



# Impact of Environmental Stress on Pistachio Orchard Performance

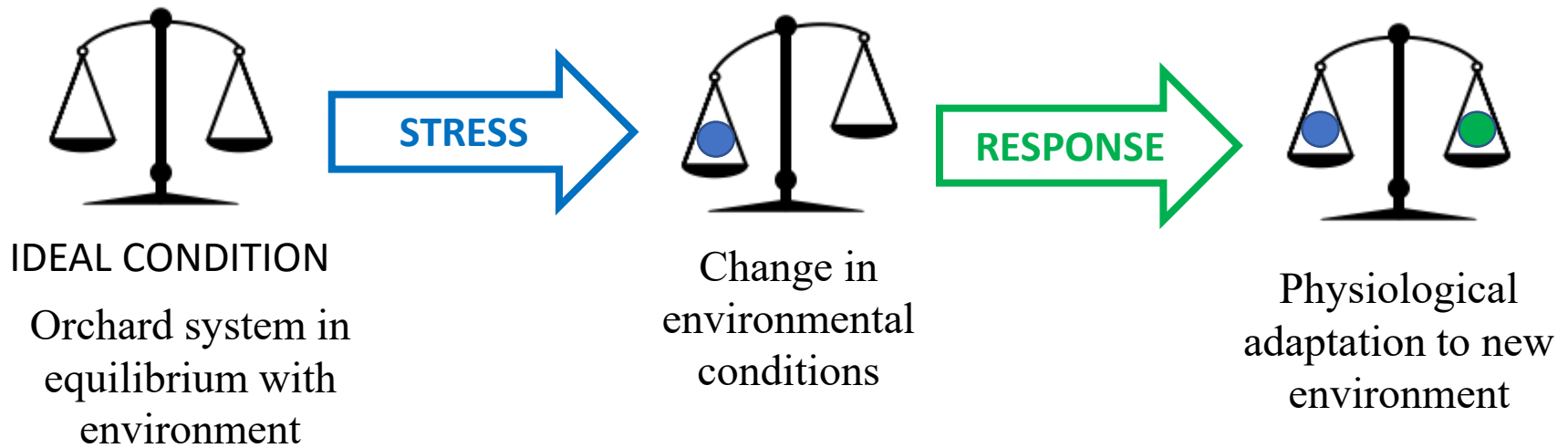
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# Stress in orchard systems



