Small Vineyard Management

Concepts for Winegrape Growers

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Vineyard Health

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- 'Health' – the state of being **free** from illness or injury

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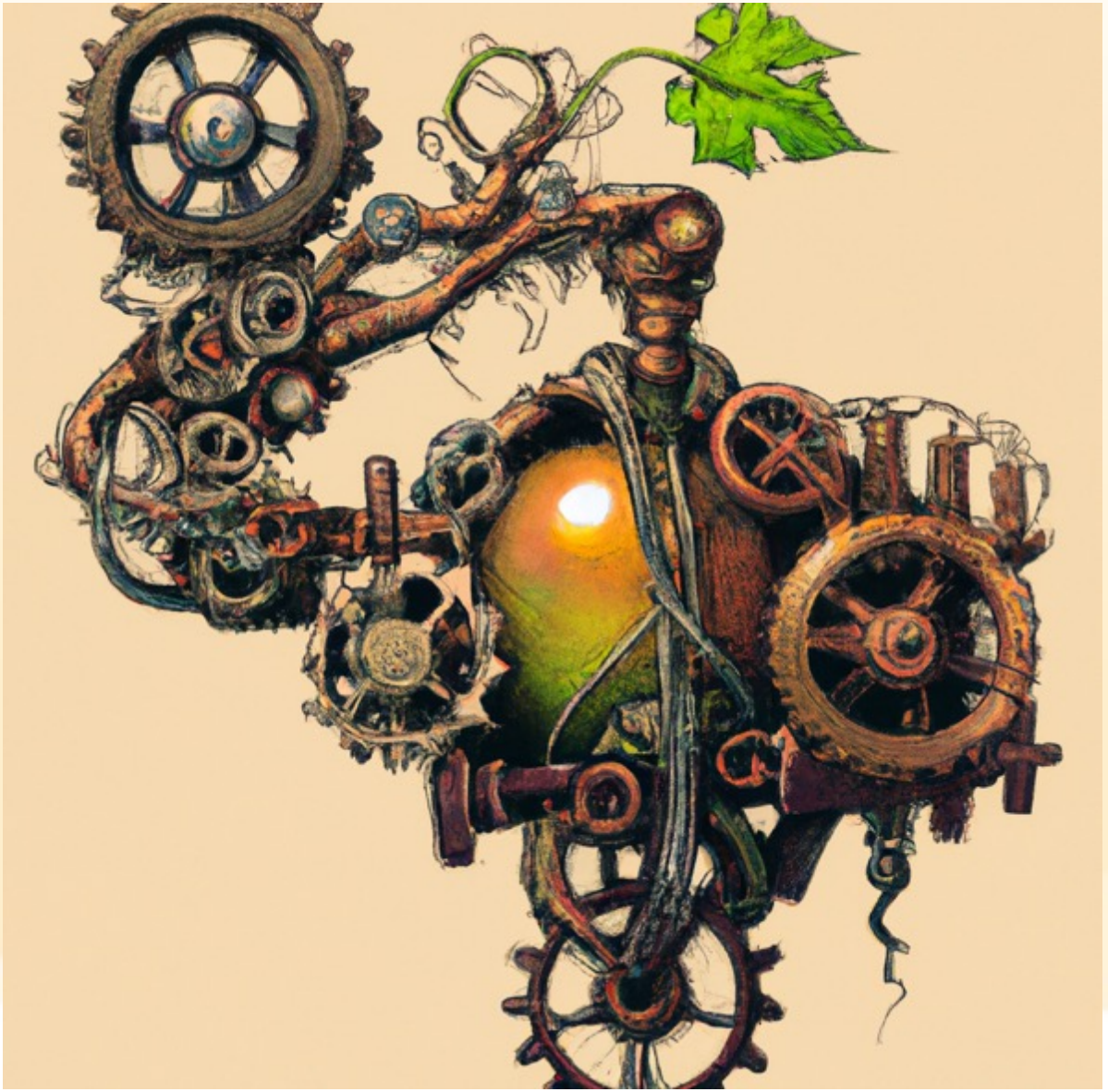
Vineyard Health

- 'Health' – the state of being **free** from illness or injury
- No way to be **totally free** of illness or injury
- The next best option is to keep illness or injury to a minimum

Vineyard Health

- **Vine Function ≈ Vine Health**

- Important Vine Functions
  i. Photosynthesis
  ii. Vascular system
  iii. Reproductive efficacy
  iv. Physical support



Changing Climates

- Climates are changing and impacting the factors that affect vine health.

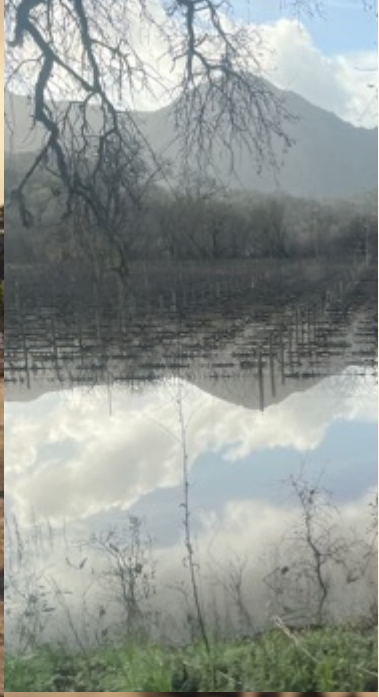
  i. Temperatures
     - Affects all aspects of vine health

  ii. Precipitation
     - Affects all aspects of vine health

  iii. Extreme weather events
     - Heatwaves, fire, and late frost events
     - Impacts photosynthesis and reproduction

