Distribution Uniformity in Vineyards

UCCE North Cost Viticulture

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Main Questions for Scheduling Irrigation

1. When do we need to irrigate?
2. How much water do we need to apply?

To answer these questions we need to know:

1. The vine moisture status between irrigations
2. The irrigation system's current performance characteristics to determine how long to operate the irrigation system

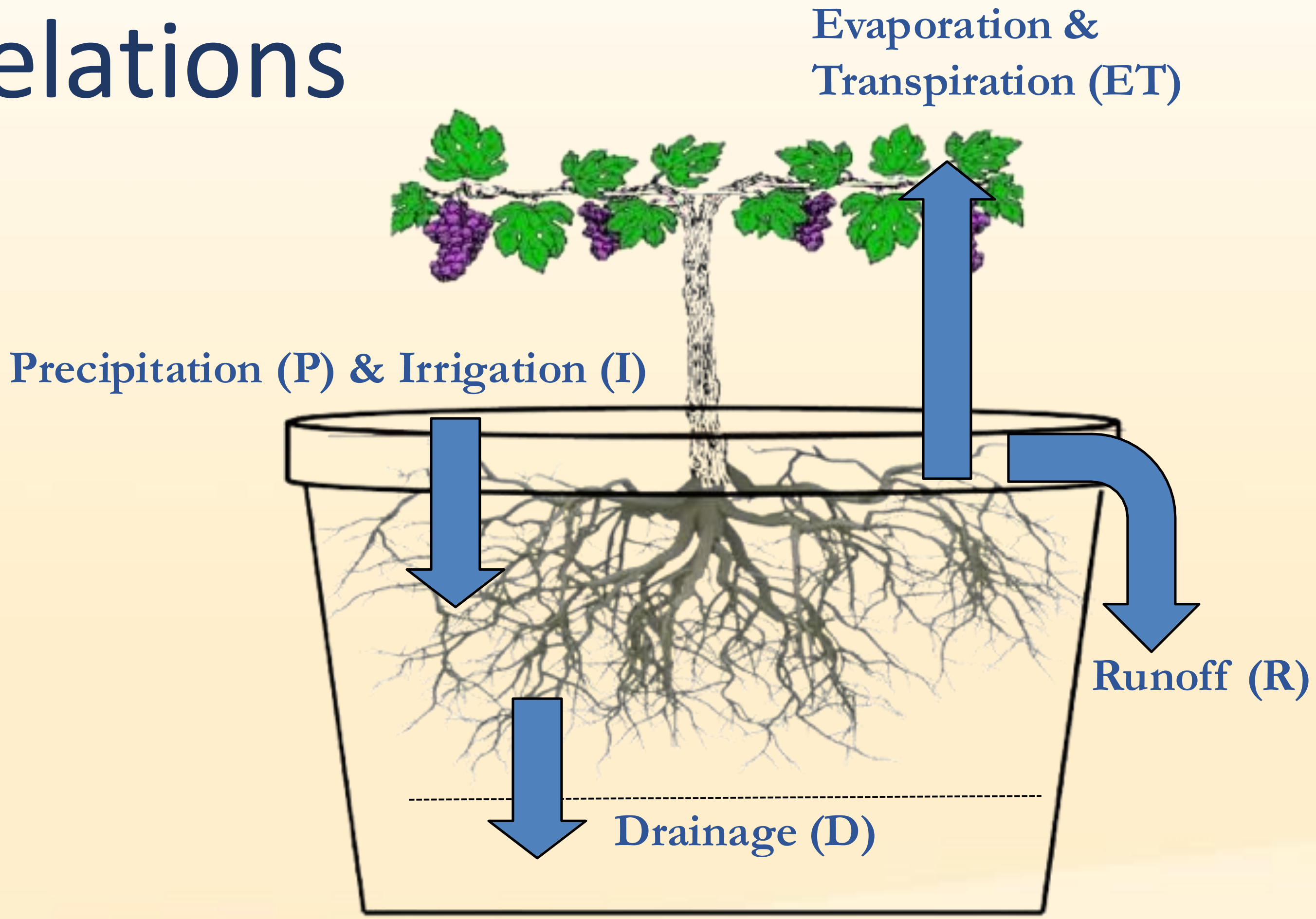
Vine Water Status

Water availability between irrigation events

Grapevine ~ Water Relations

Roles of water

- Solvent
  - Nutrients
  - Dissolved gas
- Biological function
  - Plant turgor and cell function
  - Plant metabolism
- Reactant
- Gas Exchange
  - 400 H_2O molecules / 1 CO_2



$$\text{Change in soil water} = \underbrace{P + I}_{\text{Gains}} \underbrace{- ET - D - R}_{\text{Losses}}$$