## MANAGEMENT 1



POTENTIAL  
PRODUCTIVITY

4000 lb/acre



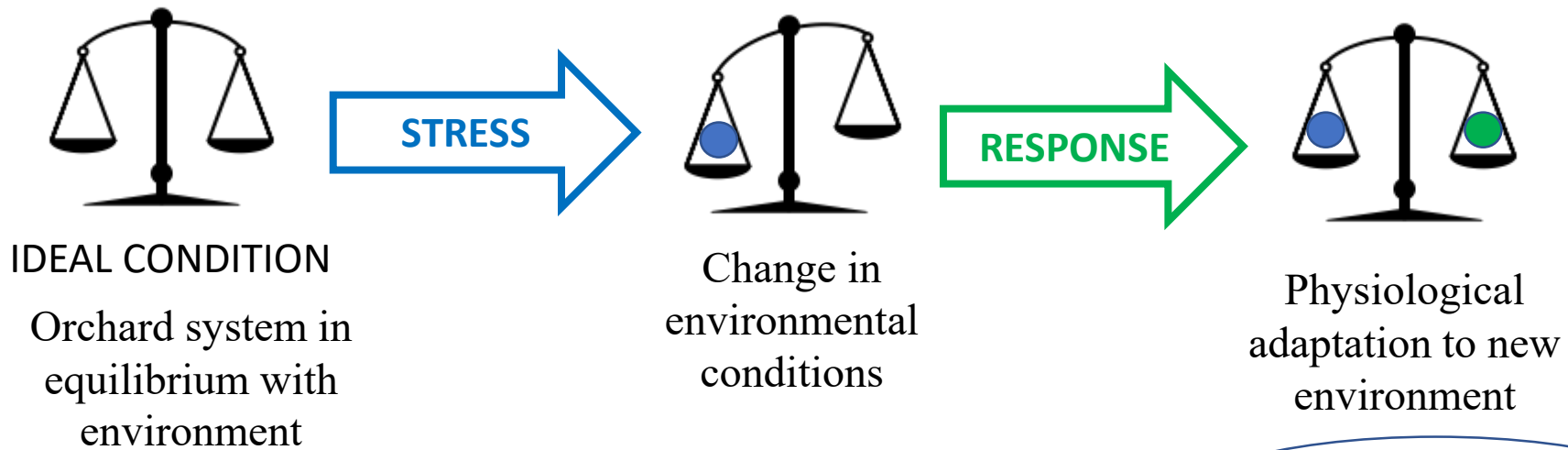
## MANAGEMENT 1



~~POTENTIAL~~  
PRODUCTIVITY

1000 lb/acre

# Stress in orchard systems



## MANAGEMENT 1

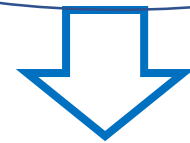


POTENTIAL  
PRODUCTIVITY

4000 lb/acre



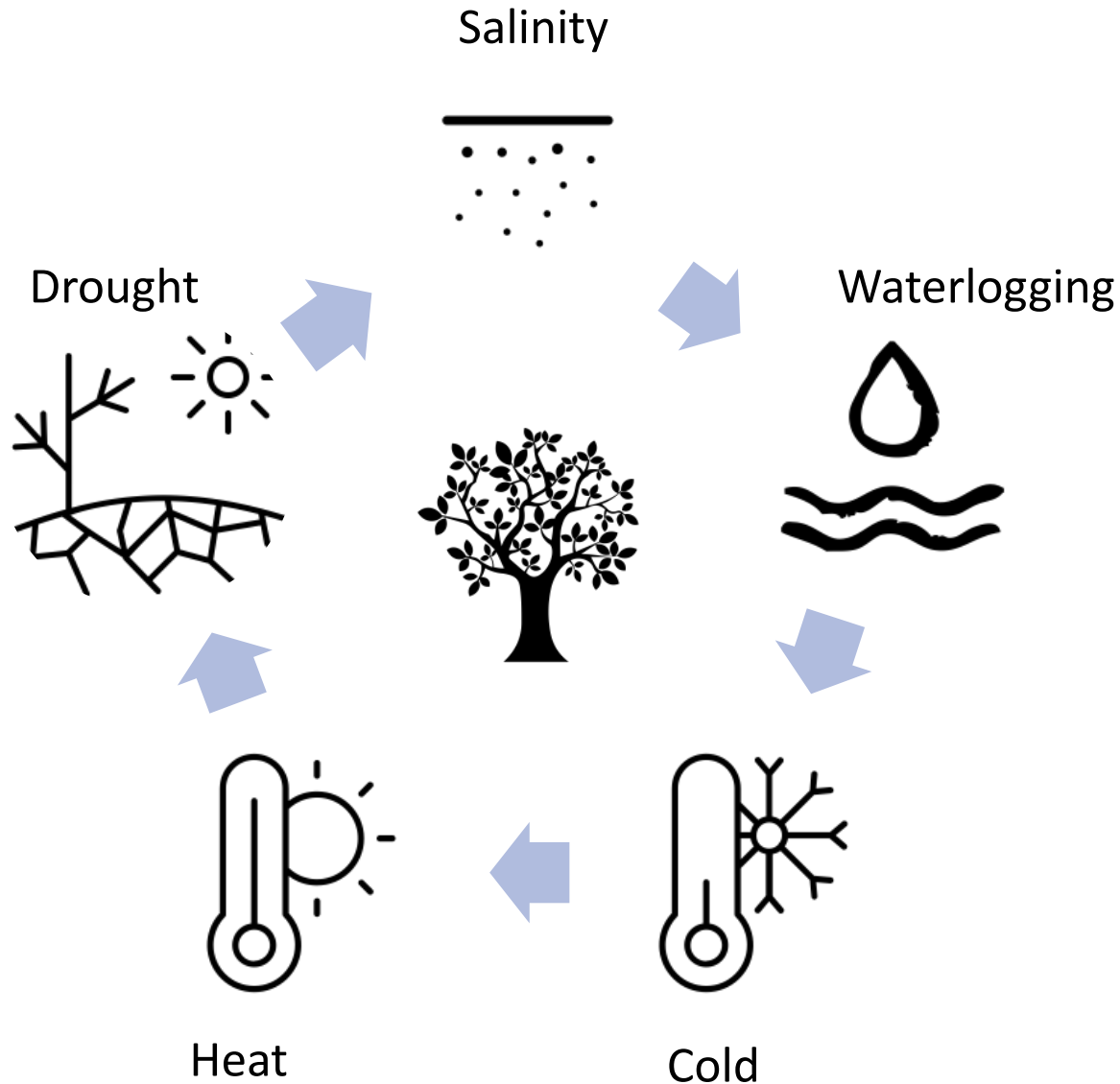
## MANAGEMENT 2



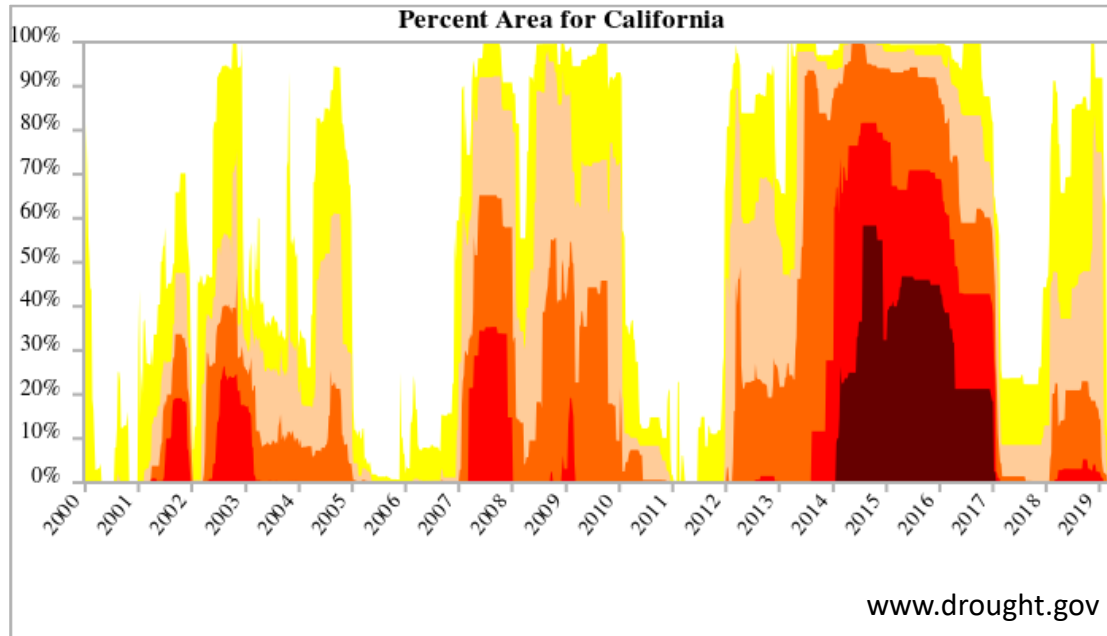
POTENTIAL  
PRODUCTIVITY

3500 lb/acre

# Environmental stressors

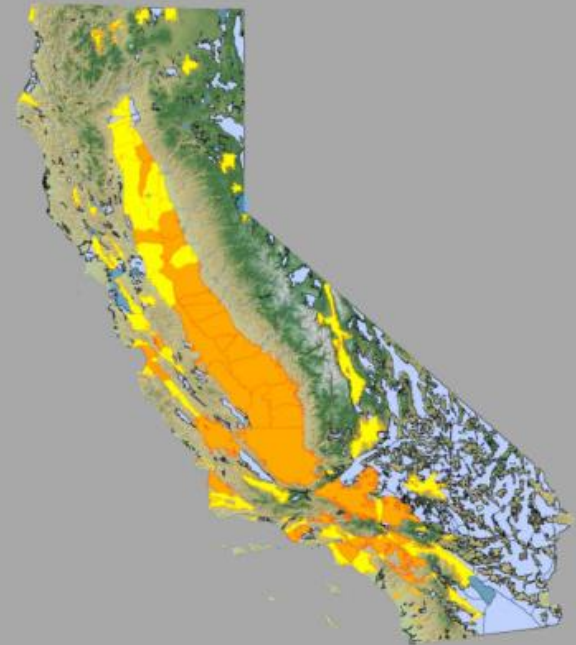


# Drought



- D0 - Abnormally Dry
- D1 - Moderate Drought
- D2 - Severe Drought
- D3 - Extreme Drought
- D4 - Exceptional Drought

## Groundwater Basins



Groundwater Sustainability Plans  
Required for **High** and **Medium**  
Priority Basins by 2020/22

PPIC, 2017

In most of the critically-overdrafted basins, SGMA will restrict GW extractions to around 1.5-2 ac-ft/ac (24 in)

