

Botany and Physiology of the Pistachio Tree

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Definitions

- Botany
 - The scientific study of plants, a branch of biology
 - What the plant is...
- Physiology
 - A sub discipline of botany concerned with the function, or physiology, of plants
 - How the plant works...

Botany of the Pistachio..

Family: *Anacardiaceae*

Genus: *Pistacia*

11 Species:

vera is edible nut

Rootstocks:

integerrima

atlantica

San Juan, Argentina: October 1, 2012



Tree Characteristics

- Temperate climate tree
 - origins in 40 to 60/70* latitude
- Deciduous
- Moderate stature: 23-35 feet (7-10m)
- Apically dominant vegetative growth
- Bears crop on year old wood
- Alternate bearing scion
- Phreatophyte
 - water extraction at 23 feet (7 meters)





Dioecious

Pistillate and
staminate
flowers are
borne on
separate trees...



Pistachio Flowers

- Apetalous
- No nectaries







Wind Pollinated:

- wind
- rain
- heat
- cool temperatures

Golden Hills
B22-31

Randy
B15-31

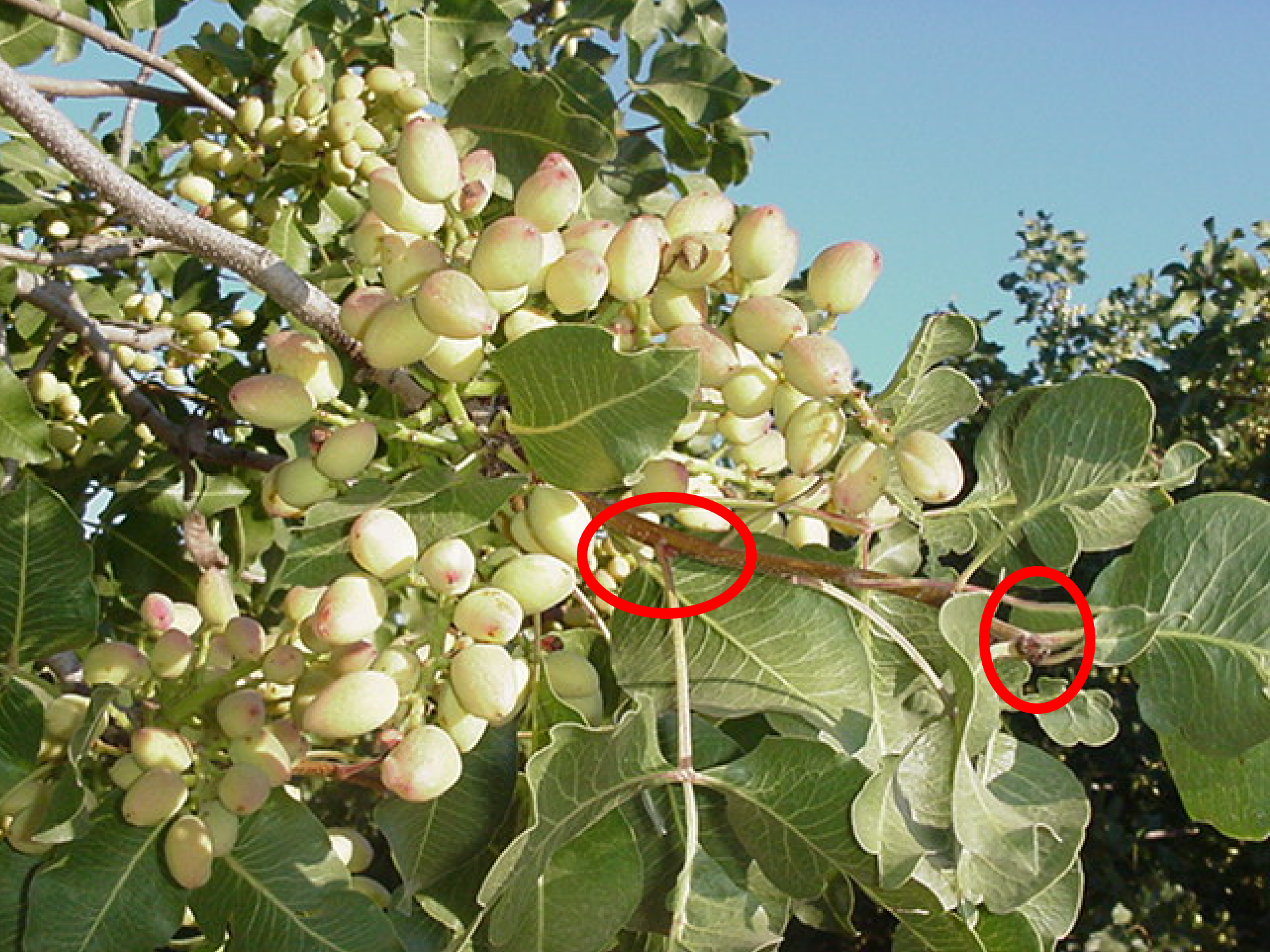
Peter

3/24/05
Trusselman

Photo: C. E. Kallsen



Bearing Habit: year old wood



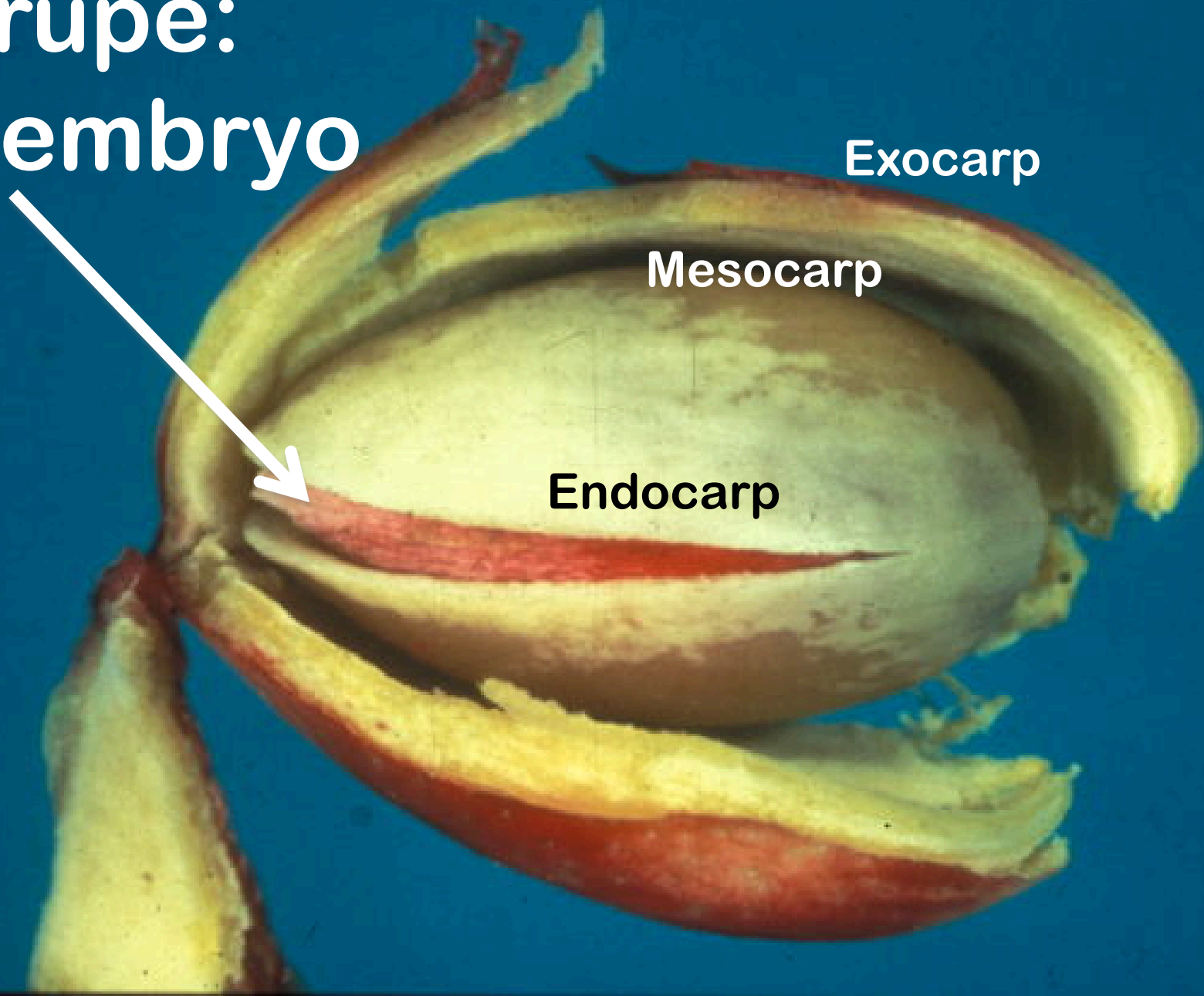


Inflorescence Characteristics



- Panicles
 - 100s of flowers
 - set less than 4%
 - average 14 nuts/cluster
- Apically dominant
 - Most nuts are terminal flowers
 - < 8% of flowers
- Parthenocarpic set
- Embryo abortion
- Bud abscission

