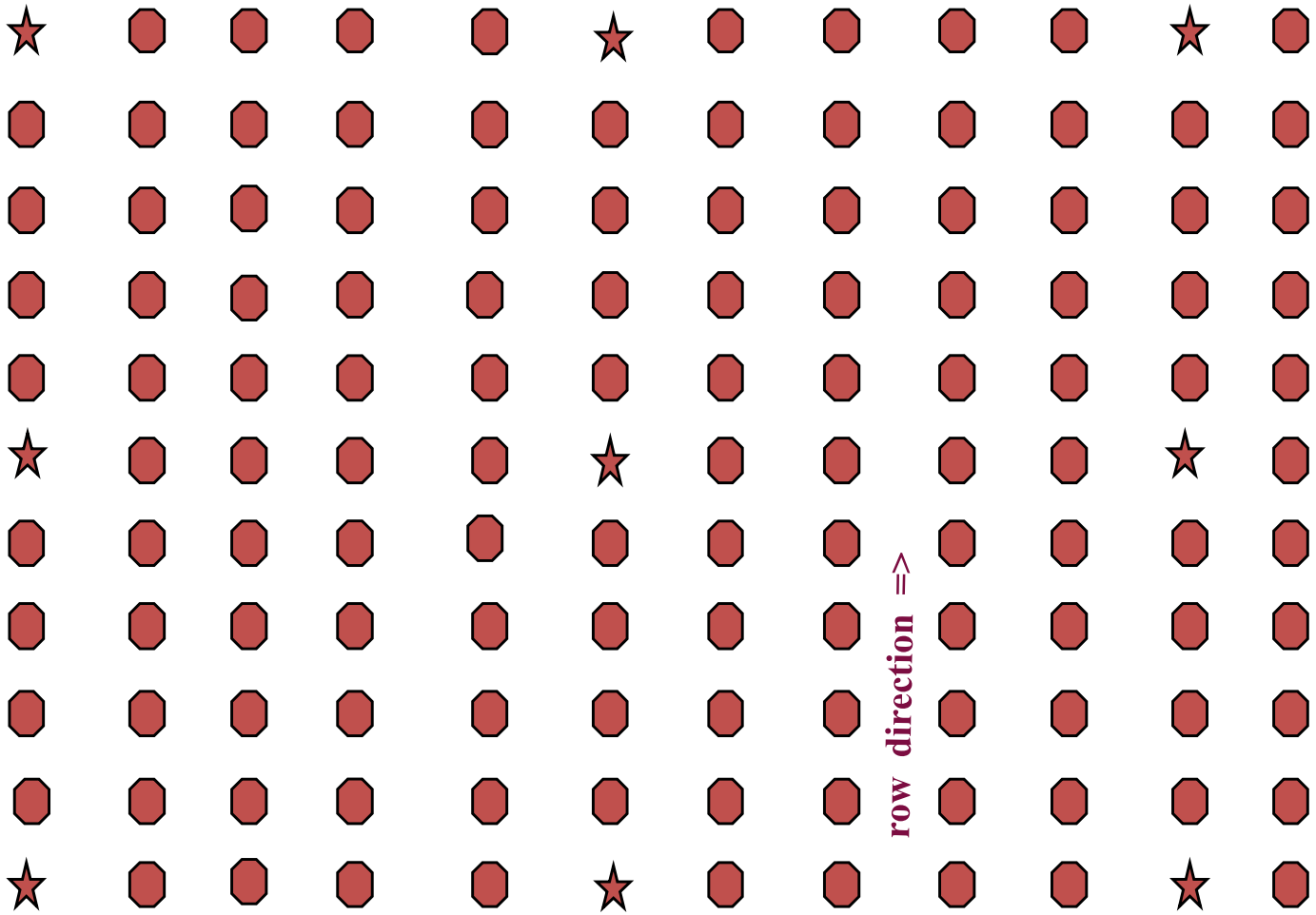
Download Pistachio Material Order Form

Order Deadline - Orders must be received by August 1 for August/September distribution.

UC CE University of California Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

An Orchard Design with Male Pollinizers in a 1:24 Ratio



Currently males are planted every 5th row and every 5th tree

Row Length?