  iv. Pests and Diseases
     - Directly limits vine health








66.6
°F/°C

Climate Impacts

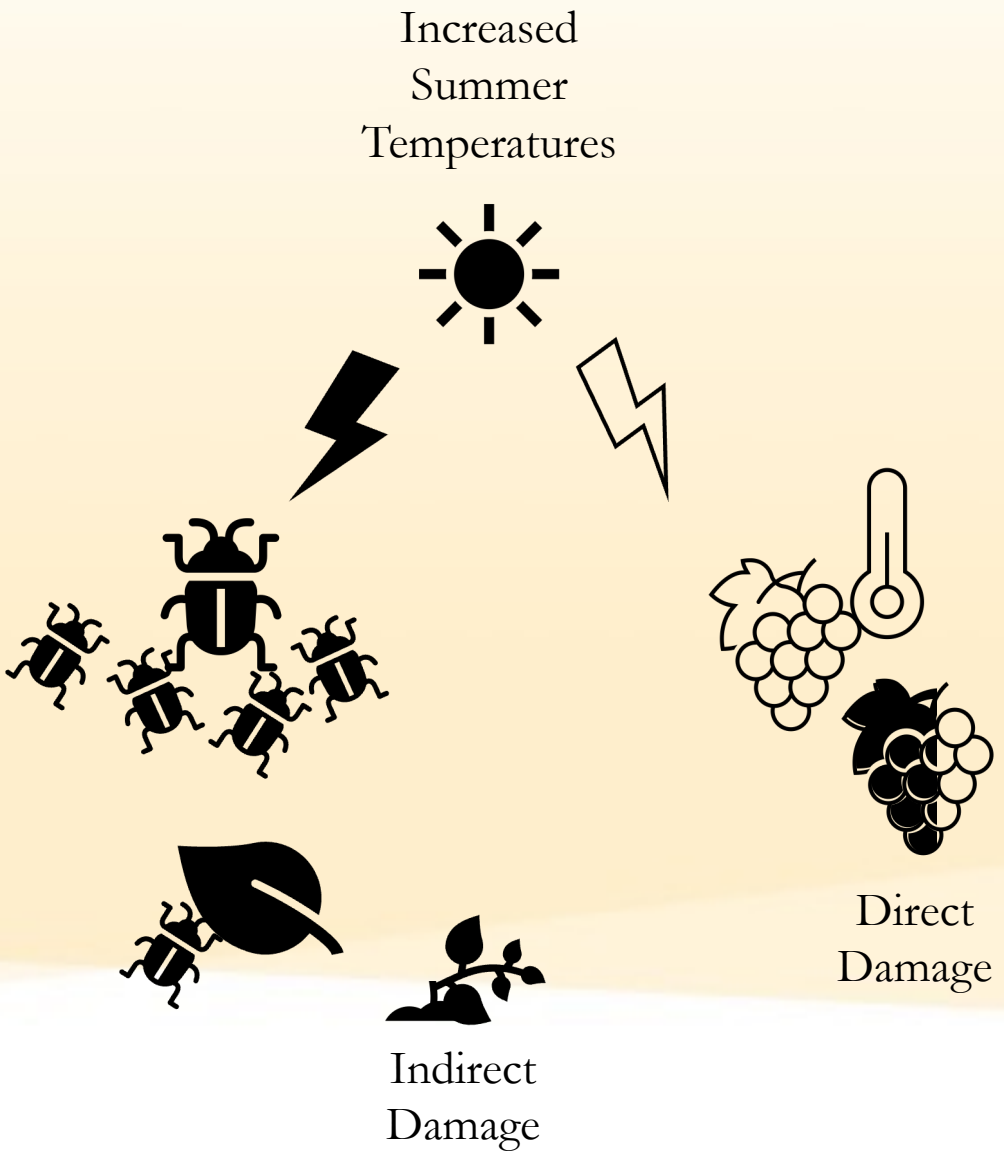
Must consider both **direct** and **indirect** impacts of changing climates

1. Change in growing season length
2. Earlier or later budbreak and ripening
3. Resource scarcity (i.e., water/fertilizer)
4. Increased soil salinity
5. More extreme weather events

Direct and indirect effects

Think of some examples of both **direct** and **indirect** impacts of climate change on cropping systems (bonus if it's specific to grapevines)

Write one or two down in the chat for everyone to discuss



Small Vineyard Management & Maintenance

Primary Objectives

1. Increase yield and improve fruit quality
2. Increase the productive lifespan of the vines
3. Conserve or improve the health and utility of the field/site
4. Conserve or improve the health of surrounding areas
5. Worker safety, health, and well-being
6. Improve profit margins to ensure operational sustainability
7. Limit inputs required to achieve these objectives

Order of importance will impact how you manage a vineyard

Environmental Conditions

- Vineyard Health is most impacted by site conditions
- These might be:
  1. Biotic
     - Pests/diseases
     - Beneficial species (i.e., Mycorrhizal fungi)
  2. Abiotic
     - Water and nutrient availability
     - Sun and heat exposure
- We can modify vineyard health by managing conditions on site and the vines themselves

Managing the Vine

Trellising and Training

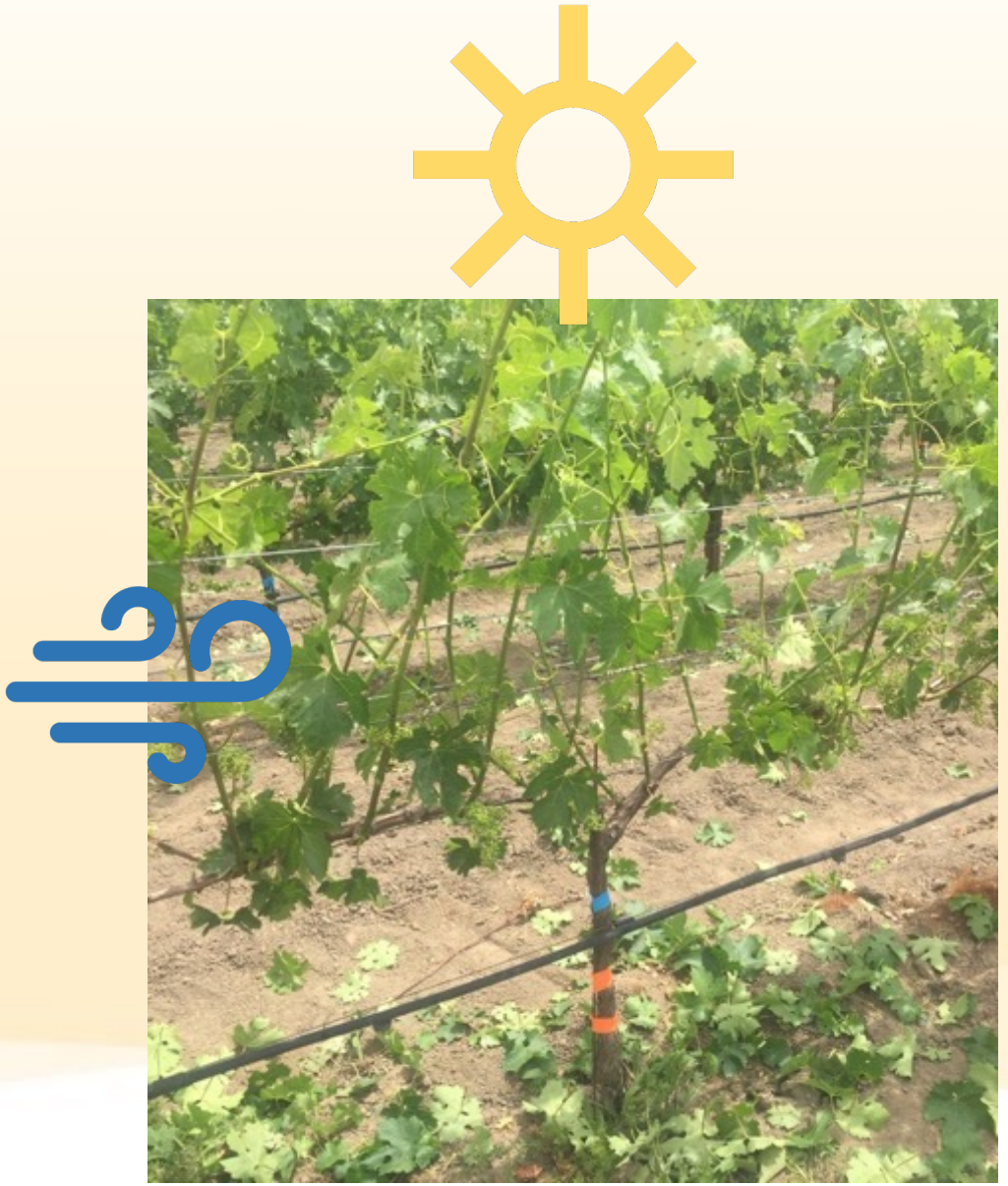
- Vines should be trained based on site conditions
  - High sun exposure = shade canopy
  - High wind site = shorter vines
- Trellising should also account for potential vigor
  - Highly vigorous = bigger canopy
  - Low nutrient soil = smaller canopy