Agroecological Water Balance

Inputs of Water

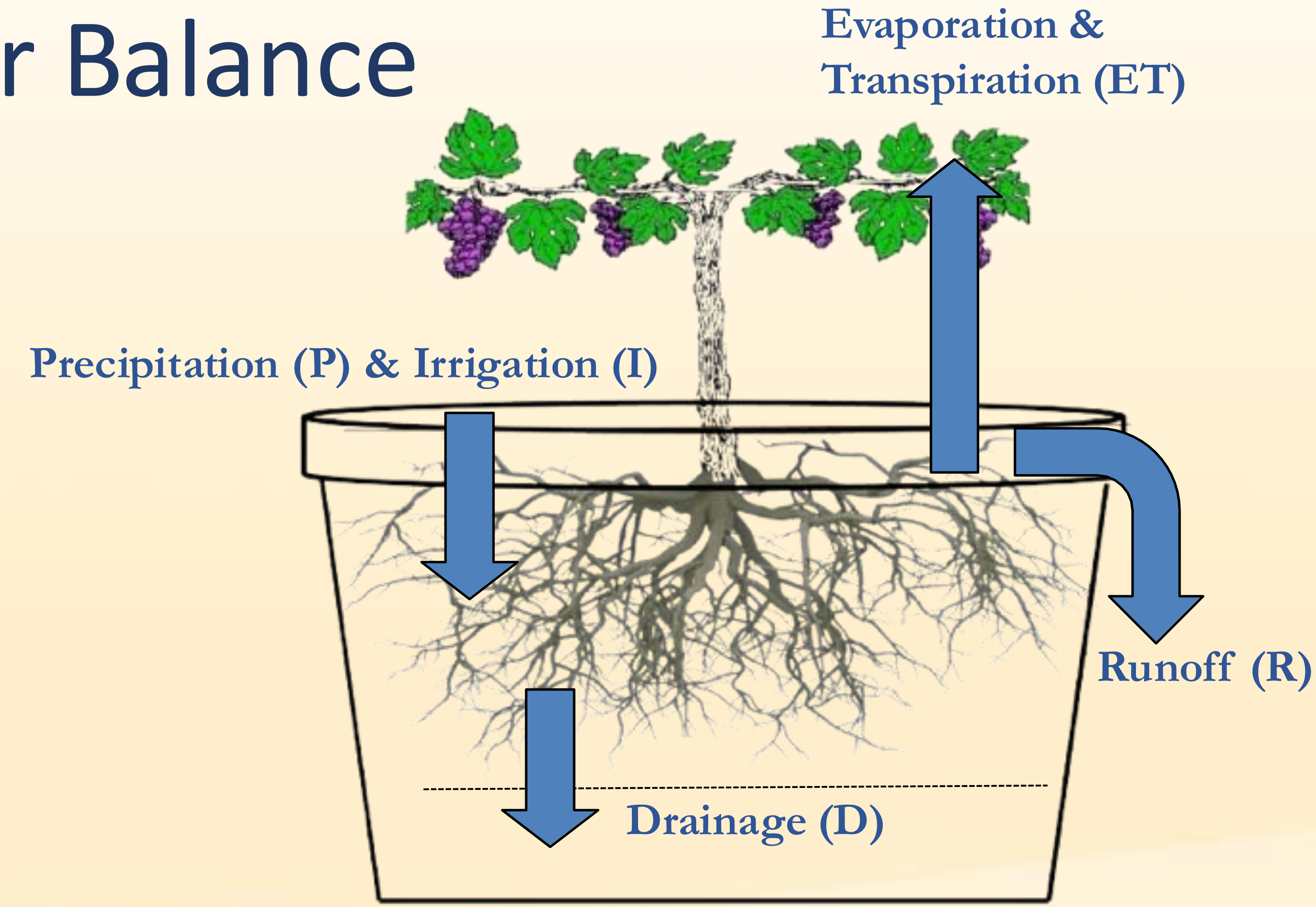
- Precipitation
- Irrigation

Losses of Water

- Evapotranspiration
- Drainage or Leaching
- Runoff

Water Storage

- Blue Water = Free water
- Green Water = in Plants



Change in soil water = P + I – ET – D – R

(P + I: Gains; ET – D – R: Losses)