Rows longer than 0.40 km should have a break (access road)to allow equipment to turn around…

A bank-out wagon on an "on" year cannot carry all the production from a row over a 0.40 km in a length.

Have a harvest loading site…

A loading site should be contiguous to every 20-hectare block

A single loading site can service 65-70 hectares

A loading site is typically 15 x 150m

A safe harvest loading site takes space

UC CE University of California Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

Try to avoid a loading site like this….

Somebody snuck in another row of citrus trees

UC CE University of California Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

Poles in tree rows are susceptible to topping.

Leave room around county roads, poles, reservoirs, filters, and pumps so harvesting and other equipment can turn or pass easily.

Leave room to turn equipment in and out of tree rows.

Young tree harvest:
trees are only going to get bigger and the canal isn't going anywhere!

UC CE University of California Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

Potential liability from pesticide drift should be considered. Is a tree-free buffer needed between the orchard and neighboring schools, houses, county or state roads?

Design to minimize existing obstructions….

These poles interfere with harvesting equipment, grading, irrigation, weed control, etc.

This air-release valve is still too tall in the tree row.

Buried vaults in the tree row protect irrigation valves, air release valves, etc. from shaker and mechanical cross-hedging. Watch out for Black Widow spiders)

Courtesy of Virginia Tech

Orchard road surfaces….

The suitability of a road material <u>varies with the following:</u>

- **the native soil of the road**
- **the current condition of the road**
- **seasonal rainfall patterns, amounts and drainage**
- **frequency that the road is traveled**
- **material cost**
- **and ability to grade, blade, replace or repair.**

Various road-surfacing materials can reduce dust and/or improve wet-weather access to the orchard.

This is an example of the native soil used as a road surfacing material.

University of California
Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

Some of the materials used to control dust on farm service roads are as follows:

- **Water**
- **Lignosulfate dust binders**
- **New or recycled asphalt**
- **Heavy road oil**
- **Washed gravel**
- **Crushed rock or decomposed granite**
- **Vinyl/acrylic emulsion/polymers**
- **Organic materials**

The Natural Resource Conservation Service has a program to provide advice and financial help with dust control at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ca/air/quality/?cid=nrcs144p2_064217

It is not necessary to plant pistachio on a raised berm. If you are planning to plant the trees on a raised berm, you should know why you are planting on a raised berm.

Raised berms can be a problem if you plan to cross-hedge the orchard. If they are too wide and/or tall they can interfere with the harvest equipment

Reservoir Considerations…

- Will a reservoir be needed and how big?
  - How does the irrigation district deliver water? Is the delivery interval so long or slow that you will have to store large volumes of water for considerable periods of time?
  - Does the district provide pressurized water on demand?
  - Are you using a well? Will you need a reservoir for pressure control or for storing water pumped at off-peak electrical rates?
  - Will you need a settling pond for silt or sand or other debris – or capacity for back-flushing of filters or capturing/recovering drainage from field.
  - Engineering of the reservoir – problems include building in steep topography, surface and deep drainage out of the reservoir, environmental considerations. Depending upon future environmental regulations, and your water quality or runoff - your reservoir could one day be labeled by a governmental agency as a wildlife refuge or toxic waste dump.

ORCHARD FLOOR MANAGEMENT…

- **Complete cultivation: irrigation hose concerns**
- **Complete vegetation cover: disease concerns**
- **Complete herbicide control: erosion concerns**
- **Strip herbicide control down tree row with cultivation of middles**
- **Strip herbicide control down tree row with cover crops in middles**
- **Intercropping**

Strip herbicide control with cultivation…

UC CE University of California Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

STRIP HERBICIDE CONTROL WITH COVER CROPS

UC CE University of California Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

Cover crops do not necessarily use a lot of water….

Summer

Spring

If you want a green cover crop all year in the row middles in the southern SJV you will have to irrigate the middles.

UC CE University of California Agriculture and Natural Resources

Terracing complicates harvest and cross-hedging…

So can high and wide berms

Cover crops may have multiple effects…

- **insect/mite control (+/-)**
- **water relations (+/-)**
- **disease (+/-)**
- **nutrition (+/-)**
- **erosion control (+)**
- **vertebrate pests (gophers, mice, voles) (-)**

We've got a lot to learn about cover crops.