Pruning

- Two main types of pruning
  1. Spur
  2. Cane
- Spur pruning is often selected for due to ease of management
- However, cane-pruned vines are less susceptible to fungal infection
- Pruning should be done in late winter and timed to fall between major rain events
  - This delays budbreak to avoid frost damage in spring and reduces fungal spore infection

Canopy Management

- Canopies should be ‘cleaned up’ in mid to late spring by removing excess shoots
- Changing amount of irrigation can reduce the need for excessive canopy management
- Canopies should have good air flow and light penetration to limit pest and disease growth in the fruit zone



Vine Nutrition

- We remove ≈ 3 lbs $_{K}$ per 1 ton of grapes
  - That must be replaced every few years
- This is true for every plant essential nutrient
  - Nutrients may not be removed entirely but may be bound in unavailable, organic forms in the soil (e.g., pruning cuttings)
- We can fertilize in numerous ways to replace these nutrients
  - Macronutrients are often applied in solid or liquid forms
  - Micronutrients are often applied as a foliar spray
- Test vines to see what they are deficient in or have too much of before deciding on fertilizer sources

Managing the Site

Soil Health

- One of the most complex environmental factors we can influence directly

- Comprised of many measures:
  1. Soil structure
  2. Soil Organic Carbon (SOC)
  3. Chemical properties
  4. Nutrient and water retention
  5. Many more
  6. Soil texture

Soil Health

- We can modify most of these parameters with enough effort

- Comprised of many measures:
  1. Soil structure
  2. Soil Organic Carbon (SOC)
  3. Chemical properties
  4. Nutrient and water retention
  5. Many more
  6. ~~Soil texture~~

- Attend other talks on soil health during this conference!

Soil Nutrition

- Many nutrients are lost or removed from vineyards every year
  - This can be through harvest, leaching, or erosion
- This is true for most plant essential nutrients
  - Some are more 'mobile' in the soil than others
  - Some are more 'available' to plants than others
- We should test the nutrients in our soils every few years to identify excess or deficient elements
- Compare your soil nutrient values to those of the vine nutrient tests
  - This can help identify incongruities in available nutrients between soil and vine

Essential Elements for Plant Growth	
Macronutrients	**Micronutrients**
Carbon (C)	Iron (Fe)
Hydrogen (H)	Manganese (Mn)
Oxygen (O)	Boron (B)
Nitrogen (N)	Molybdenum (Mo)
Phosphorus (P)	Copper (Cu)
Potassium (K)	Zinc (Zn)
Calcium (Ca)	Chlorine (Cl)
Magnesium (Mg)	Nickel (Ni)
Sulfur (S)	Cobalt (Co)
	Sodium (S)
	Silicon (Si)

Abiotic Stress Management

- Frost
  - Spring and fall frost risk
  - Can damage any fruit or green tissues
- Sun Exposure
  - Can lead to berry shrivel
  - Degrades phenolic compounds
- Heat Mitigation
  - Decreases vine water use efficiency
- Drought
  - Limits vine growth
  - Requires water to reverse impacts

Frost Protection

- Frost risk increases by height
- Trellis height can decrease frost risk
- Vegetative cover reduces soil heat absorption
- Wet, compacted soil helps retain heat
- Frost damage risk is reduced using either:
  - Water protection
  - Wind turbulence