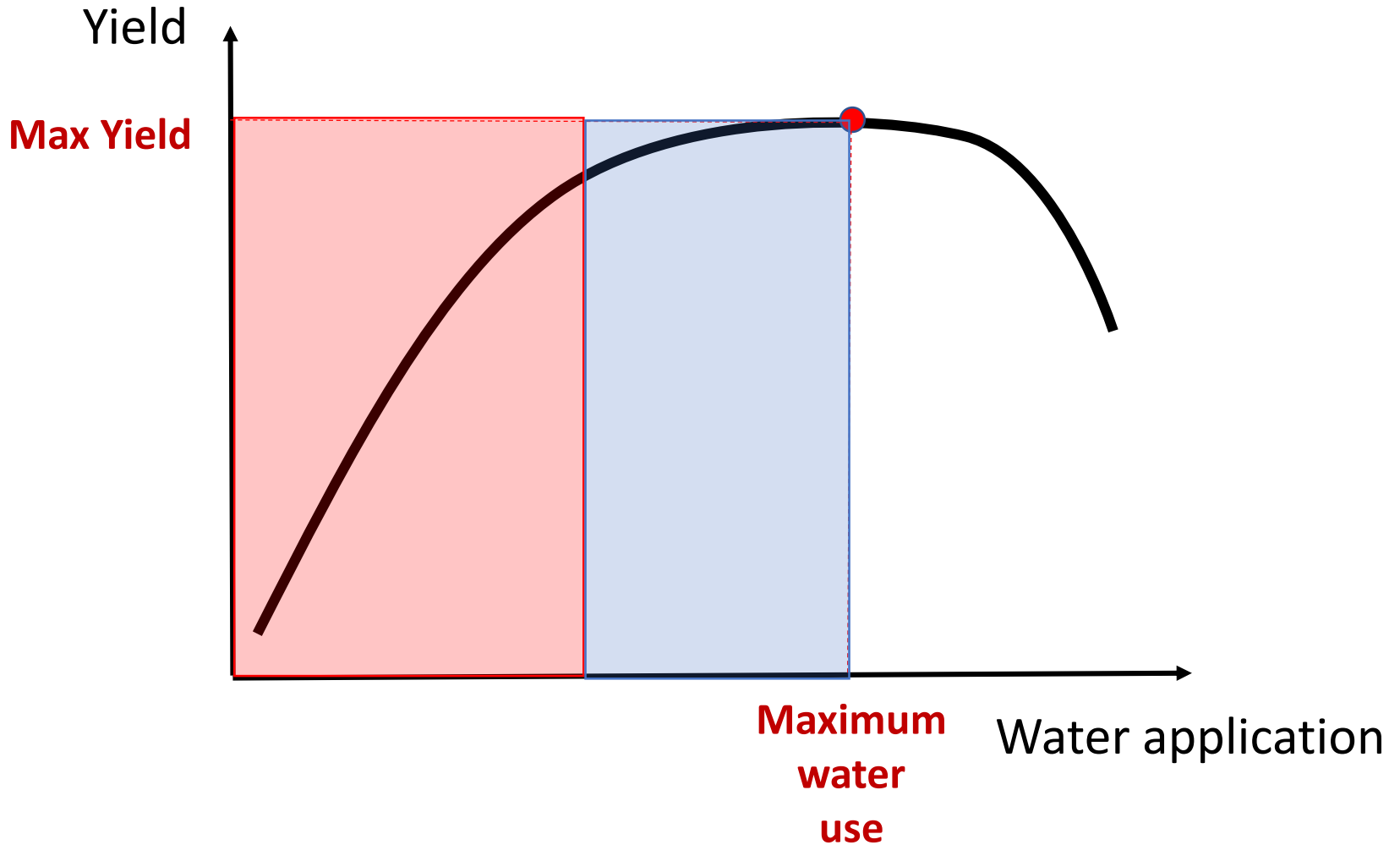
# Drought

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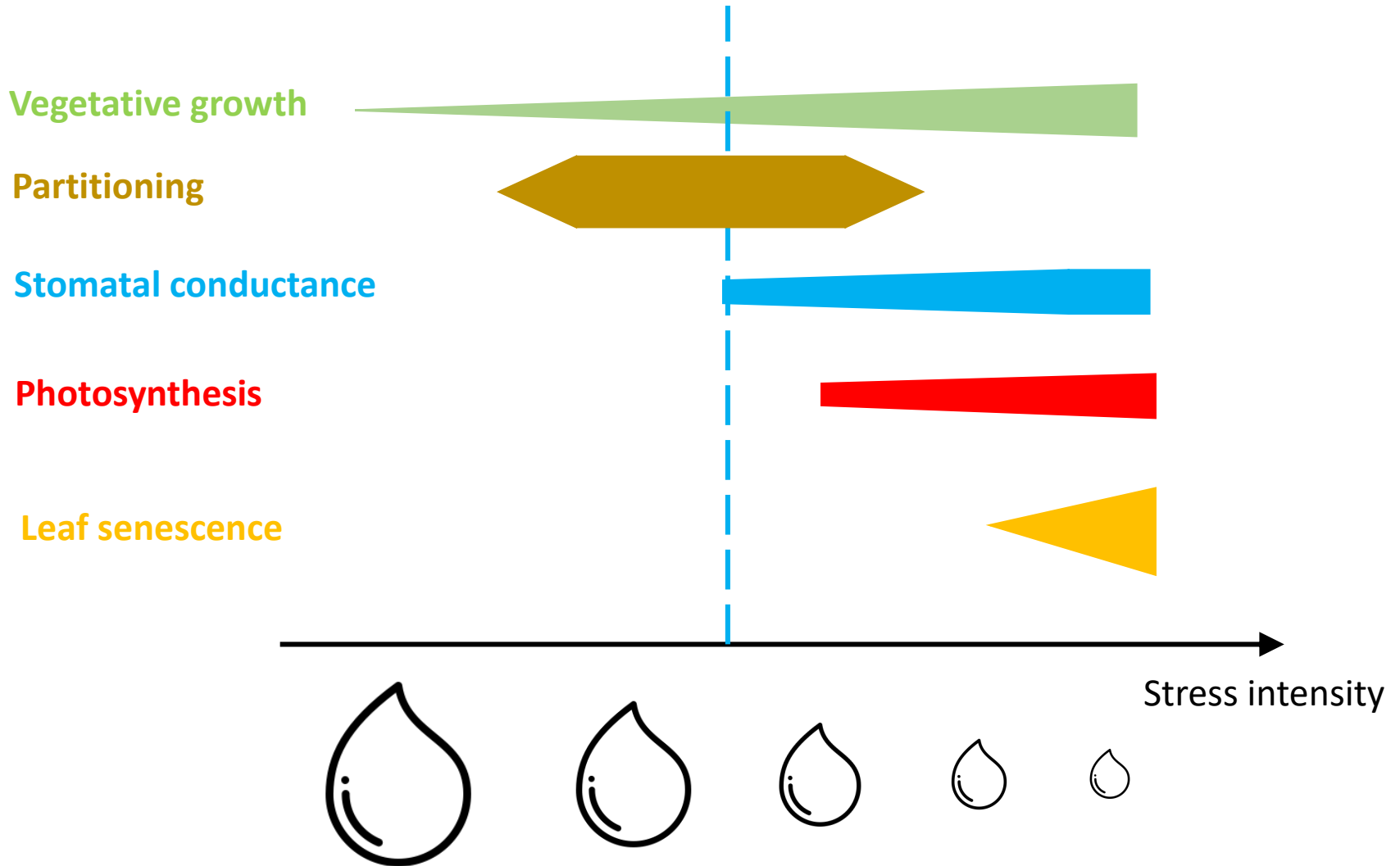