Deficit Irrigation

Based on the **inputs** and **outputs** of water on a weekly basis

Water = Precipitation + Irrigation – Evapotranspiration – Drainage – Runoff

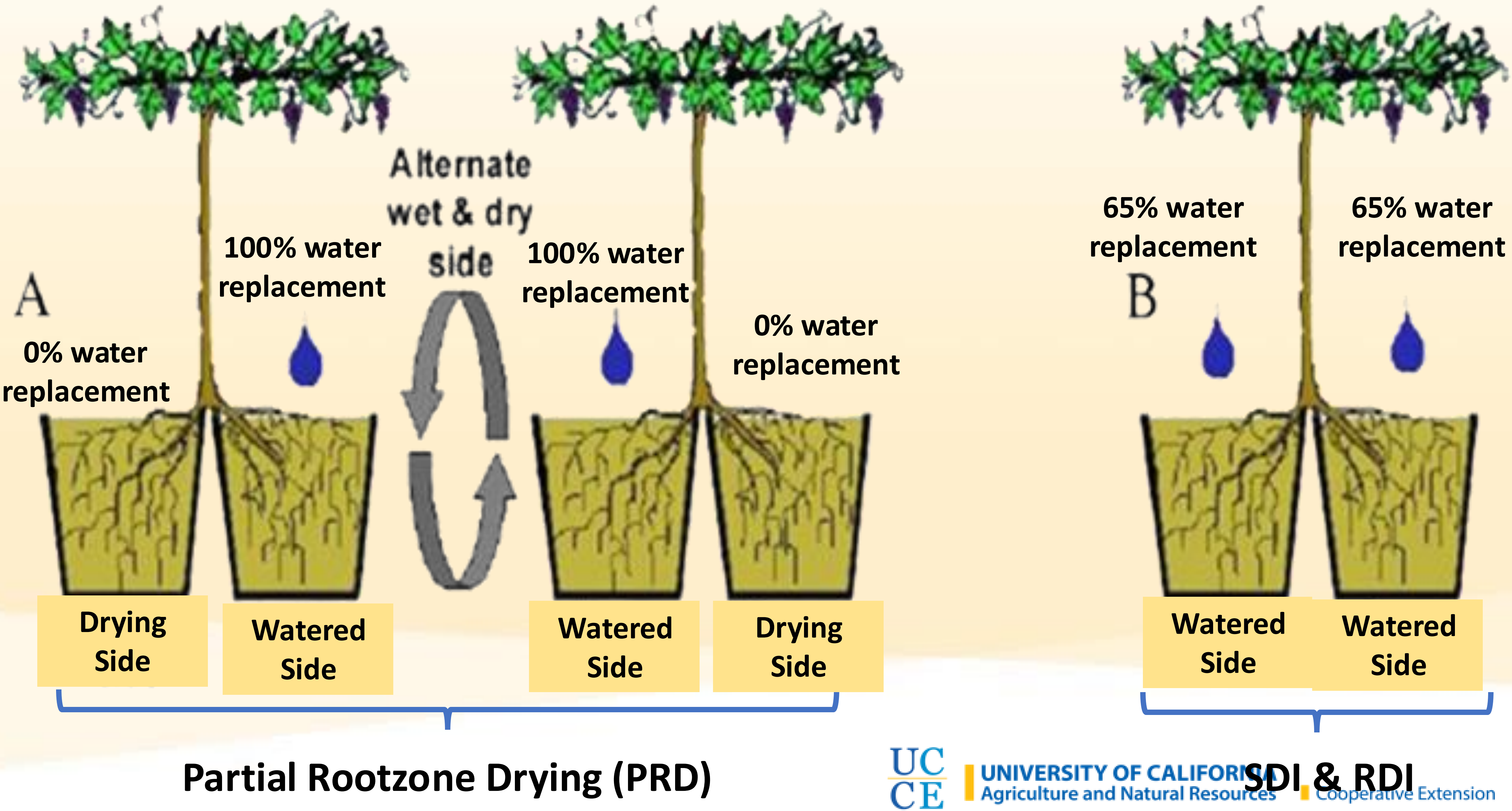
The **actual water volume** required for a certain % of water replacement is based on the ET_c equation