Photo: Rick Snyder

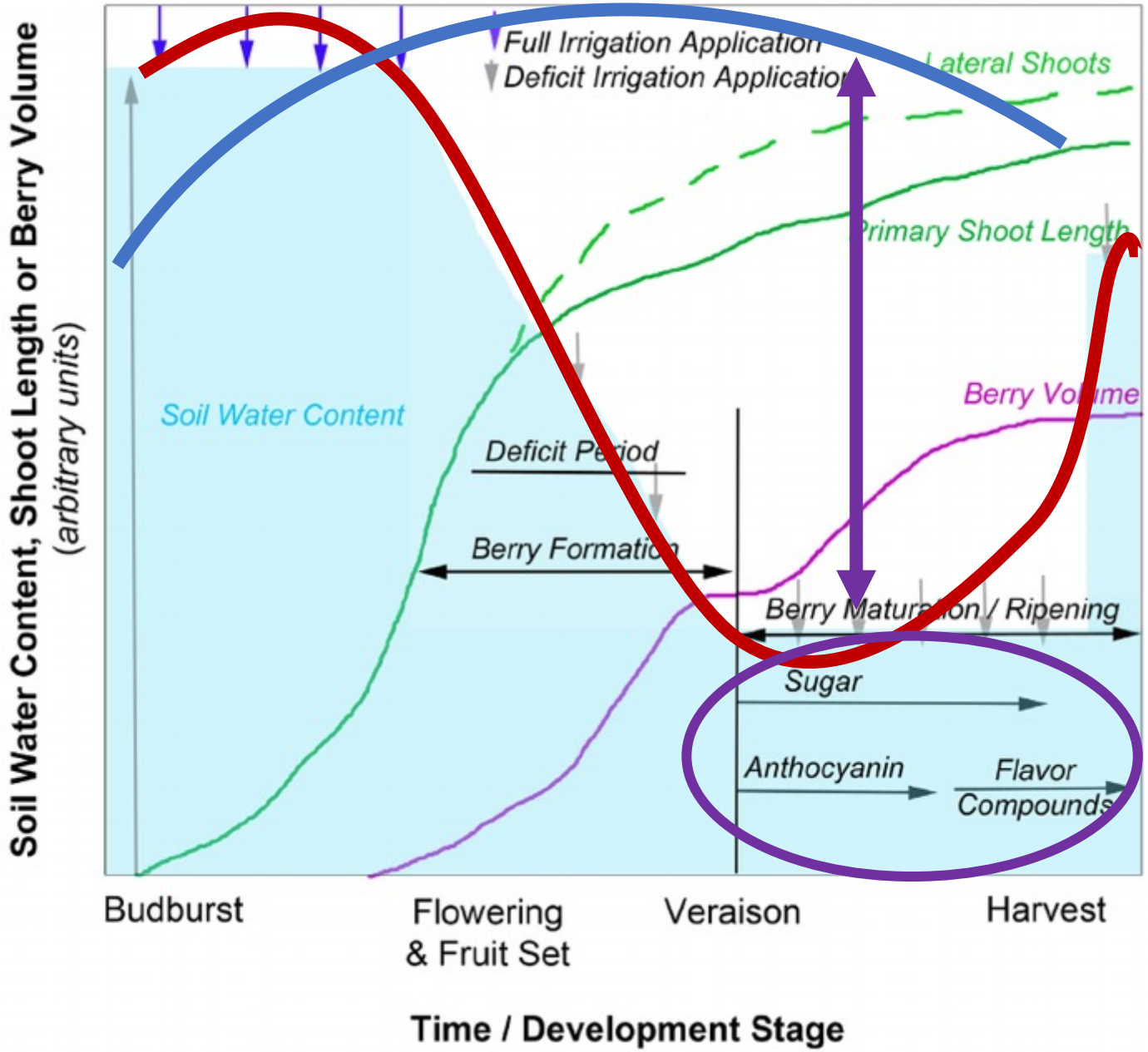

Photo: Mark Battany

Heat and Solar Radiation Mitigation

- Solar radiation and excess heat damage different compounds in grapes and lead to rapid degradation
- Large canopies can be used to shade out excess sunlight naturally
- Artificial shading can also be used with shade nets or films

Irrigation Scheduling

- Vineyards use between 0.6 – 1.2 ac-ft of water per acre per year
  - 195,000 – 390,000 gallons/acre/year
  - Much lower water demand than many perennial crops
- Irrigation amounts are based on the Crop Coefficient (k_c) and the Reference Evapotranspiration (ET_o) which both change throughout the summer
- Vineyards are often deficit irrigated
  - Deficit irrigation replaces less water in the field than is lost in a given period
  - Regulated Deficit Irrigation (RDI) is the most common style
  - This can improve the quality of desirable phenolic compounds in the fruit



Standard Irrigation

Regulated Deficit Irrigation

Primary Pests & Diseases of Grapevines

Types of pests and diseases

1. Microbial
    - Fungal
    - Viral
    - Bacterial
2. Animal
    - Invertebrate pests
    - Vertebrate pests
3. Plants
    - Weeds

Fungal Trunk Diseases

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Eutypa and Esca

- Symptoms first become apparent in vineyards 5 to 7 or more years old
- Wedge-shaped wood cankers form in infected wood
- Dead spurs and shoot dieback
  - Symptoms shared among multiple trunk diseases
- Spores enter through pruning wounds
- Difficult to identify until too late

Managing/Controlling Trunk Diseases

Late Pruning or Double-Pruning

Clean your equipment before and after each use

Remove infected wood and retrain trunk

Paint large pruning wounds with protectant

- *Trichoderma* Based biological fungicides (Vintec, Bio-Tam, Crab-Life)
- Can help control Eutypa (*E. lata*) and Botryosphaeria Dieback (*N. parvum*)

Mildews & Bunch Rot

Downy Mildew

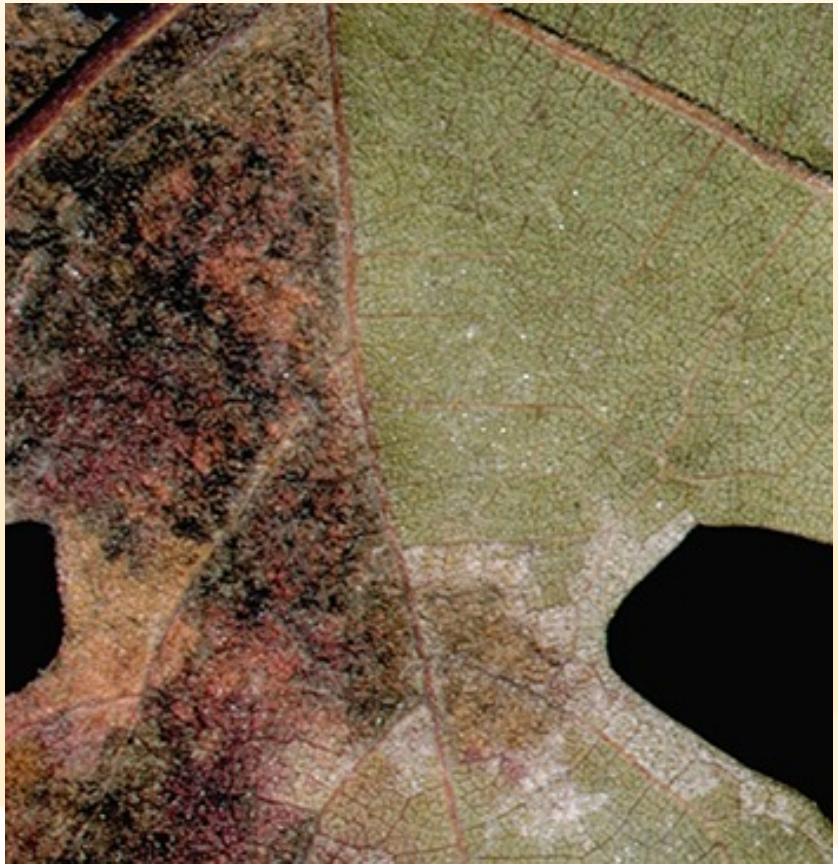
Not a huge problem in California

- Limited rainfall in spring and summer generally limits the spread of the disease in California

Requires warm and wet periods during the growing season

- Spring – Summer

In California the greatest potential for disease development exists when a wet winter is followed by late spring rains



Powdery Mildew

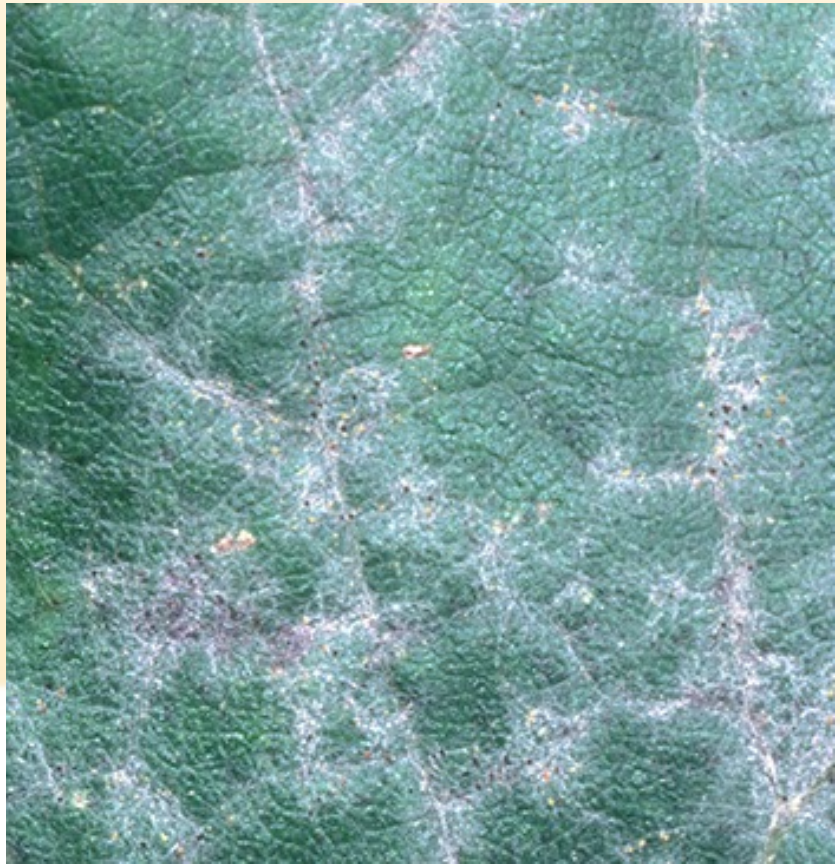
First appears on leaves as chlorotic spots on the upper leaf surface