Pistachio is drought resistant but can use large volumes of water

# Drought: Impact on yield

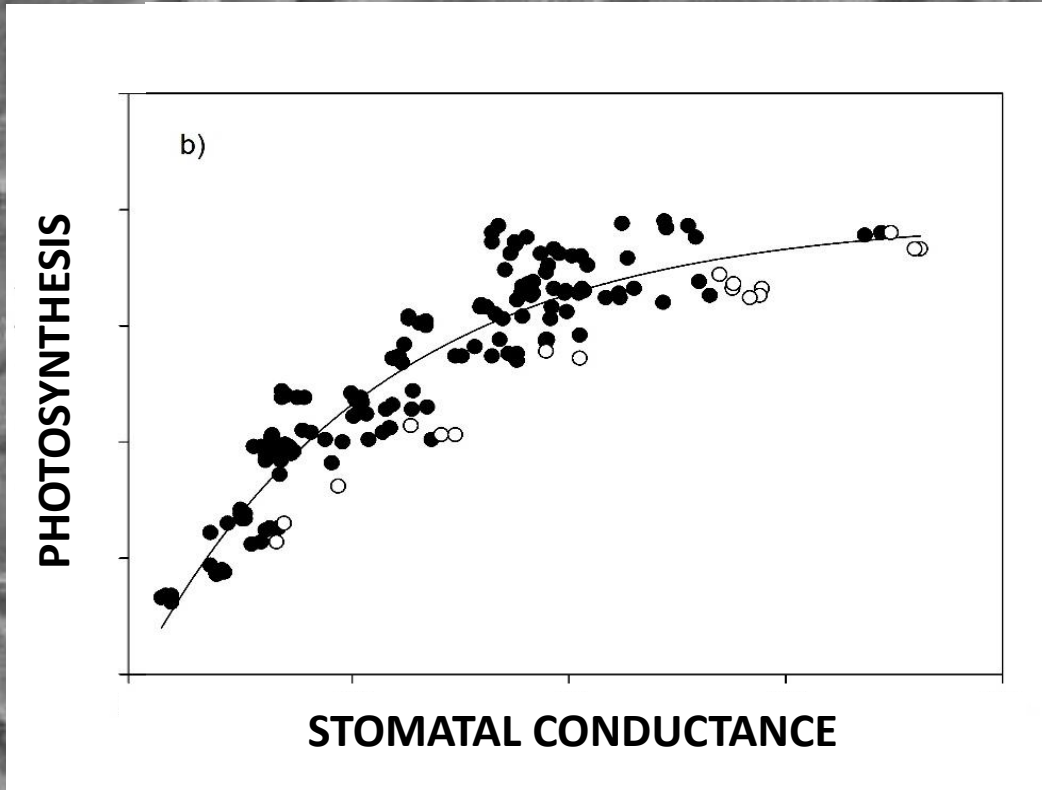


# Effect of drought on tree physiology



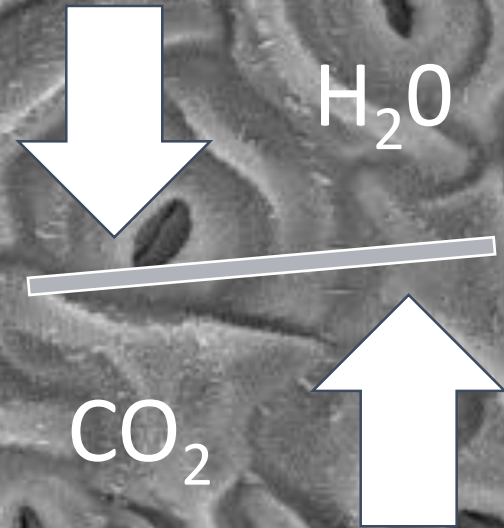


# Drought: Physiological response.



Marino et al 2018

Leaf Water Use

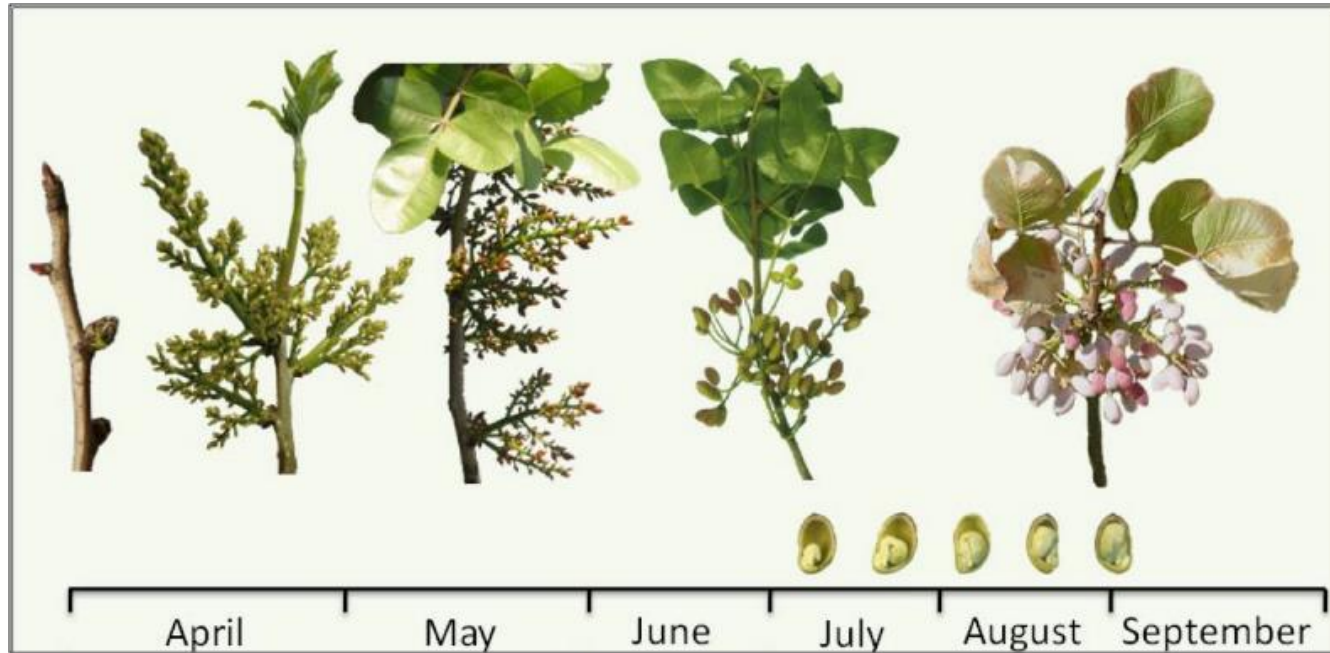


pot Magn  
0 400x

Det WD  
BSE 10.1

50  $\mu m$

# Orchard Management: Drought



Nut growth  
Leaf expansion

**STAGE 1**

Shell hardening  
Trunk growth

**STAGE 2**

Embryo filling

**STAGE 3**

Senescence



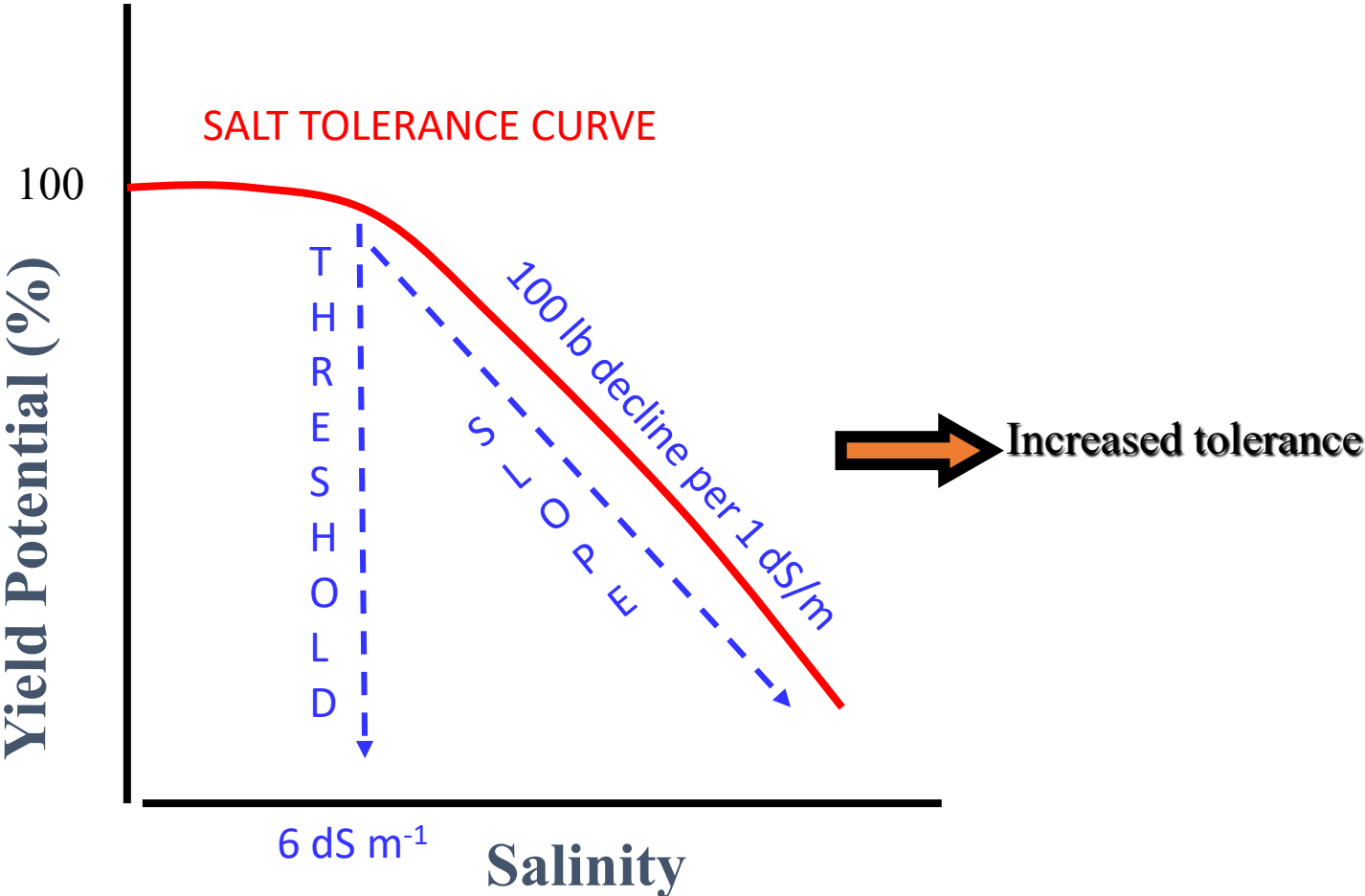
# Salinity

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Pistachio is salt tolerant