Drupe:
- embryo



Exocarp

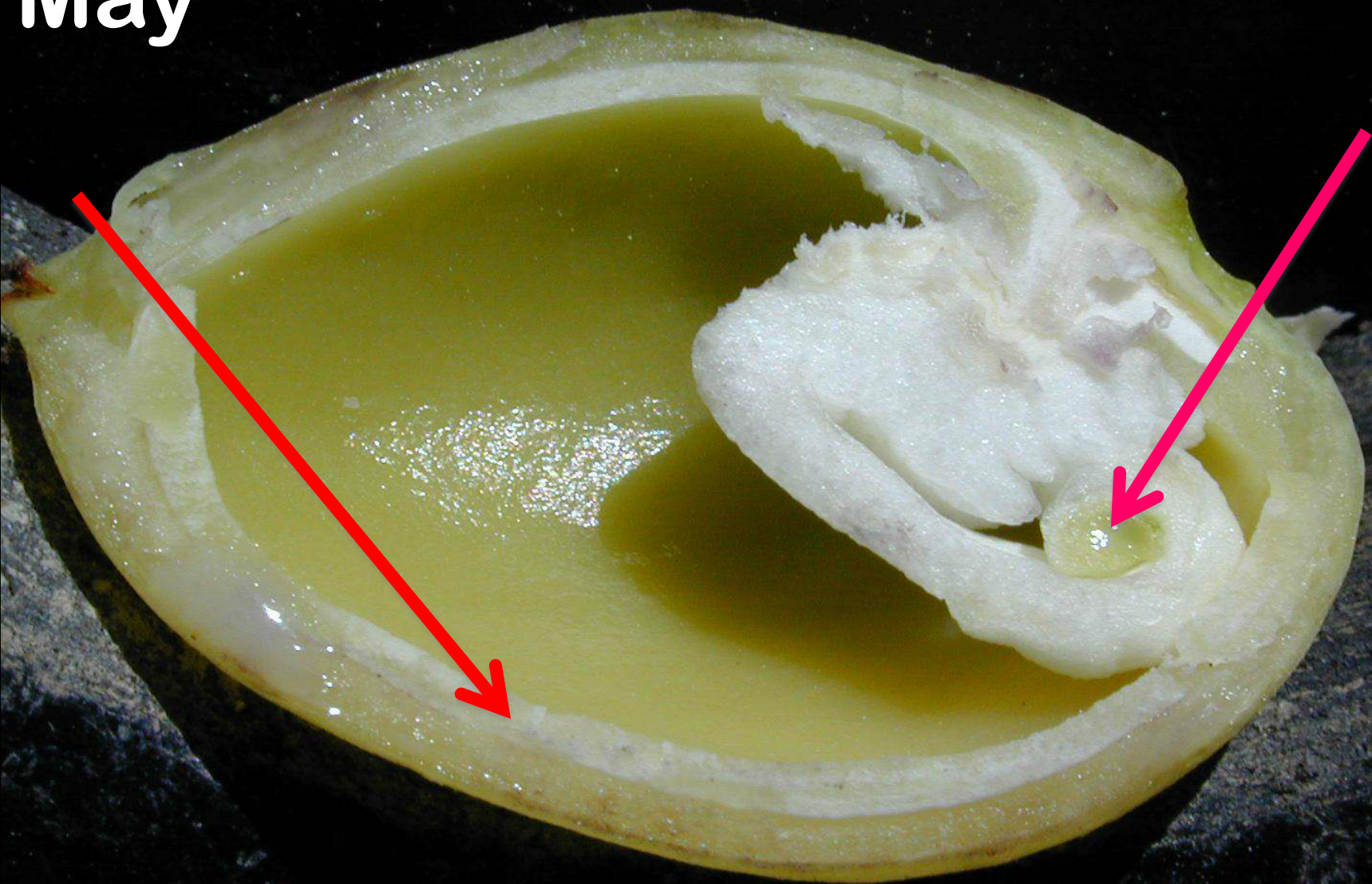
Mesocarp

Endocarp



April – early June

May



June







August



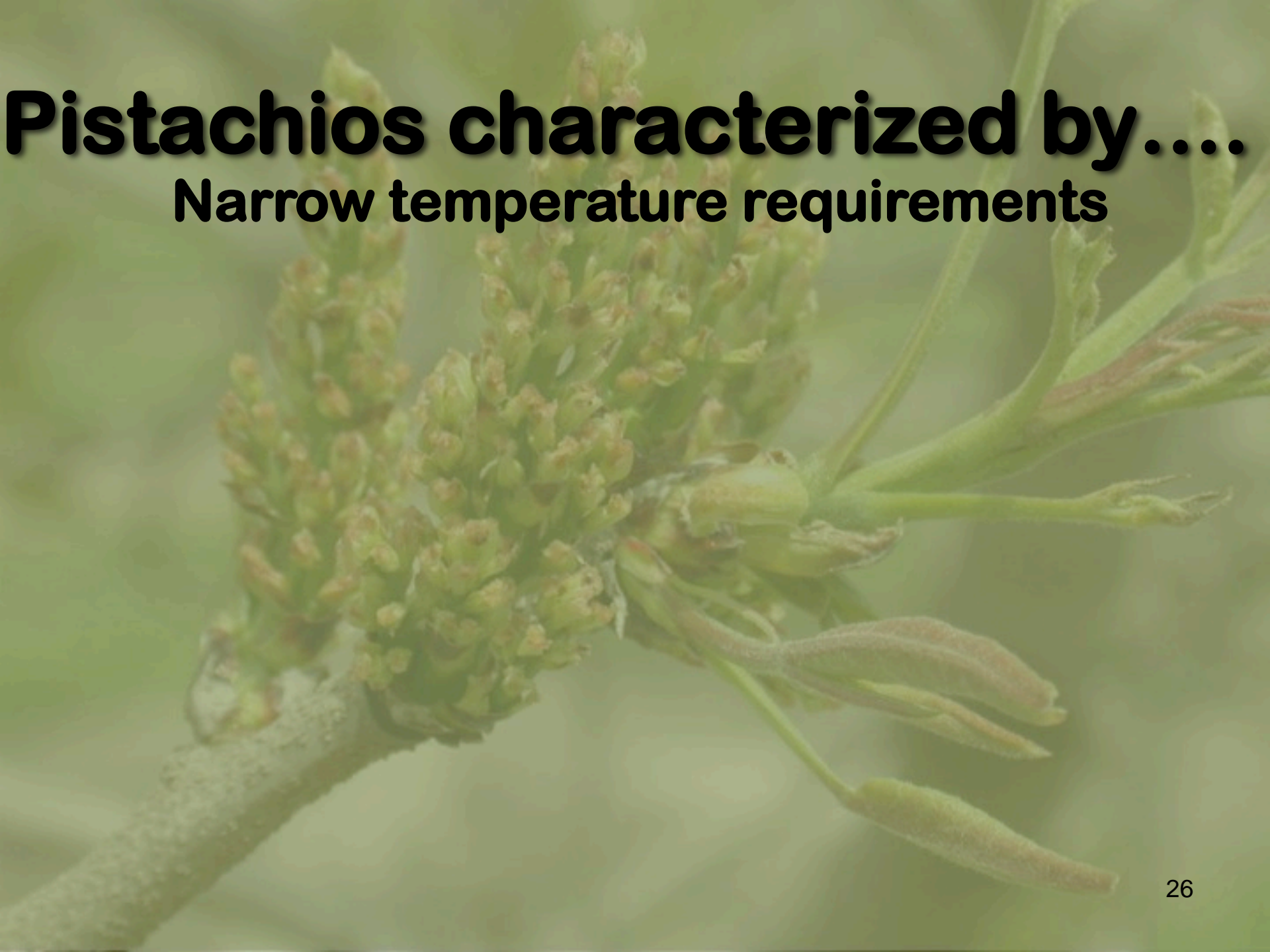


September



Pistachios characterized by....

Narrow temperature requirements



Climatic Requirements ...

Are unique in their narrow ranges for mortality and productivity:

Dormant chill, but susceptible to freezing

- early fall freezes**
- late spring frost**

High summer heat for maturity

- won't grow or split**

Critical Climatic Limits...

Heat: little documentation

77 - 86°F (25 -30°C)

Freeze: 1990; 1 year old rootstocks

11 nights: 4°F (-15.5°C) – 11°F (-12°C)