Visible signs = White, webby mycelium on the lower leaf surface

Infected areas have a white-powdery or dusty appearance

- On leaves and fruit

Black/Brown scarring = signs of a former colony



Bunch Rot

Bunch rot is also very common

Can be worsened when the canopy or cluster is too dense

Results in loss of whole clusters

Managing Mildews

Keep things dry!

- Effective soil drainage and reduction of sources of overwintering inoculum

Leaf removal by itself can result in 50% disease control

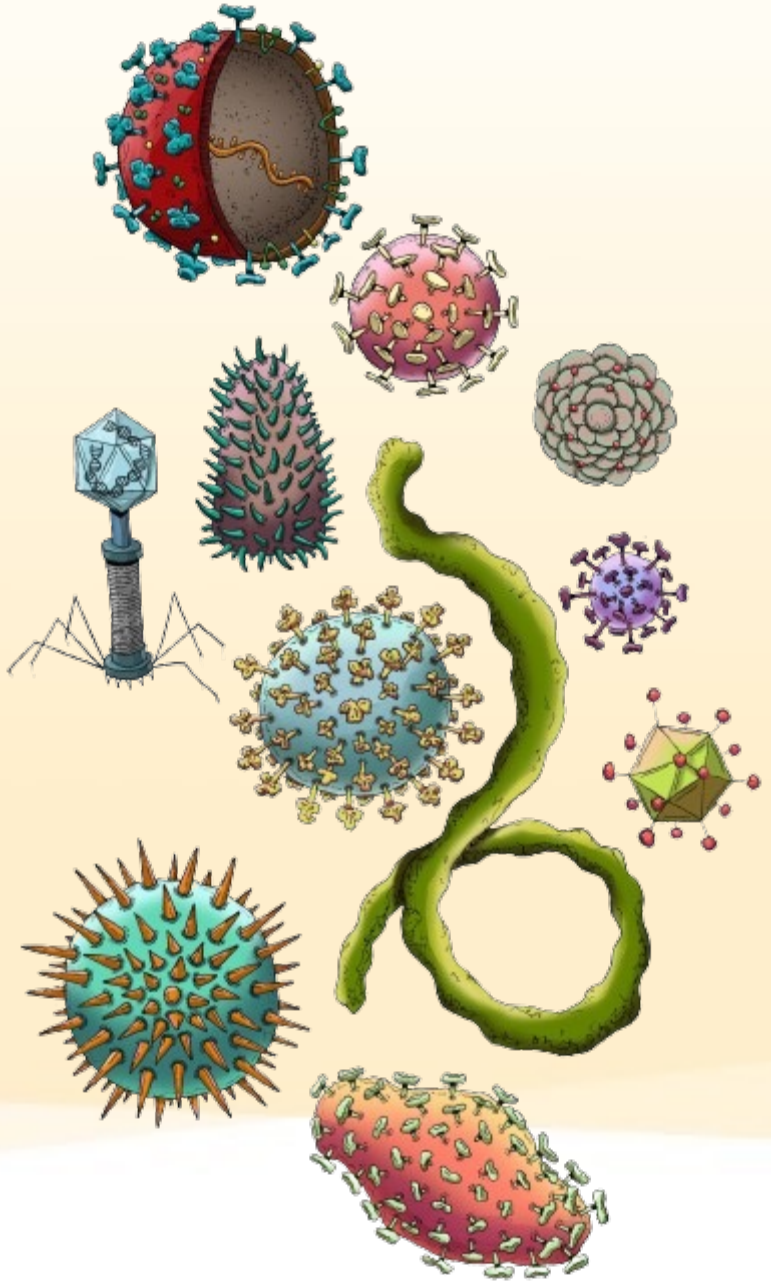
Preventive fungicides must be applied before an infection period begins

- Early season copper sprays

Micronized sprayable sulfur application or oil should be applied prior to other fungicides

PM Risk Assessment Index and Spray Index (UC ANR)

Viral and Bacterial Diseases



Red Blotch

- Grapevine Red-Blotch associated Virus (GRBaV)
- Limits sugar accumulation in fruit
- Leaves and leaf **veins** turn red in late summer – early fall

  (red varieties)
- Can delay ripening too late and result in lost crop
- Vectored by Three—Cornered Alfalfa Hoppers

Leafroll

- Grapevine Leafroll associated Virus (GLRaV)
- Complex of 9 viruses
- Leaves roll at ends
- Red leaves but leaf **veins remain green**
- Limits sugar accumulation in fruit
- Vectored by mealybugs

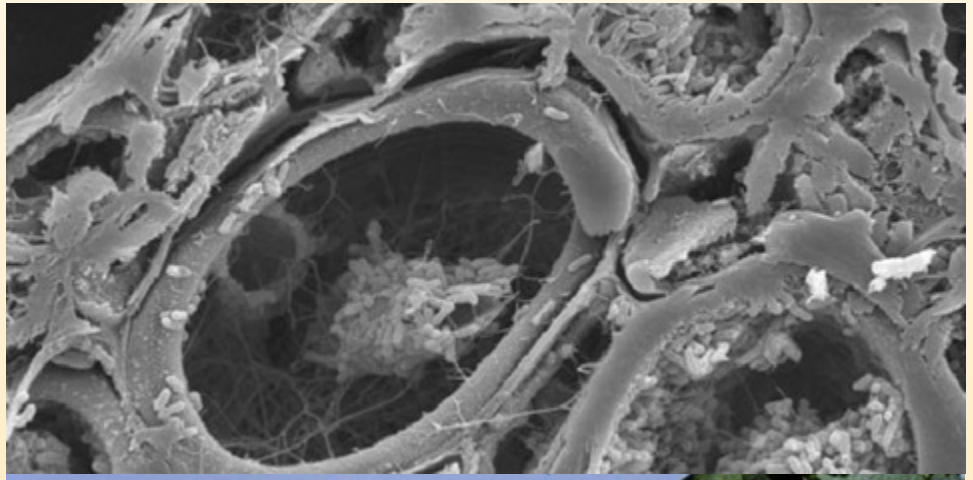
Credit: OK Extension

Fanleaf

- Grapevine Fanleaf Virus (GFLV)
- Deforms and discolors leaves
- Prevents berry development and results in many ‘shot’ berries
- May reduce yields significantly
- Vectored by Dagger nematodes