# Pistachio salt tolerance



# Effects of salinity on Pistachio yield



Specific Ion toxicity

- Nutrient Imbalances
- Higher Energy cost



< soil osmotic potential



Degradation of soil structure

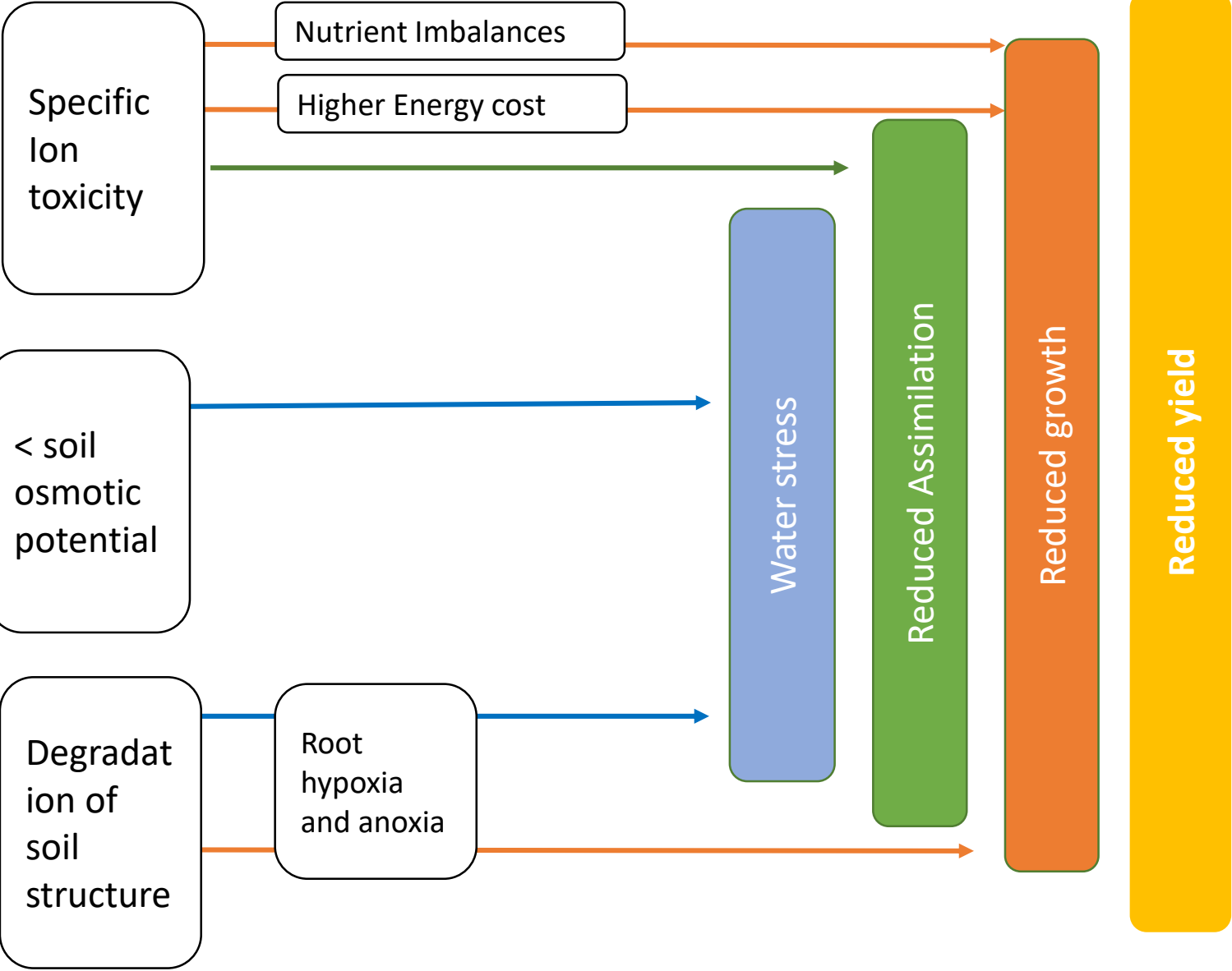
Root hypoxia and anoxia

Water stress

Reduced Assimilation

Reduced growth

Reduced yield



# Orchard management

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- Tolerant rootstocks and cultivar (Pistachio Breeding program, Pat. J Brown, Craig Kallsen)
- Winter and summer leaching (Ferguson)
- Soil amendments
- Better water management (Zaccaria)

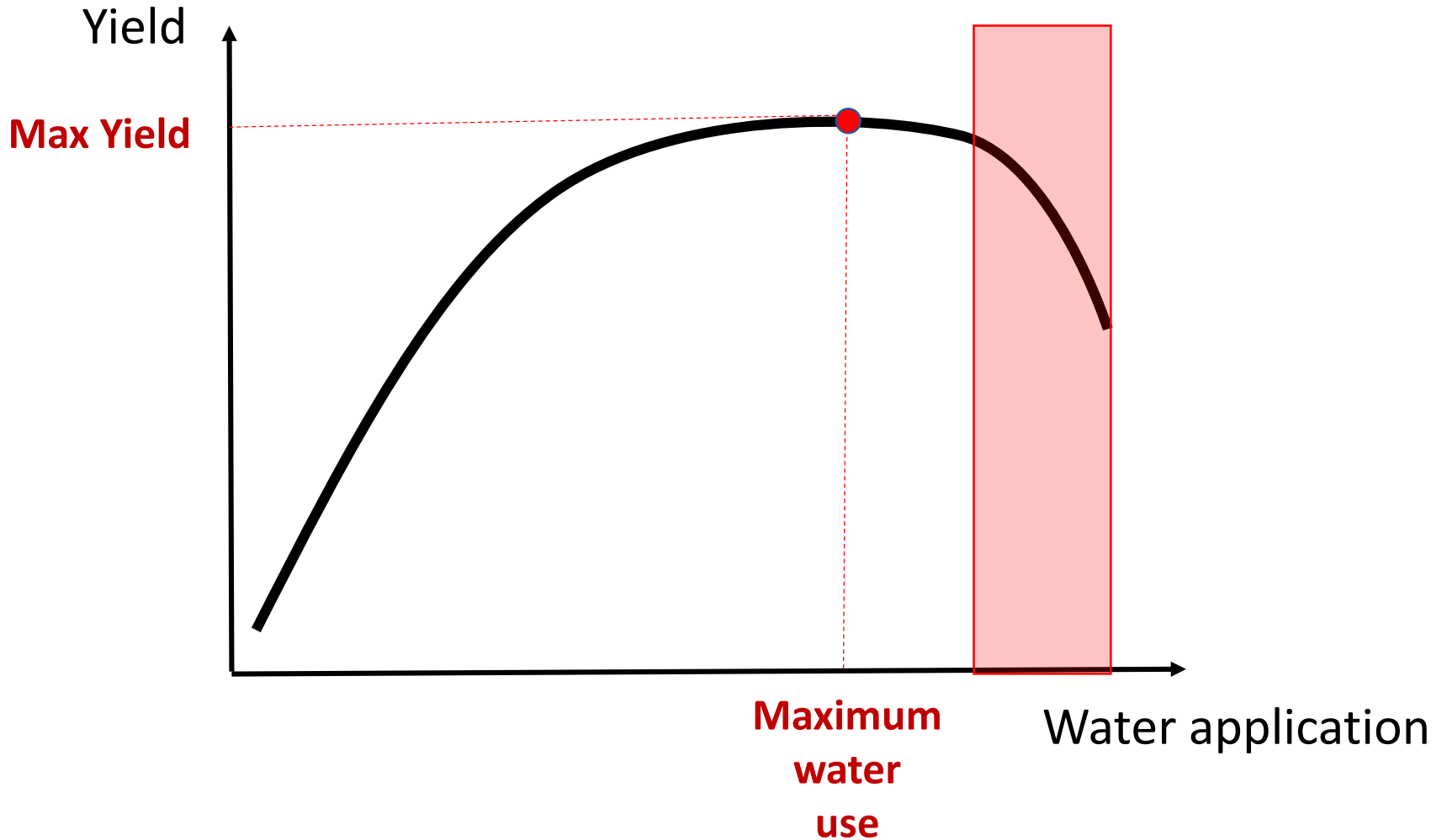
# Flooding

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Pistachio does not tolerate saturated soil