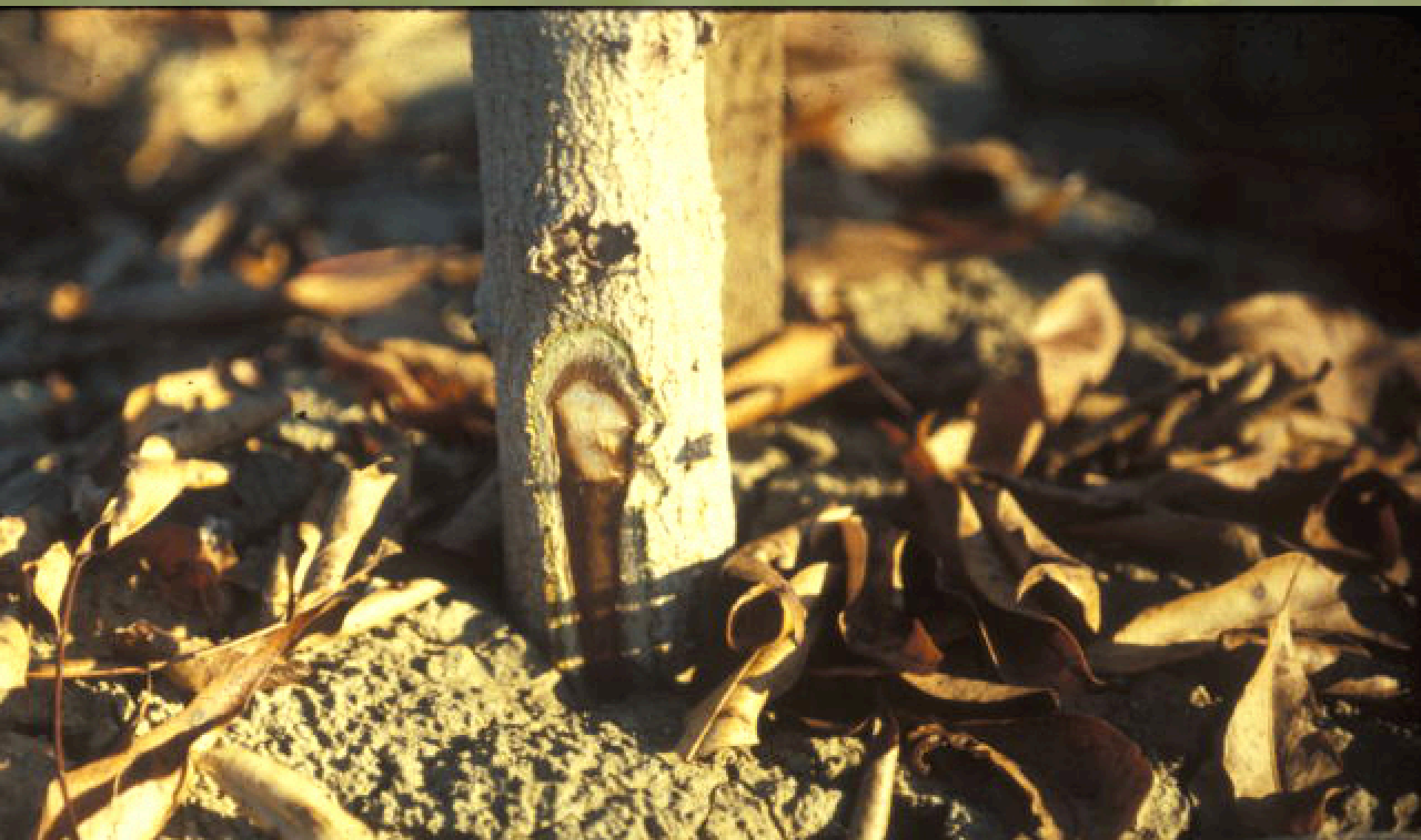
- Rootstock differences

- *P. integerrima*:

- 41% mortality

- *P. atlantica* x *P. integerrima*

- 0% mortality



Rootstocks less cold tolerant



November, 2009

Climatic Requirements for Productivity...

Heat: 2200 – 2800 heat units

6 – 7 months @ average 60°F (15°C)

< 2500 feet altitude

Chill:

Females: > 750 hours @ < 42-45°F

**Males: > 900 hours @ < 42-45°F
(5.8 - 7.2°C)**

Humidity: < 50%

Foliar fungal diseases

Potential Climatic Problems...

Chill:

- Achieving sufficient dormant chill
- Measuring dormant chill
- Chill all we should be measuring?
 - perhaps combine with heat
- Newer models for temperate species grown in subtropical climates
 - South Africa
 - Australia
 - Argentina

Does it matter which model is used?

What is known about chill models

Information from controlled experiments	Chilling Hours	Utah	Utah+	Dynamic Model	
Depends on temperature	+	+	+	+	
Daily temperature cycle	+	+	+	+	
Weighted temperatures	-	+	+	+	
Continuous weights	-	-	-	+	
Warm temperatures -	-	+	-	+	
Moderate temperatures +	-	-	-	+	
Two-phase process	-	-	-	+	

Luedeling et al. Erwerbsobstbau (submitted).

Pistachios characterized by....

Long juvenility:

- 6 – 8 years to beginning bearing
- 8 -10 years to full bearing
- well capitalized



Pistachios characterized by....

Drought tolerance:

- growth**
- fruit quality**

Morphological tolerance mechanisms...

Roots:

- Phreatophytes:
roots to 7 meters: 27 feet**

Leaves: varies among species

- Xerophytic palisade layer adaptation**
- 1.3 – 13.3 abaxial to adaxial stomata**
- placement of stomata – near veins**
- > stomatal conductance abaxial vs.
adaxial leaves**
 - ability to maintain turgor**

Drought yield responses...

Components of yield:

$(\# \text{ clusters}) \times (\# \text{ nuts}) \times (\text{nut weight}) \times (\text{nut quality}) = \text{yield}$



Drought yield responses...

Components of yield:

Current year crop response:

- nut yield and quality
 - nut number and individual weight
 - nut quality: filled and split

Growth for following year:

- shoot growth
 - carbohydrate storage and buds
- trunk diameter growth
 - carbohydrate storage

Drought yield responses...

Components of yield responses:

Mild drought stress:

- empty nuts**
- failure to set**
- embryo abortion**
- closed nuts**
- poor nut growth**

Severe drought stress:

- shoot growth and number**





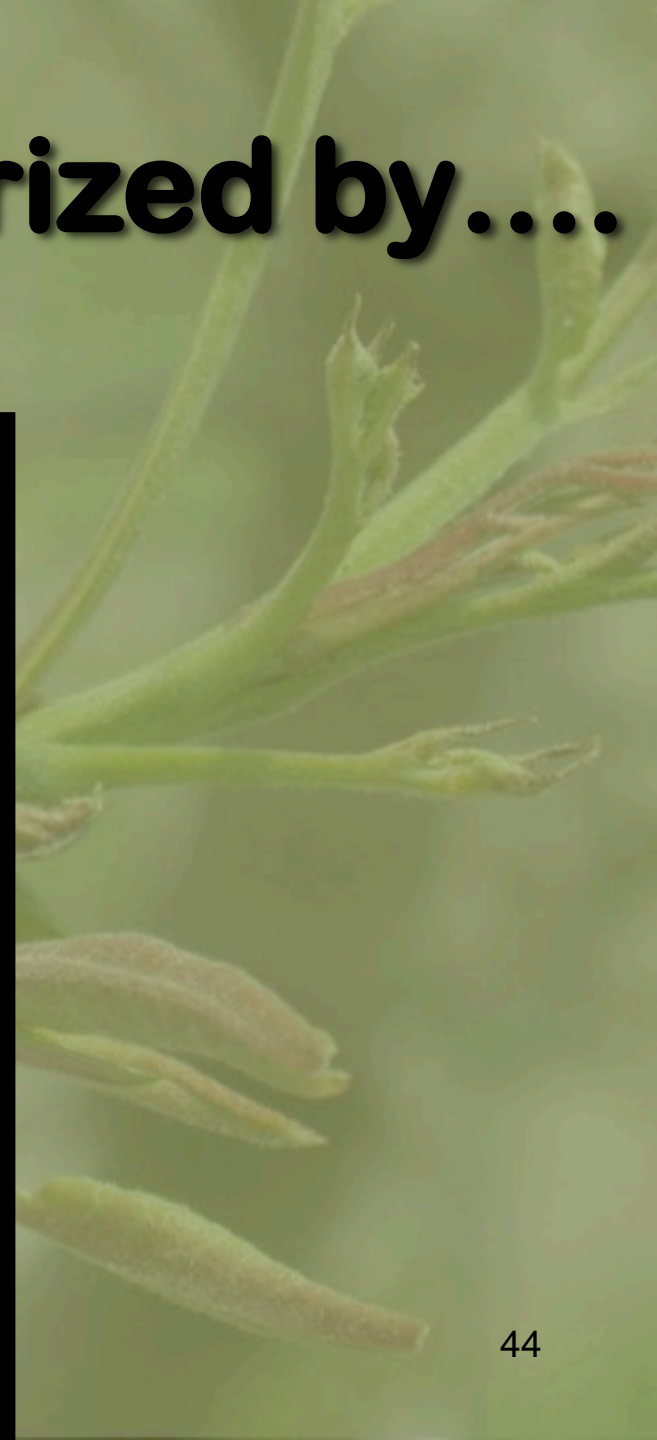




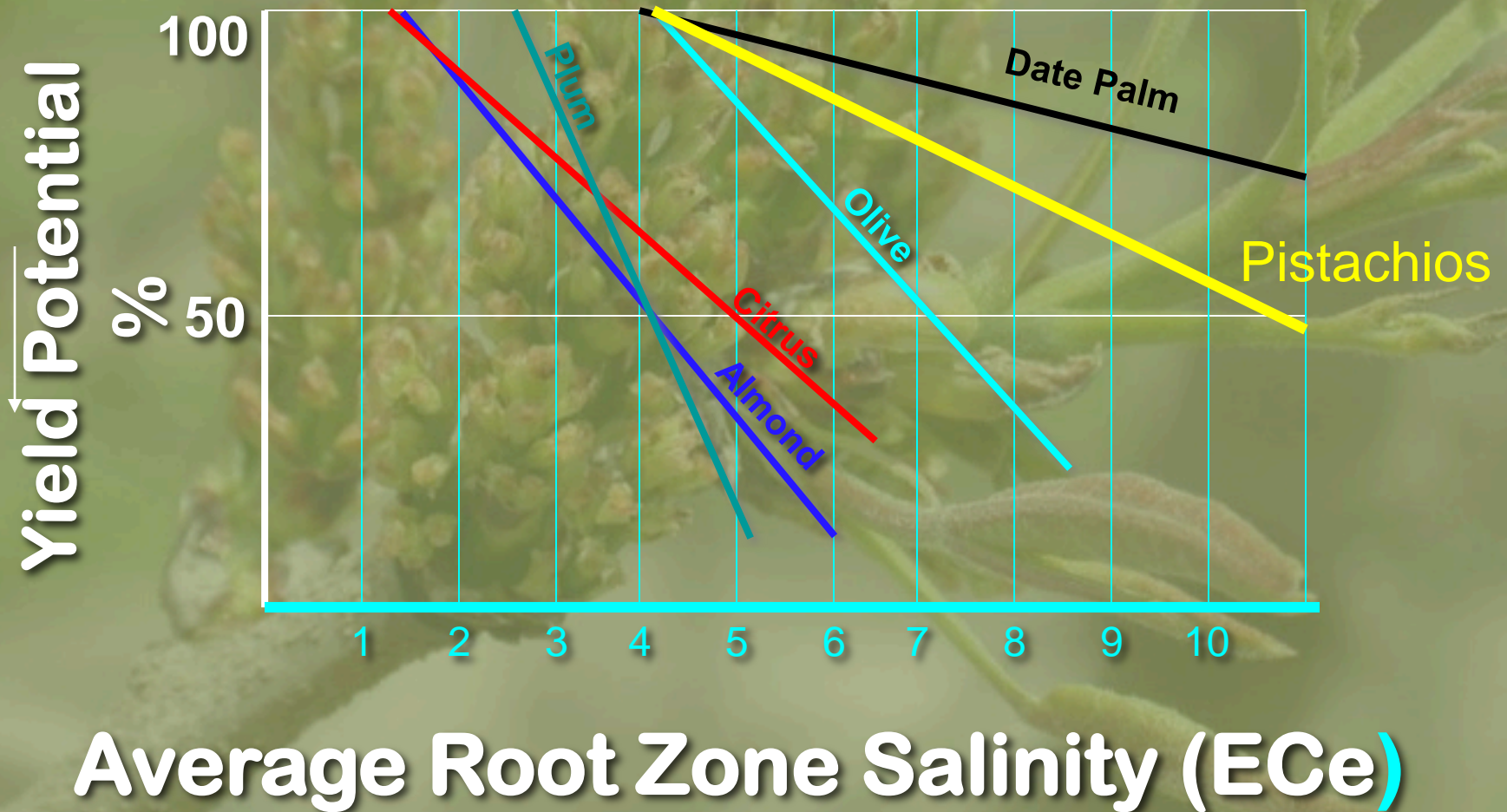
Do not tolerate saturated soils...

Pistachios characterized by....

Salinity tolerance



Relative Salt Tolerance





Specific Ion Damage

Osmotic Effects

6/6/2018

Major Findings.....

- **Field Trial: 2002**
 - Established trees can be irrigated with saline water up to 8.4 dS/m
- **Greenhouse Trial: 2001**
 - Osmotic effects > specific ion damage
 - Difference among rootstocks in how they partition Na, CL

Major Findings.....

- Field Establishment Trial: ongoing
 - When developing an orchard with saline water up the salinity levels may need to be lower: 6.4 dS/m
 - Hybrid rootstocks with *P. Atlantica* are more tolerant than *P. integerrima*



November, 2009

Na

Saline Sodic So

Pistachios characterized by....

Need based nutritional uptake



Pistachios characterized by....

Need based nutritional uptake:

- **Macronutrient applications based on current crop**
 - **not luxury consumers**
 - **groundwater quality issues**
- **Strong demand for micronutrients**
 - ***P. integerrima* parentage rootstocks**
 - **boron, zinc and copper**

Annual Nutrient Demand and Uptake in Pistachio



Pistachios characterized by....