Interplanting in young pistachios…

Because pistachio take more years to come into production than other perennial crops, some growers are interplanting cotton, melons or other crops between rows of young pistachio trees.

There can be financial advantages to interplanting when the pistachios are young, know how to grow the interplanted crop before attempting interplanting.

<u>Potential problems</u>:

- **weed control (herbicides), phytotoxicity, registration**
- **fertilizers, irrigation, discing roots, harvest timing, etc.**
- **shading**
- **pests – meadow mice (voles), insects and mites**

Preparing the orchard…

- **Soil pits: ~ 10 hectares**
  - **Determine modification**
- **Preplant:**
  - **slip plowed in-row @ 1.5m**
  - **Single shank between @1.5m**
  - **Stubble disc, finish disc, float x 2**

Preparing the orchard…

- **Soil pits: ~ 10 hectares**
  - **Determine modification**
- **Preplant:**
  - **slip plowed in-row @ 1.5m**
  - **Single shank between @1.5m**
  - **Stubble disc, finish disc, float x 2**

Lay out and test irrigation line…

- Incorporate slack….

Rootstocks selected and delivered…

- Early spring….past danger of frost
- Seedling or clonally propagated
- Unbudded, prebudded, topped trunk

Dig hole…

- **Balling shovel…**

Dig hole…

- **Toss aside topsoil if preemergent treated….**

Dig hole…

- **Ensure sides are not glazed…**

Insert rootstock…

- **Maintain soil level; do not cover with soil….**

Stake tree…

- **At the edge of the root ball….**

Make a basin…

- To ensure uniform irrigation….
- Place sleeve..

Keep water at the base of the tree…

Check root ball regularly…

Check water frequently first 8 weeks…

Keep water at the base of the tree…

Overwatering causes poor root growth

Healthy

Water-logged and rotted

Control weeds…

Rootstock ready for budding basin…

- Irrigate a week before….
- Irrigate 5 days after..

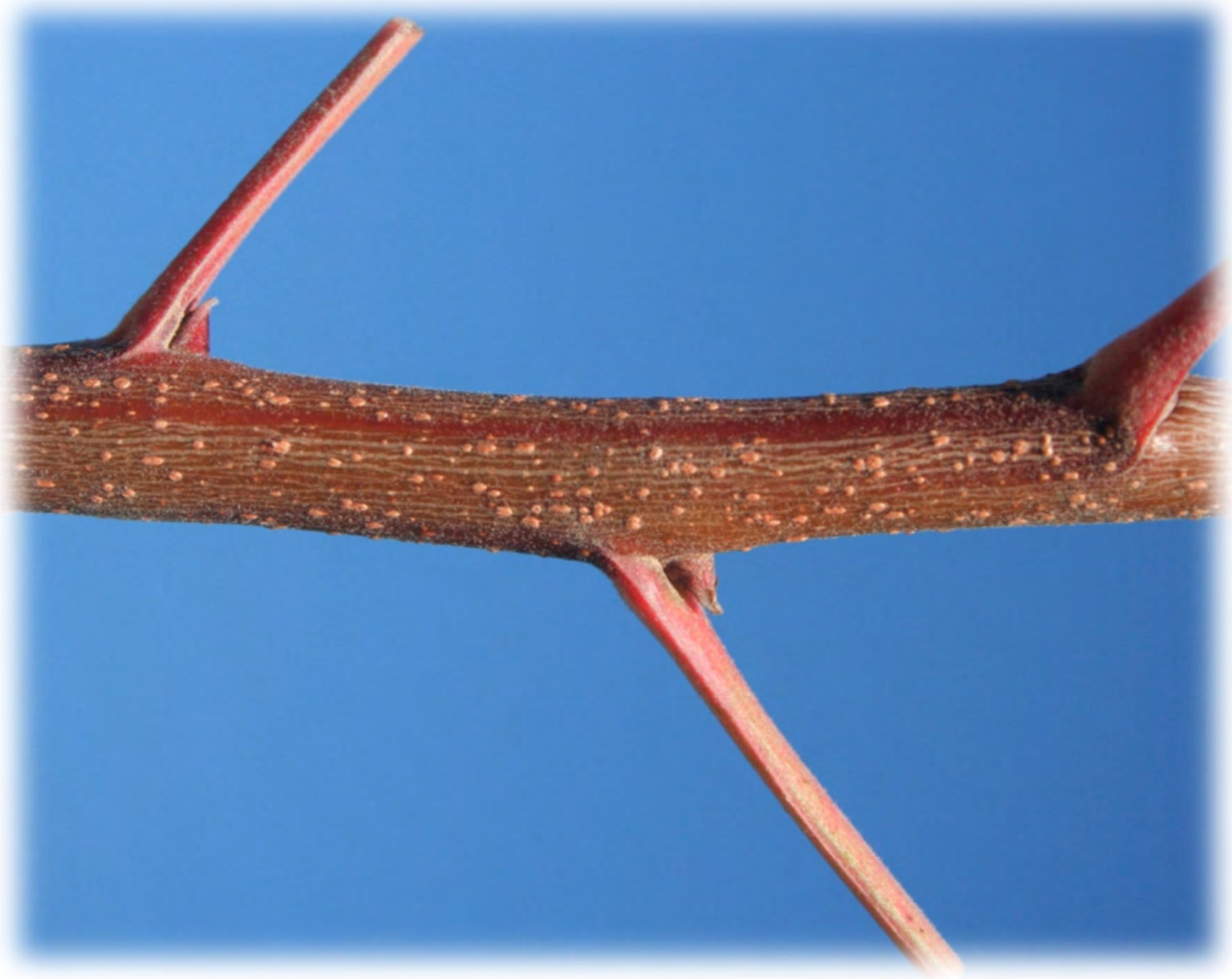
Planting date, rootstocks vigor, bud size, and budder availability…