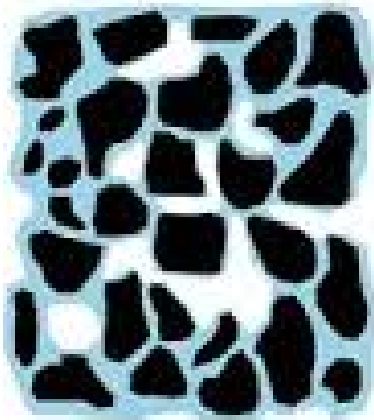
# Flooding: Impact on yield





# Flooding

Field capacity



Saturation



- Salinity
- compaction
- sodicity
- over irrigation

As water saturates the soil pores, gases are displaced, creating low oxygen concentration in the rootzone that limit (hypoxia ) or inhibit (Anoxia) **root respiration**

# Flooding: Impact on tree physiology

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- Photosynthesis
- Stomatal closure
- Water uptake
- Transport of carbohydrates
- Early leaf senescence
- Decay of the root system

**SIMILAR TO DROUGHT, LESS REVERSIBLE**

**NO MUCH INFORMATION FOR PISTACHIO**

Yellow shoots in current year (due to wet conditions) results in blank zones in the following year, similar to what we have seen in walnut.



Bruce Lampinen's observations on the impact of excessive irrigation on Pistachio

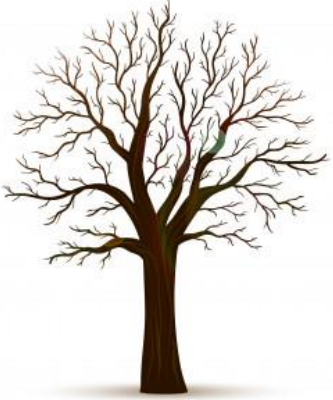
# Orchard management: Flooding

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- Apply the right amount of water
- Soil amendments
- Improve soil infiltration

# Temperature

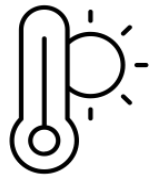
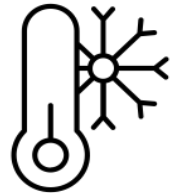
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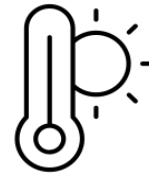
Winter