Crop load responses:

- alternate bearing**
- splitting**
- embryo abortion**

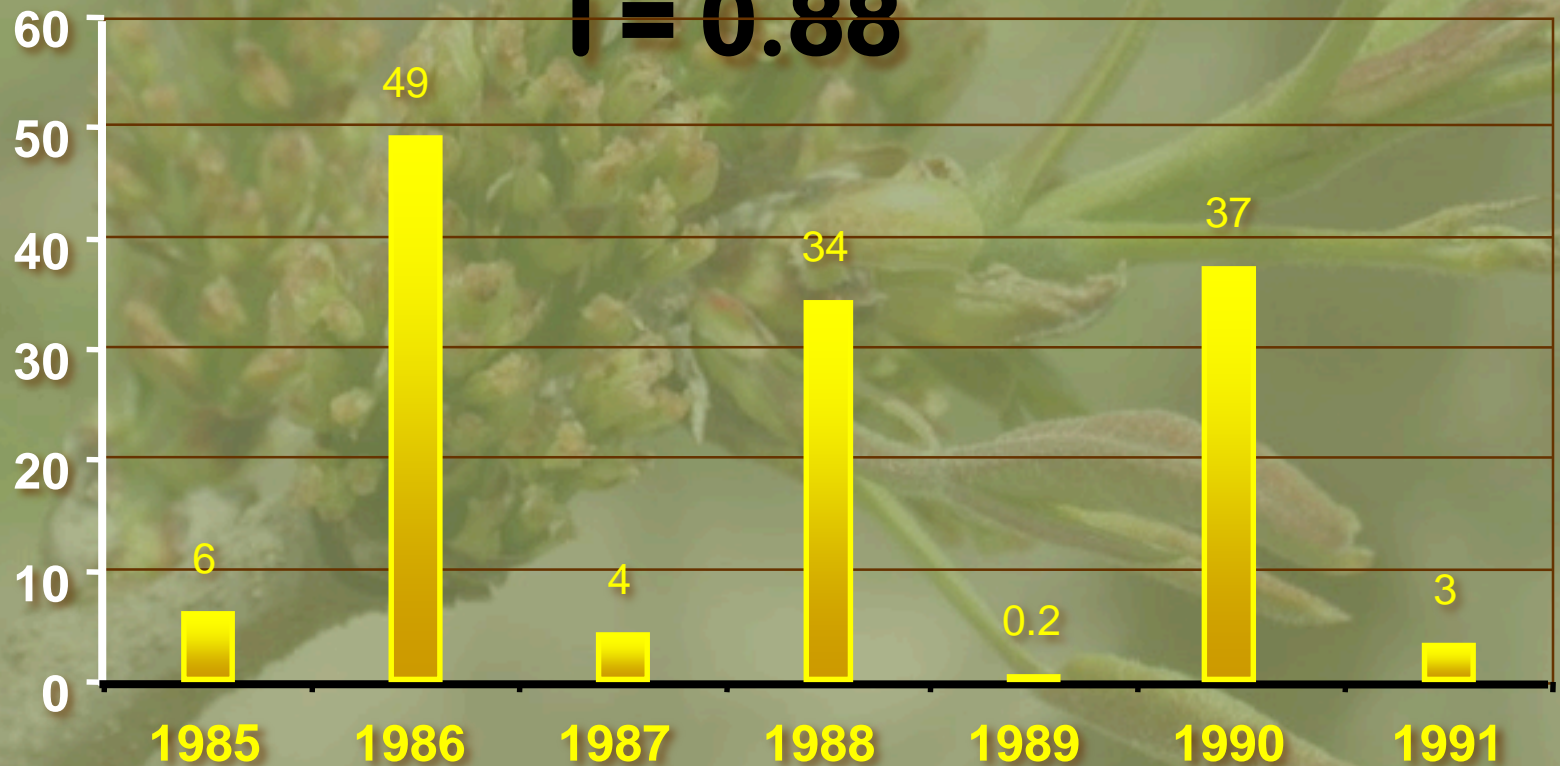


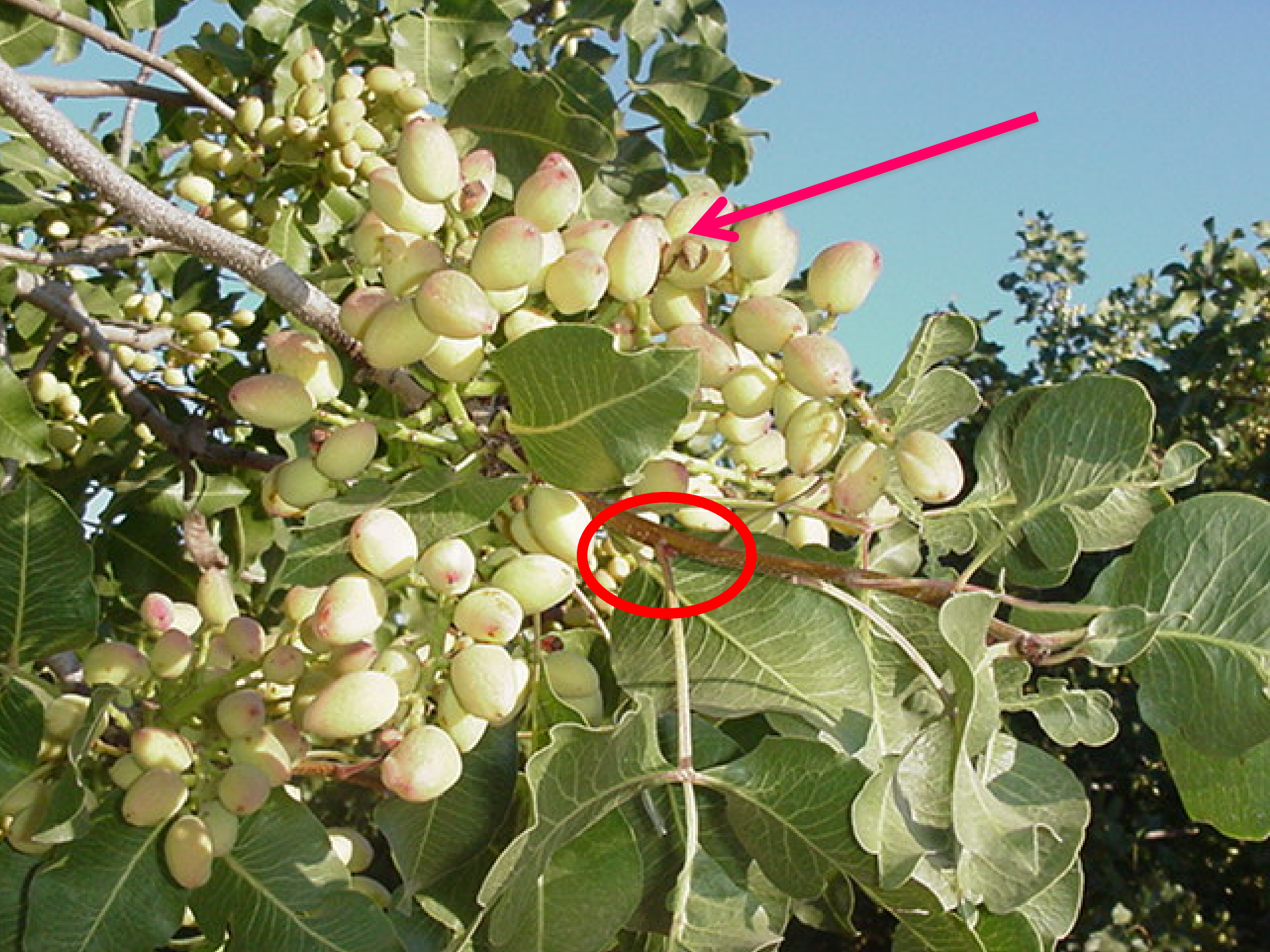
Alternate Bearing in Kern County

1985 – 1991

$I = 0.88$

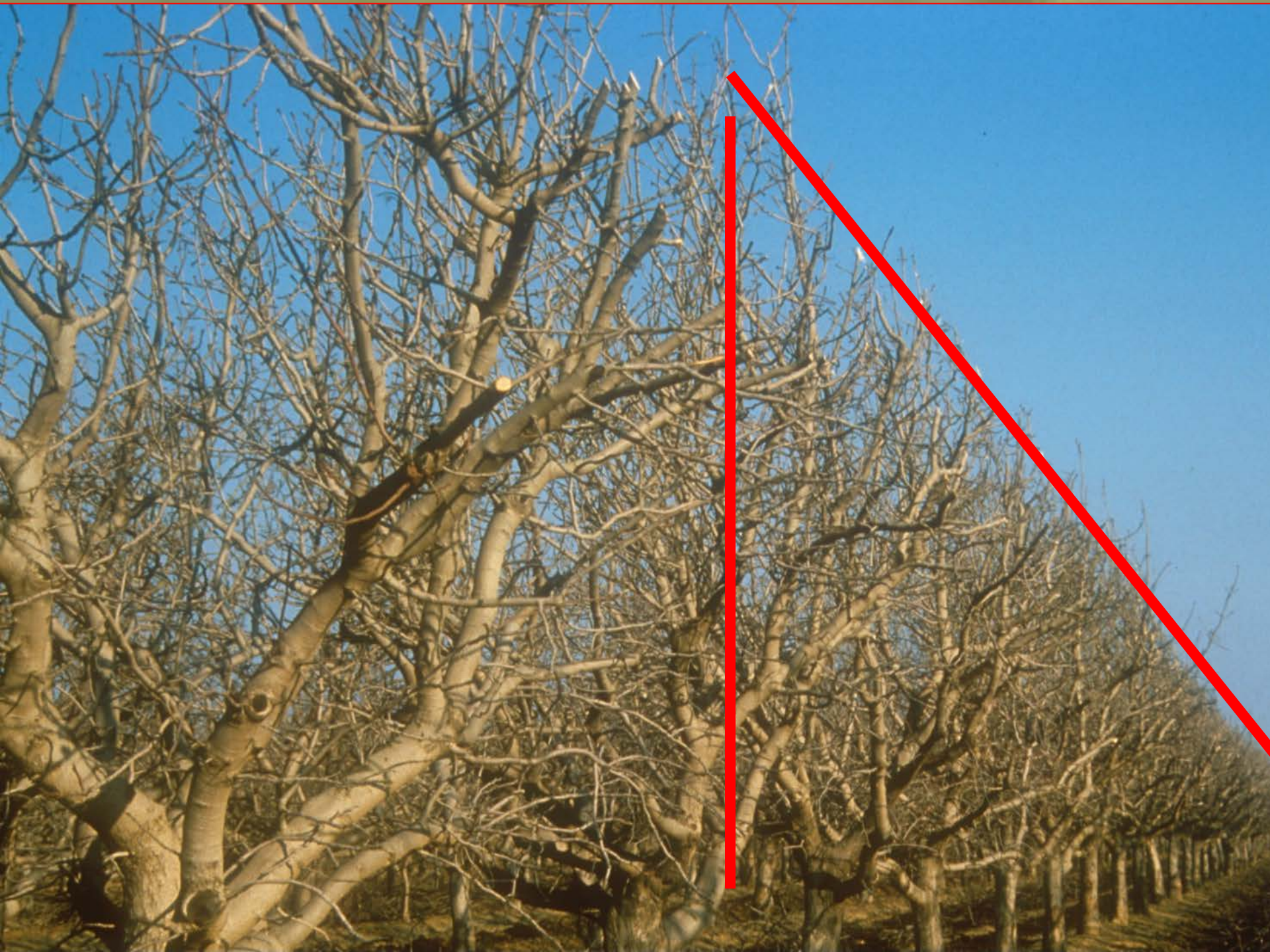
Average Lbs/tree











7 Year Yield Response

P. atlantica

- Hedged and Topped

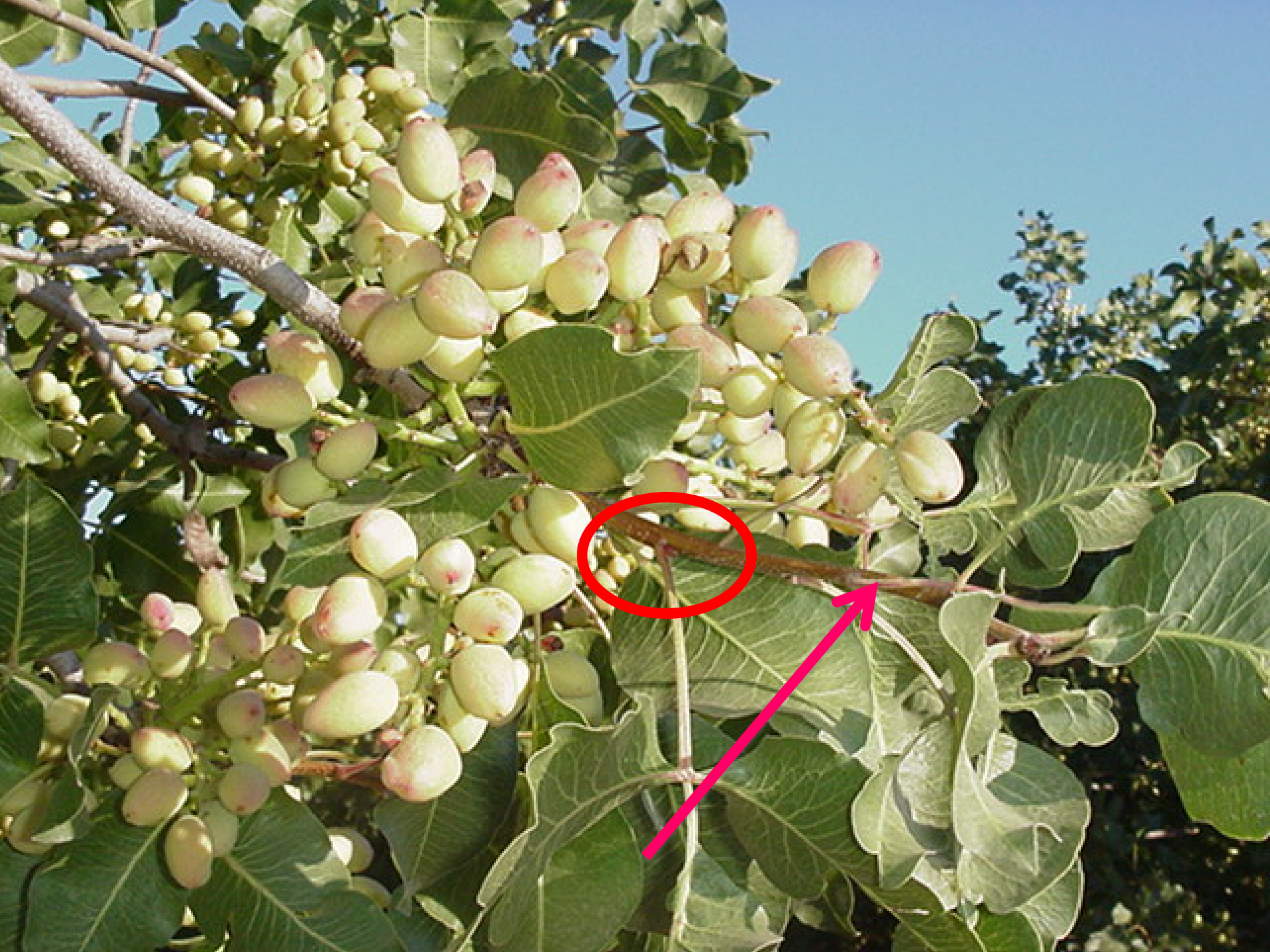
- 1985: 0.8 kg/tree
- 1986: 12.7 kg/tree ON!
- 1987: 6.4 kg/tree
- 1988: 11.8/kg/tree ON!
- 1989: 5.1/kg/tree