1. **STOCK PLANTED FROM JULY TO EARLY OCTBER SHOULD BE 3/8” IN DIAMETER BY MID-JANUARYTO EARLY-FEBRURY DEPENDING UPON PLANTING DATE, ORIGINAL PLANT SIZE, AND CULTURAL PRACTICES.**
2. **DO NOT PUSH FOR BUDDING TOO EARLY! LARGER DIAMETER TREES TAKE A BUD BETTER AND PUSH THE BUD HARDER THAN MARGINALLY SIZED TREES. THE BUDWOOD ALSO HAS TO BE UNIFORMLY MATURE.**
3. **CULTIVARS LIKE GOLDEN HILLS HAVE LARGER DIAMETER BUDWOOD, HENCE THE “SHIELD” CUT FROM THE STICK IS LARGER, AND THUS THE TREE NEEDS TO BE LARGER TO GET A GOOD BUD TAKE. BE CAREFUL ABOUT PUSHING THE BUD WHEN BUDDING AFTER THE FIRST WEEK IN March. EARLY FROST IN MAY CAN KILL THE SHOOT, AND YOU HAVE LOST A YEAR**
4. **PISTACHIOS CAN BE BUDDED DURING MARCH, BUT DO NOT FORCE THE BUD. ALLOW IT TO REMAIN DORMANT, THEN CUT BACK THE STOCK IN JULY AND TRAIN THE BUD UP THE STAKE IN THE SPRING.**

Bud as soon as ready…

- If early, use dormant collected budwood…

Good quality budwood…



Budding video…

https://ucanr.edu/site/2020-advances-pistachio-short-course

Bud at 70-80 cm…

TO GET THE BUD UNION ABOVE THE LOCATION OF WHERE THE SHAKER HEAD ATTACHES TO THE TREE FOR HARVEST. HAVING THE UNION IN THE CLAMPING ZONE GREATLY INCREASES THE RISK OF TEARING THE BARK ON THE TRUNK.

PISTACHIOS, ALTHOUGH NOT SUSCEPTIBLE TO TRUNK WOUND CANKER DISEASES LIKE ALMOND, HEAL VERY SLOWLY. EXCESSIVE DAMAGE WEAKENS THE TREE MAKING IT POTENTIALLY LESS PRODUCTIVE.