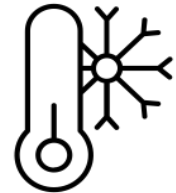
Spring



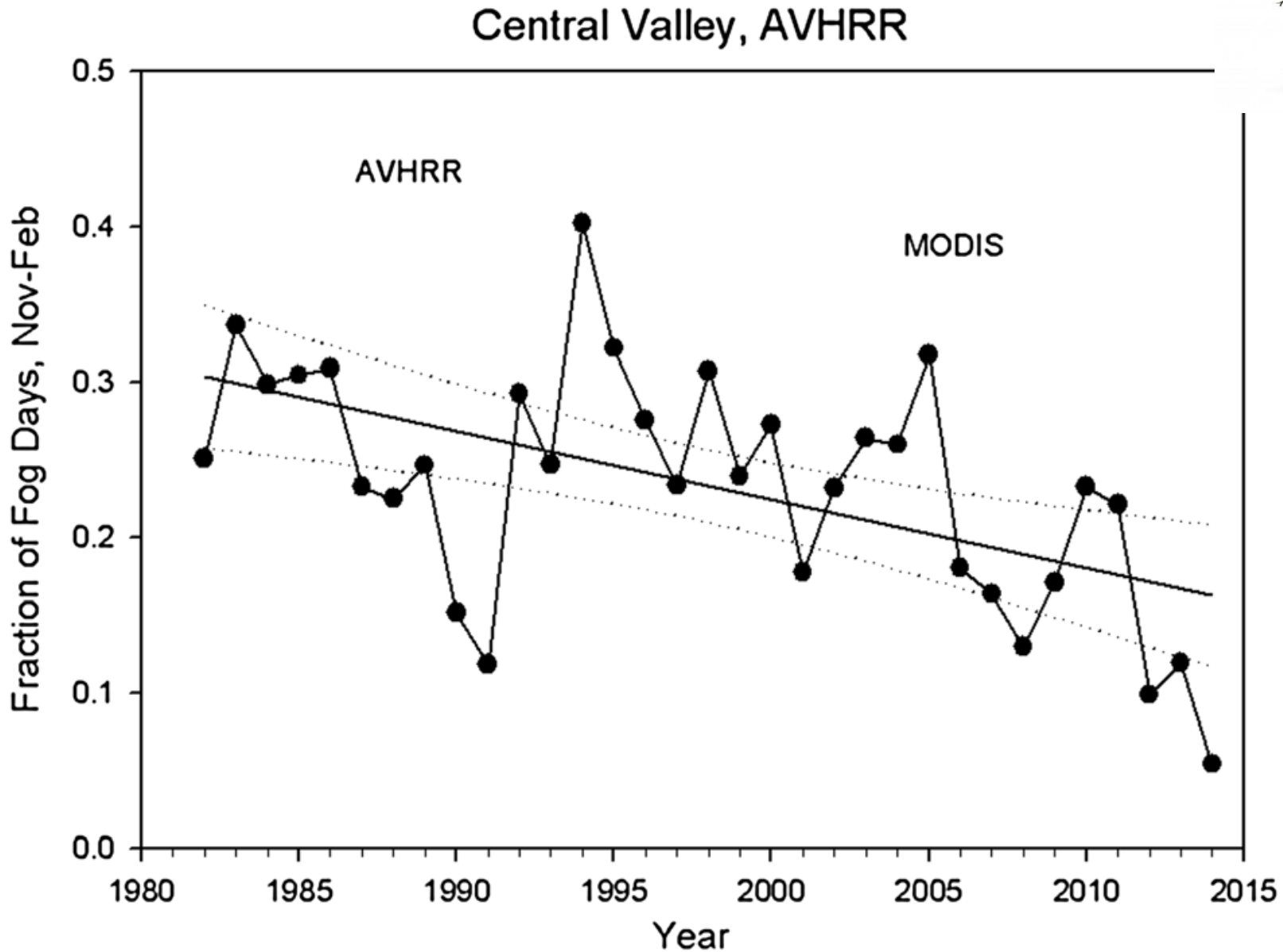
Summer



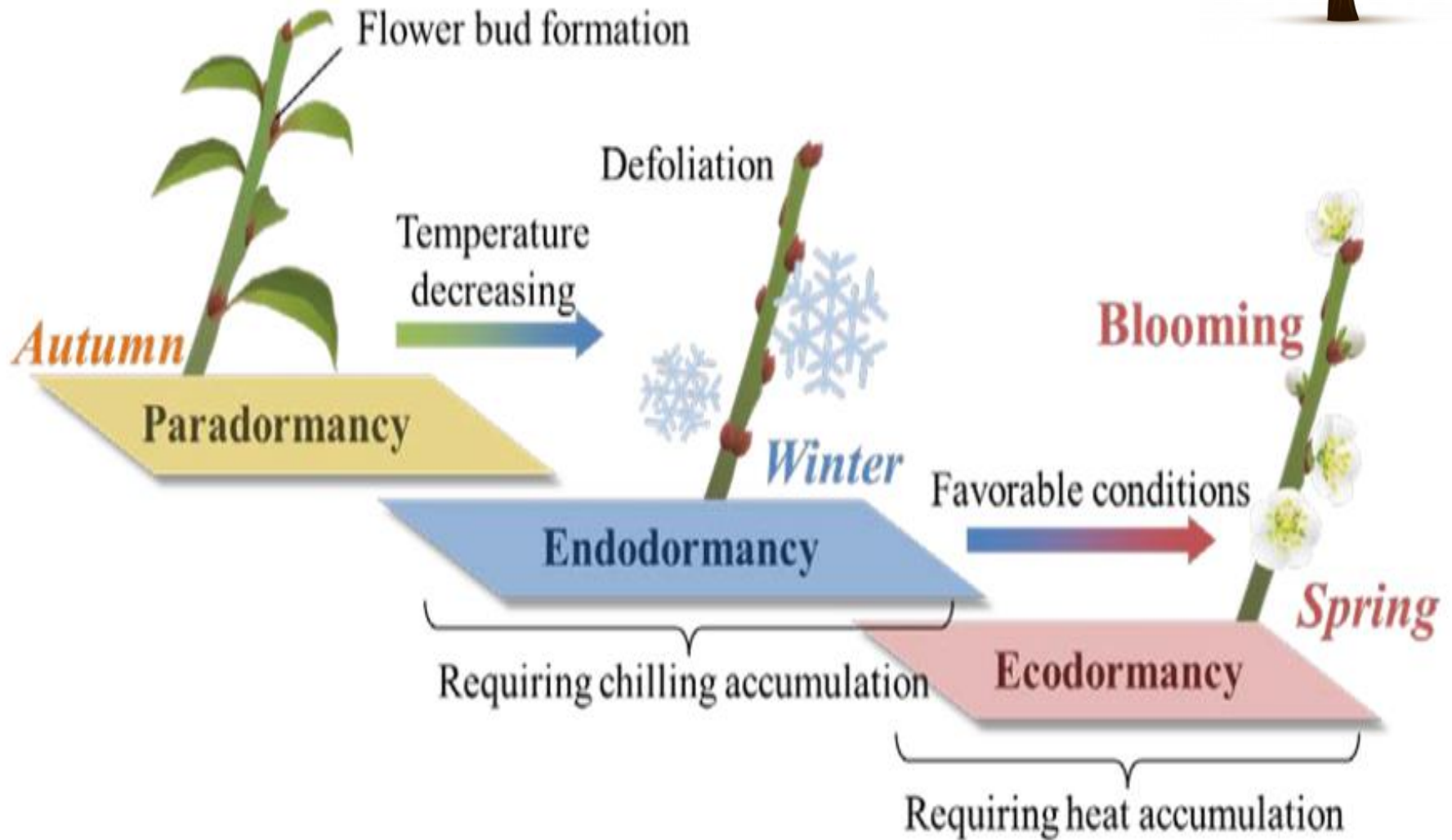
Fall



# Temperature: winter



# Temperature: winter



# Temperature: winter

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Late and uneven bloom and low  
quality nuts





# Temperature: winter

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# Temperature: winter

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Picture courtesy of Barbara Blanco Ulate

# Temperature: winter

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- Mismatch of male and female bloom



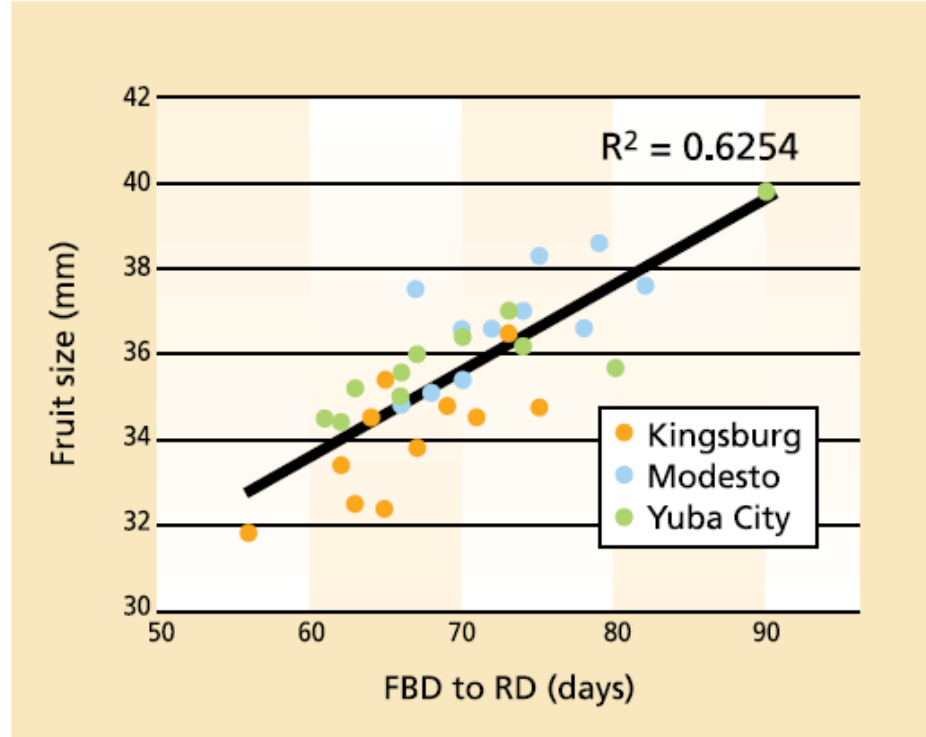
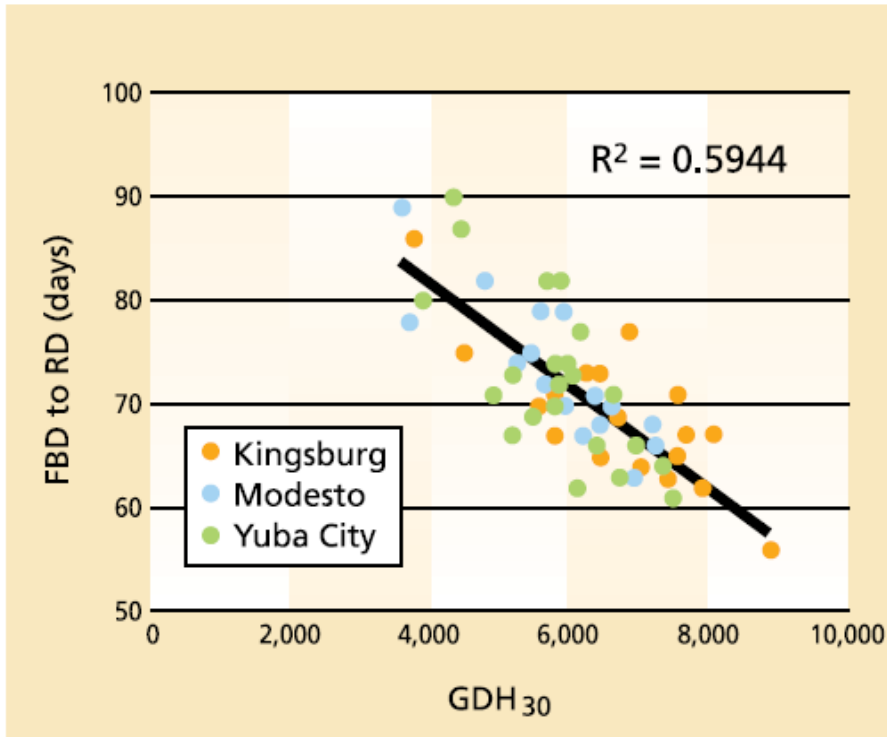
Photo courtesy of Elizabet Fithchner

# Orchard management: low winter chill

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- Cultivar with lo chill requirement
- More pollinators with different chill requirement
- Oil application or dormancy breaking agents
- Light reflecting products
- Shading
- Above canopy irrigation