Xylella Fastidiosa – Pierce's Disease

- Bacterial infection
- Lives in xylem of grapevines
- Can clog the vascular system
- Results in stunted shoots
- Reduces yields over time
- Will kill grapevines entirely
- Has wiped out vineyards in S. California at least three times in 100 years
- Vectored by Sharpshooters



Common Insect Pests and Vectors

Sharpshooters and Leafhoppers

- Look similar, but have different impacts on vines
- Sharpshooters vector *X. fastidiosa* (i.e., Pierce's Disease)
  - Glassy-Winged Sharpshooter (S. CA)
  - Blue-Green Sharpshooter (N. CA)
- Leafhoppers feed directly on leaves causing damage to canopies
  - Virginia Creeper Leafhopper

Glassy-Winged Sharpshooter

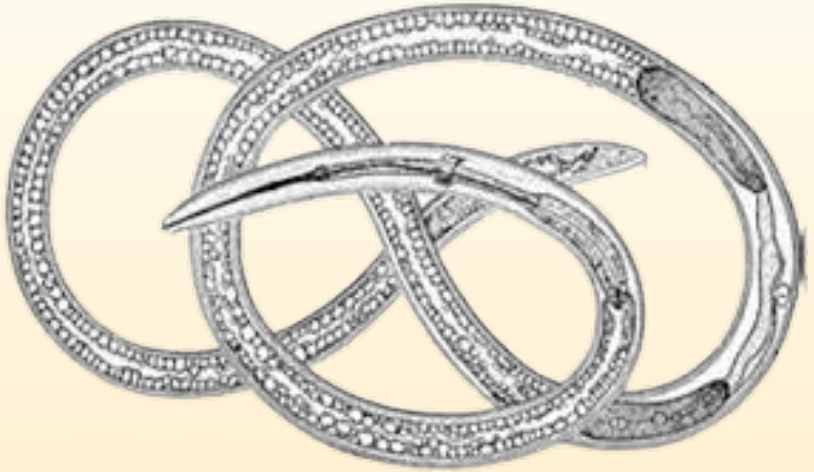
Virginia Creeper Leafhopper

Mealybugs

- Can be often found by following ants
  - Ants don't eat grapes, but they do 'farm' mealybugs
- Vector of Leafroll viruses
- Can also promote sooty mold from excrement
- Vine mealybug is most problematic and not native to our region

Nematodes

- Nematodes are both vectors and phytophagous pests of grapes
- Dagger nematodes can vector Fanleaf Virus by feeding on roots
- Types of nematodes to look for:
  - Dagger Nematodes
  - Root-Knot Nematodes
  - Citrus Nematodes
  - Ring Nematodes
  - Lesion Nematodes



Weeds

- A ‘weed’ is any unwanted plant
- Many weed species in one farming system are considered desirable in a different system
- These are often controlled chemically and/or mechanically
- They can also be great benefits to improving soil structure and soil organic carbon content

Questions to Ask Yourself

1. What tissues are impacted?
2. How old are the vines that display symptoms?
3. How long have the symptoms been apparent?
4. What does the pattern of spread look like?
5. Do your neighbors have a similar problem?

What tissues are impacted?

This is important to address when identifying pathogens

- Different pathogens infect and impact different tissue types

Each tissue type may be impacted differently:

- Trunk and permanent wood fungi
- Foliar (leaf tissue)
- Fruit (clusters)
- Roots

Many pathogens infect more than one tissue type, but are more visible on one

What does the pattern of spread look like?

Look at your entire vineyard

- Draw a map

Where was the first symptomatic vine

- Label it on the map

Where did the disease progress?

- Label other symptomatic vines on the map
- Is it a circular pattern of spread or does it hop across multiple rows?

Pest Responses to Climate Change

Disease Expression

- Host-Pathogen interaction is broadly impacted by environmental conditions
- Certain abiotic stressors can increase susceptibility of grapevines to pathogens or trigger symptomatic expression of the pathogen (10)
- Fungal trunk diseases
  - Have expressed more symptoms in vines than usual in N. Coast
  - Two years of extreme drought followed by late spring frost and summer rains

10. A Songy, O Fernandez, C Cl´ement, P Larignon, and F Fontaine. Grapevine trunk diseases under thermal and water stresses. Planta, 249:1655– 1679, 2019. ISSN 1432-2048. doi: 10.1007/s00425-019-03111-8.

Climate Concerns

Frost damage, heat, and drought

Vine susceptibility ~ abiotic stress

No natural immune system

- Additive resistance
- Defense compound synthesis
- Abiotic stressors redirect resources

Can tolerate pests/diseases under best conditions

Overwinter Recovery – *Xylella fastidiosa*

Overwinter recovery from Pierce's Disease relies on cold Winter temperatures < 53 ºF for prolonged periods

Warmer winter temperatures could impede the phenomenon of overwinter recovery

Winter temperatures in California have risen around 2 ºF since the 1970s and made overwinter recovery of *X. fastidiosa* less likely to occur in hotter regions.

‘New’ diseases in vineyards

Often can be difficult to identify:

- Lime disease on the West Coast or GRBV in vineyards

Grapevine Red-Blotch Associated Viruses

- Flagship example for grapevines
- Not known until 2008 (Oakville, CA)

Insect/pathogen migration in response to changing climates

A migration of insects and pathogens is expected to move northward as climates change. (15)

- This is the case for more crops than grapevines

Temperatures and elevated CO_2 levels are essential components to estimate the potential for pest/disease migration (20)

20. Holly A. Ameden and David R. Just. Pests and agricultural production under climate change, 2001.

Questions for you

- What do you think is going to become the biggest challenge for growing grapes in our changing climates?
- What would you try to overcome that challenge?
- Type answers in the chat

Best Management Practices for Small Vineyards

Monitoring

Monitoring the vineyard regularly is probably the most important practice any viticulturalist can subscribe to

Use consistent monitoring techniques so current observations can be related to conditions earlier in the year

Examples of conditions to keep track of:

1. Water demands of the site and vines (Evapotranspiration)
2. Phenological development of the vines
3. Signs or symptoms of pests and diseases of grapevines
4. Local weather conditions and extreme weather events
5. Infrastructure functionality (i.e., damaged irrigation lines)