Notch above the bud with a hacksaw…

- **Bud should push within 14 days….**

Tip rootstock 50%…

- 5 days after budding and keep below bud…

Tie up as soon as possible…

- **Ensures a straight trunk…**

Visit every 10-14 days…

- To tie to stake
- Tip rootstock shoots
- Remove base suckers

Season one goal: trunk or central leader

- Turn water off early to avoid freeze damage..

Top in dormant season…

- 1.2m for vase trained tree….
- 1.4-6m for a modified central leader training

Vase trained tree…

- 6 years of heading cuts @ 12-24 inches

Three Training Systems for Pistachio: 2024

Conventionally pruned

Modified central leader

Untrained

Comparison of training methods…

Treatments

Conventional (wooden stakes)

- Following Pistachio Production Manual **Annual 30-60cm**

Modified central leader (5/16" x 8' metal stakes)

- Trees headed at 62 inches at end of first dormant season
- Dormant pruning only- no in season tipping **1.6m**
- No shoots were removed but all shoots that grew more than 18-24" were tipped **45-60cm**
- In addition, the most central shoot was tipped and retrained to a central leader and left longer than all other shoots

Untrained (3/8" x 10' metal stakes)

- No heading or pruning (only limbs that were too low were removed but this was done on all treatments)

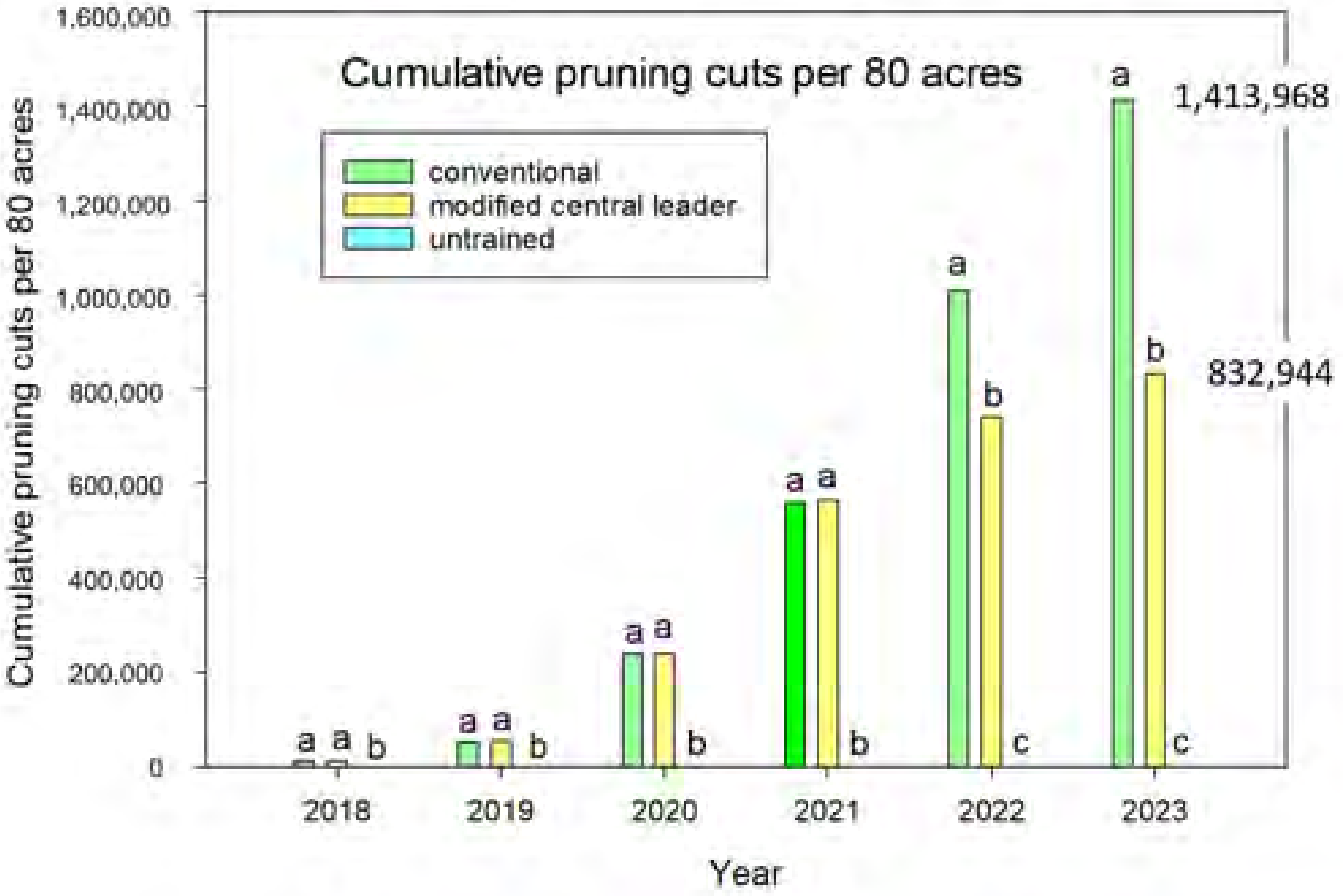
Modified central leader trained tree…

After year 2 pruning

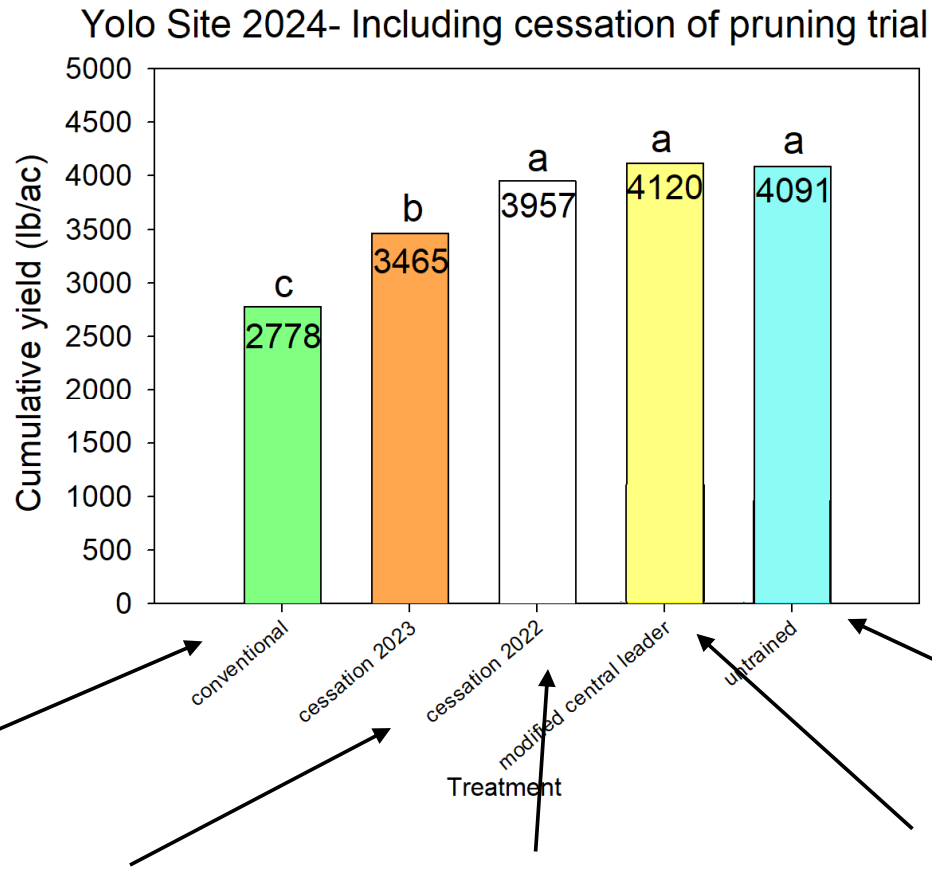
Modified central leader trained tree…

After year 3 pruning

Data: decreased training cuts…



Data: earlier and better yields.