# Temperature: Spring



Gerardo Lopez, R. Scott Johnson  
and Theodore M. DeJong

# Temperature: Fall

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late October through to the end of December in 1st through 8th-leaf trees

# Temperature: Fall

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high sodium levels in the soil and water, or the presence of hardpans increase freeze damage

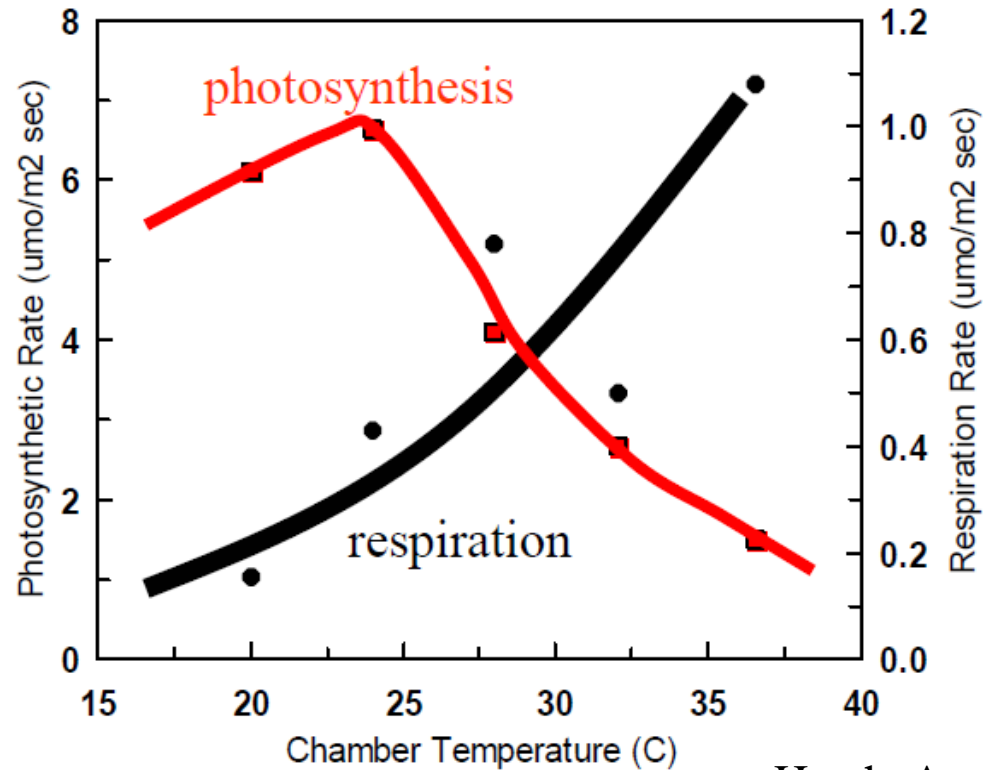
# Orchard management: fall freeze

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- Cut off water early enough to push the tree into dormancy (August)
- Defoliate trees (October)
- Leach salt before planting in high saline sodic areas
- Do not apply nitrogen after July 1. Do not train 2nd leaf trees after mid-August or earlier



# Temperature: summer



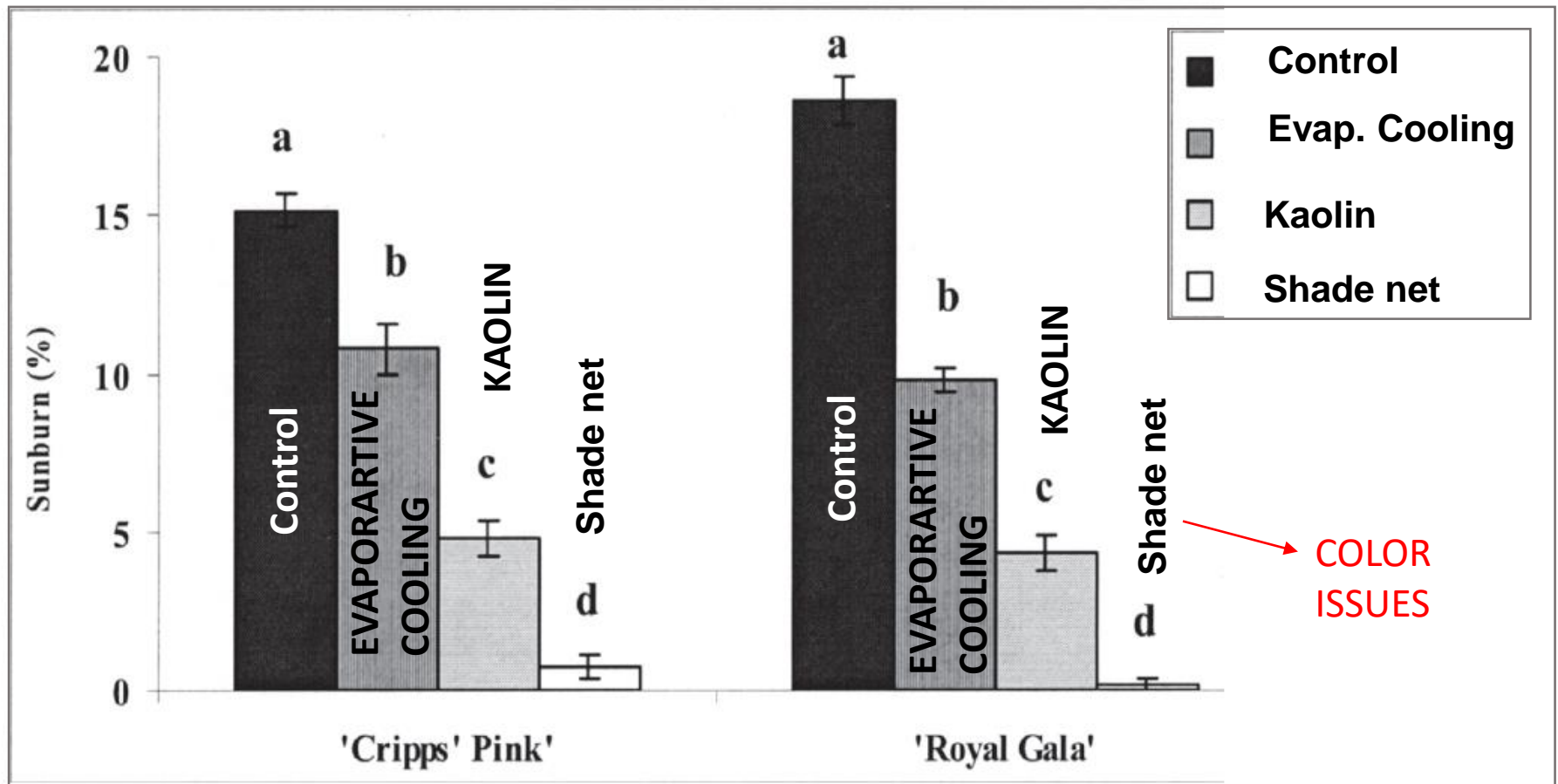
Heath, Arpaia, Mickelbart

Respiration has a much higher temperature optimum than photosynthesis

Respiration increases rapidly with temperature, often by 50 to 200% per 10 °C.

Under prolonged heat stress depletion of carbohydrate reserves for maintenance  $R$  and plant starvation are also observed

# Orchard Management: summer heat



# The real world: stress interaction

	Drought	Heat	Freezing	Pathogen	Nutrients	Boron	Flooding	Humidity
Salinity			?					
Drought			?			?	?	
Heat					?	?	?	?
Freezing				?	?	?	?	?
Pathogen						?		
Nutrient								
Boron							?	?
Flooding								?

	Potential negative interaction	?	Unknown mode of interaction
	Potential positive or negative interaction		No interaction
	Potential positive interaction		

**THANK YOU**