Adaptation

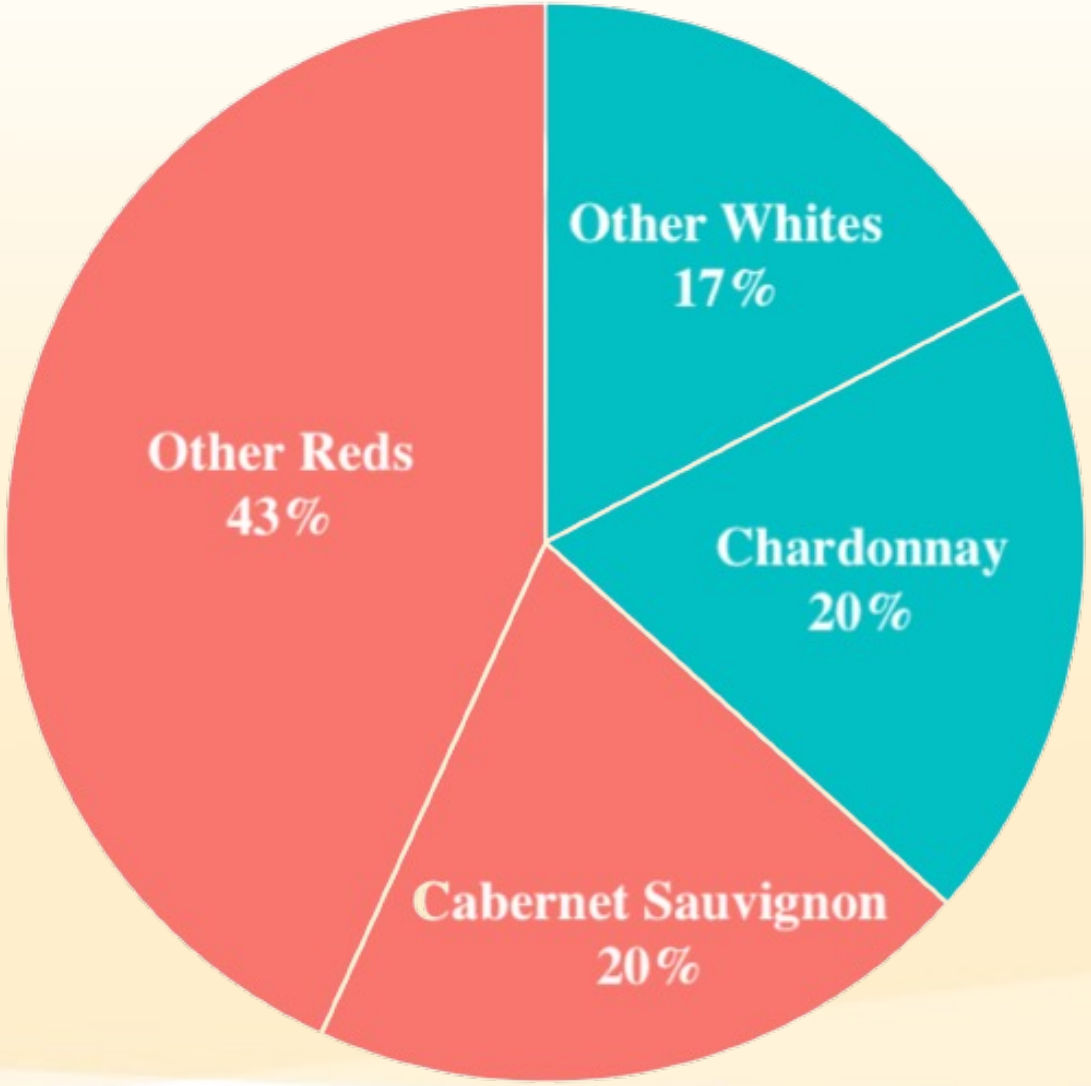
- Be willing to try out new practices and plant new varieties
- There is a wide range of traits in the grapevine world that are under-utilized in real vineyards
- New technology and methods are being developed all the time. Try them.

Scion Variety Bottleneck

- Market limitations on profitable cultivars
- Bottleneck down to two scions
- Wide range of climate adaptation in scions

Examples of desirable characteristics:

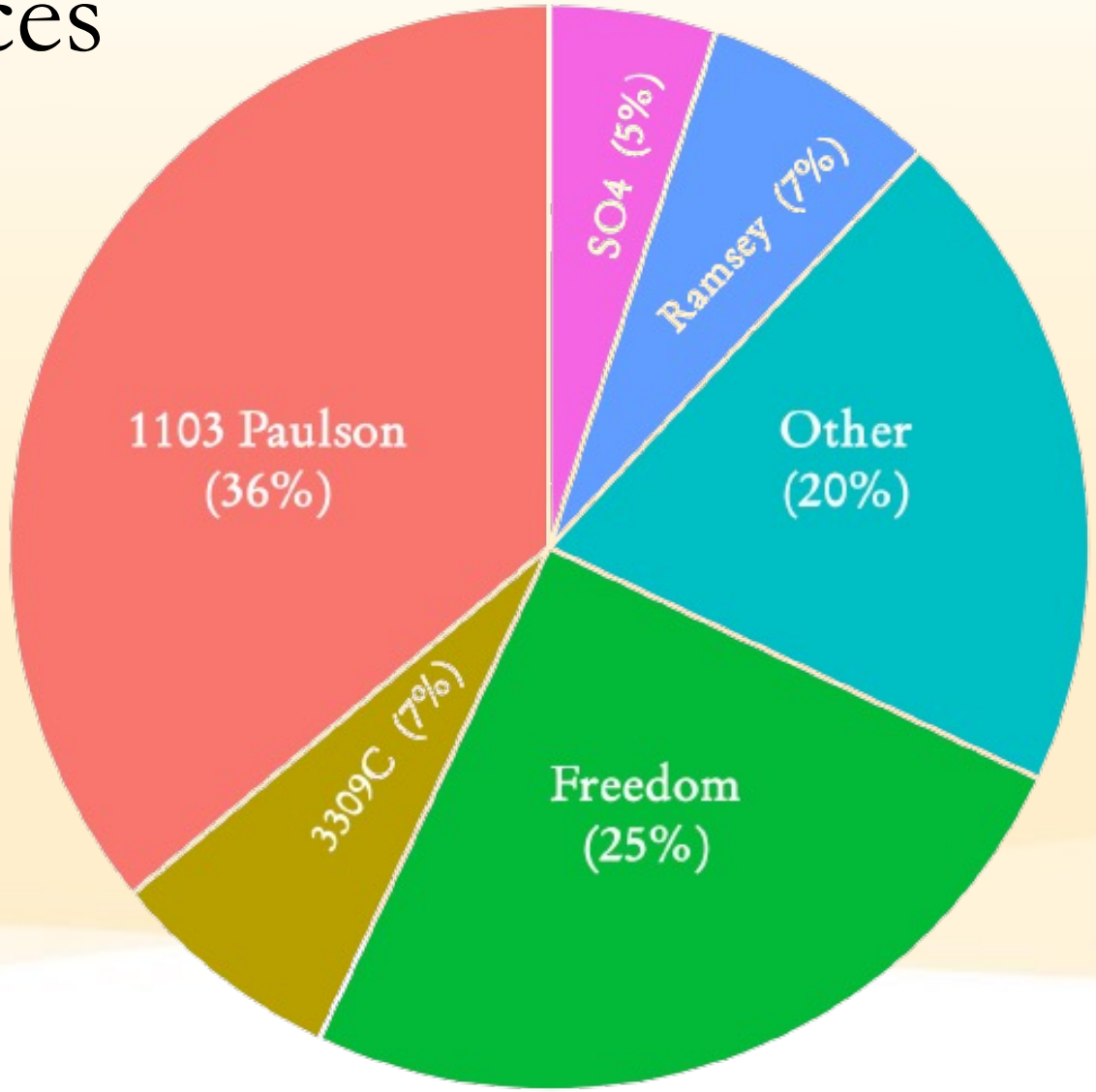
i. Late budbreak (avoid frost)
ii. Moderate vigor (less water demand)
iii. Early fruit maturity (maybe)
    e.g., Sémillon; Tempranillo