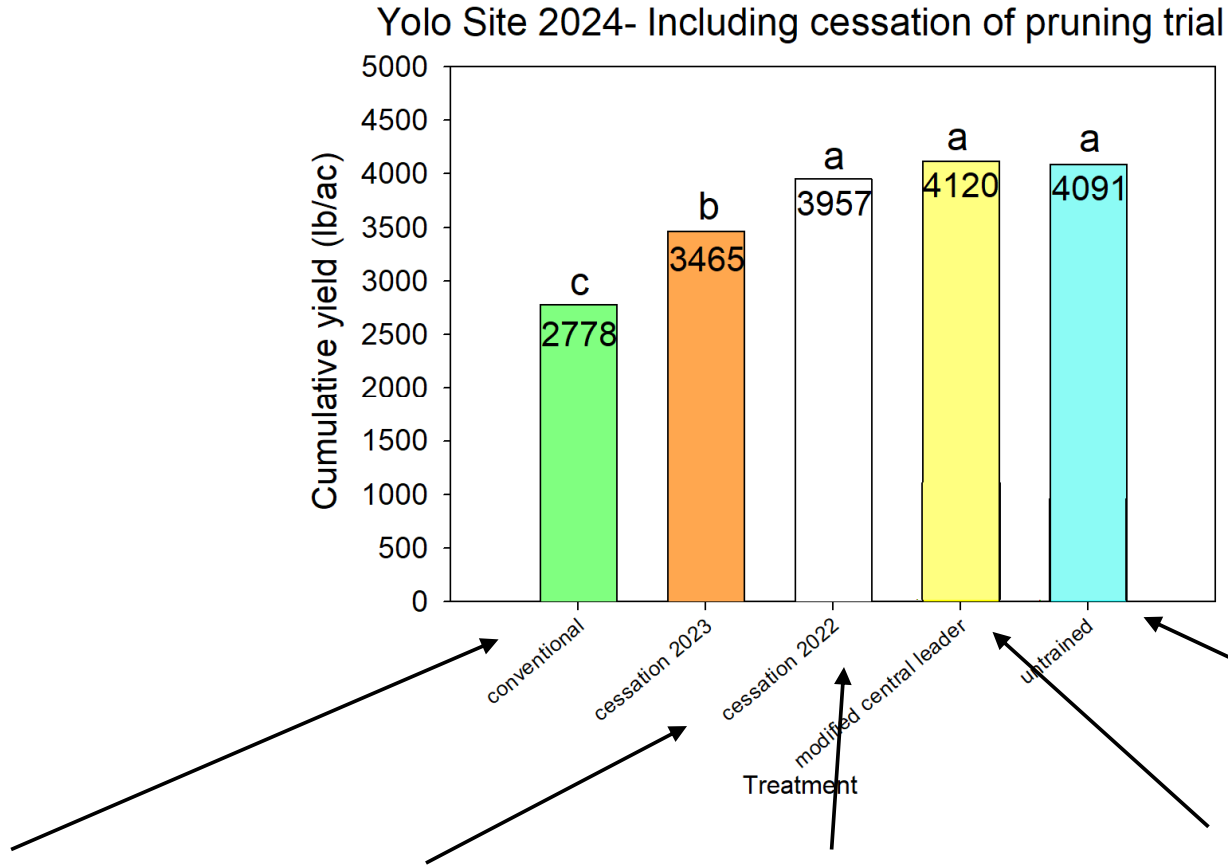
Pruned continuously
Cumulative yield = 2778 lb/ac

Cessation 2023
3465 lbs/ac

Cessation 2022
3967 lbs/ac

Modified central leader
4120 lbs/ac

Untrained
4091 lbs/ac



Pruned continuously
Cumulative yield = 2778 lb/ac

Cessation 2023
3465 lbs/ac

Cessation 2022
3967 lbs/ac

Modified central leader
4120 lbs/ac

Untrained
4091 lbs/ac

Craig Kallsen, Bob Beede, Bruce Lampinen
Farm Advisor and Specialists Emeritus
Louise Ferguson
LFerguson@UCDavis.edu
+(1) 559-737-3061

UCDAVIS
DEPARTMENT OF PLANT SCIENCES
College of Agricultural and Environmental Sciences

UC CE University of California Agriculture and Natural Resources