- 1990: 12.2/kg/tree ON!
- 1991: 11.6/kg/tree

- 60.6/kg/tree
cumulative

- Control

- 1985: 2.9 kg/tree OFF!
- 1986: 22.1 kg/tree
- 1987: 1.6 kg/tree OFF!
- 1988: 15.3/kg/tree
- 1989: 0.1/kg/tree OFF!
- 1990: 16.7/kg/tree
- 1991: 1.4/kg/tree OFF!

- 60.1/kg/tree
cumulative



A photograph of a large orchard of bare trees in a field. The trees are arranged in rows and are without leaves, showing their intricate branch structures. The ground is a mix of dirt and sparse grass. In the foreground, there are four red-bordered labels with white text: 'Atlantica', 'PG II', 'PGI', and 'UCBI'.

Atlantica

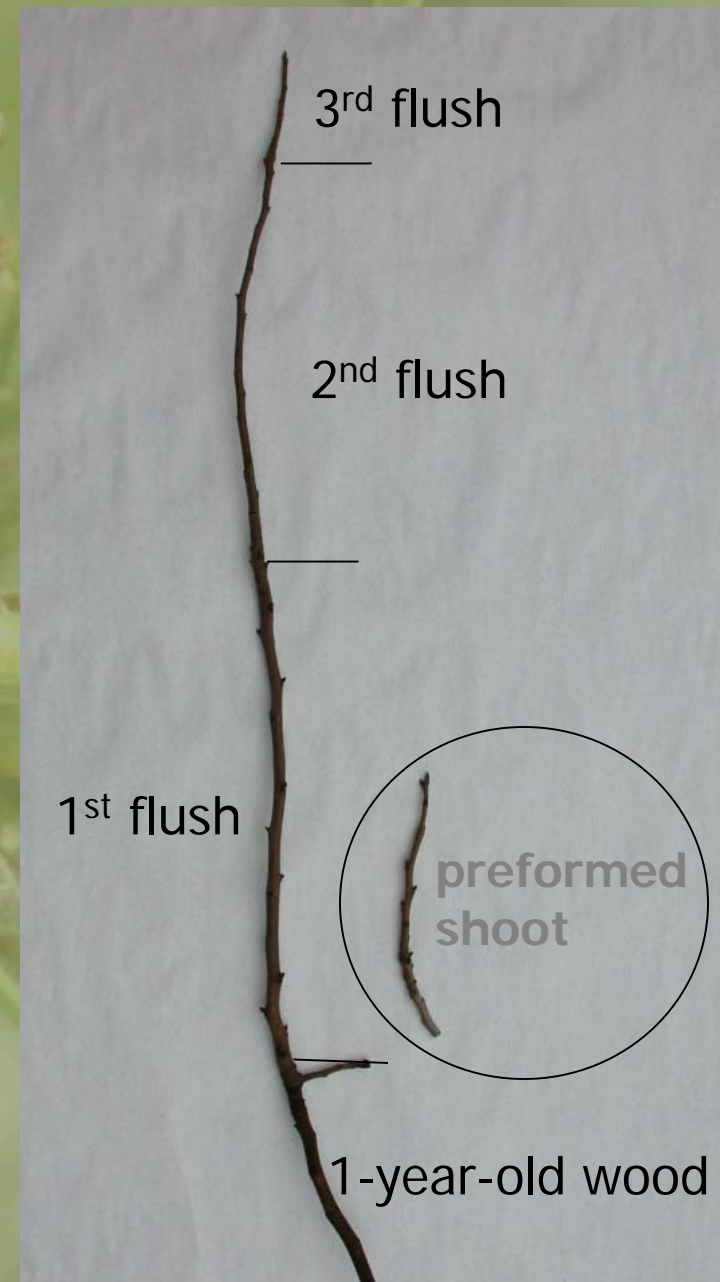
PG II

PGI

UCBI

Rootstock Effect

- Kerman on PG-I and UCB-1 produces multiple flushes
- Spring growth flush is preformed on all rootstocks
 - Time separation between node initiation and extension
- Later flushes are neoformed
 - Nodes are initiated and extended simultaneously



Contact Information

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