CA Grape Acreage Report (2020)

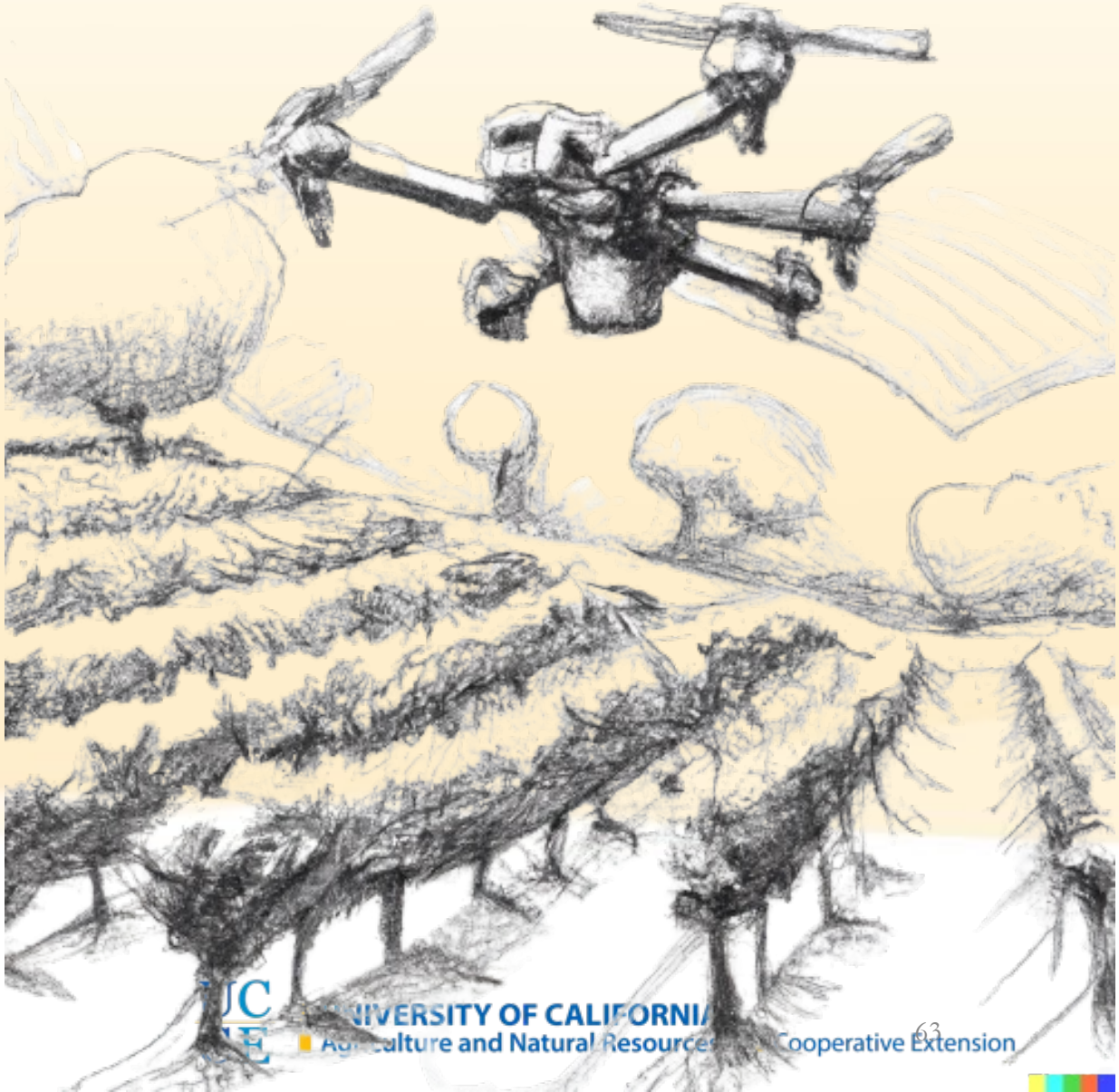
Limited Rootstock Preferences

- The trend observed in scions appears to hold true for rootstock varieties as well
- In 2022, only 5 rootstocks accounted for 80% of rooting material for grapevines sold



The Climate-Adaptive Vineyard

1. Water Use Efficiency
   - Drought tolerant cultivars
   - Precision irrigation methods
   - Water-efficient cultural practices
   - Better soil-water dynamics
2. Heat/Drought tolerant varieties
   - Research and testing
   - Available and adopted
3. Pest-tolerant rootstocks
   - Identify future pest risks
   - Research and testing
   - Available and adopted



The Climate-Adaptive Vineyard

4. Efficient management practices
   - Precision irrigation
   - Optimize canopy design
5. Improving soil health
   - Increasing water infiltration
   - Improve water retention
   - Improve nutrient retention
   - Promote mycorrhizae health
6. Desirable employment
   - Make jobs desirable
   - Improve employee retention and well-being
   - Keep skilled-labor

The Climate-Adaptive Vineyard

7. Consistent monitoring
   - Look out for new issues
   - Observe and record patterns and trends
   - Get ahead of challenges before they become costly
8. Ready adoption of new practices
   - Growers willing to try out new concepts and practices
   - Increase our climate-resilience greatly

Homework

Knowing what you know now, which of the primary objectives of vineyard management below would make **your top three** for prioritizing in your vineyard and why?

A. Increase yield and improve fruit quality
B. Increase the productive lifespan of the vines
C. Conserve or improve the health and utility of the field/site
D. Conserve or improve the health of surrounding areas
E. Worker safety, health, and well-being
F. Improve profit margins to ensure operational sustainability
G. Limit inputs required to achieve these objectives

Based on your top three, which aspects of the Climate-Adaptive Vineyard should you focus on?

Summary

1. Our objectives for vineyard management are to improve vine growth, longevity, and reproductive efficacy
    - We can achieve our objectives through modification of the vines and conditions on site.

2. Climate change may increase abiotic stress from extreme weather events and biotic stress from pests

3. A sustainable, climate-adaptive vineyard of tomorrow will take into account the economic, environmental, and social effects of climate change on agriculture to make informed management decisions

Thank You

Sources

You can find this presentation at:

1. https://ucanr.edu/sites/chenlab
2. Speaker Presentations

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