$$ET_c = k_c \times ET_o$$

Crop (grape) Evapotranspiration

Crop (grape) coefficient

Reference (turf grass) Evapotranspiration



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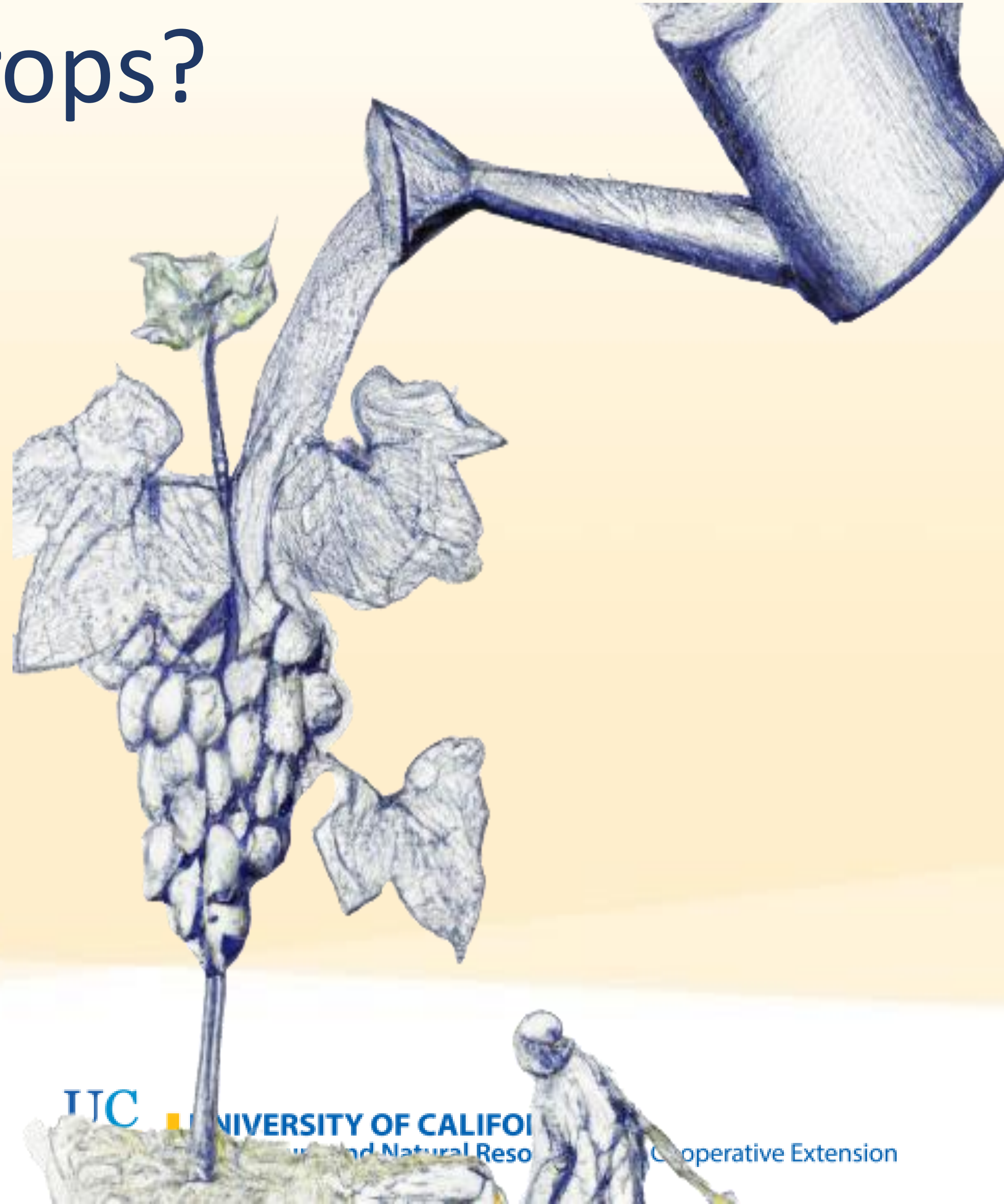
When do we irrigate our crops?

Two options for **when** we irrigate:

1. Before plants face a water deficit or become water stressed

   or

2. At specific deficit/stress levels that benefit yield and quality



How can we tell our vines need water?

We need to monitor water stress

Main methods of measuring vine water stress:

1. Pressure chamber/bomb readings
2. Soil moisture probes
3. Plant moisture probes
4. Weather-based decisions

Ranges of Water Stress in Grapevines

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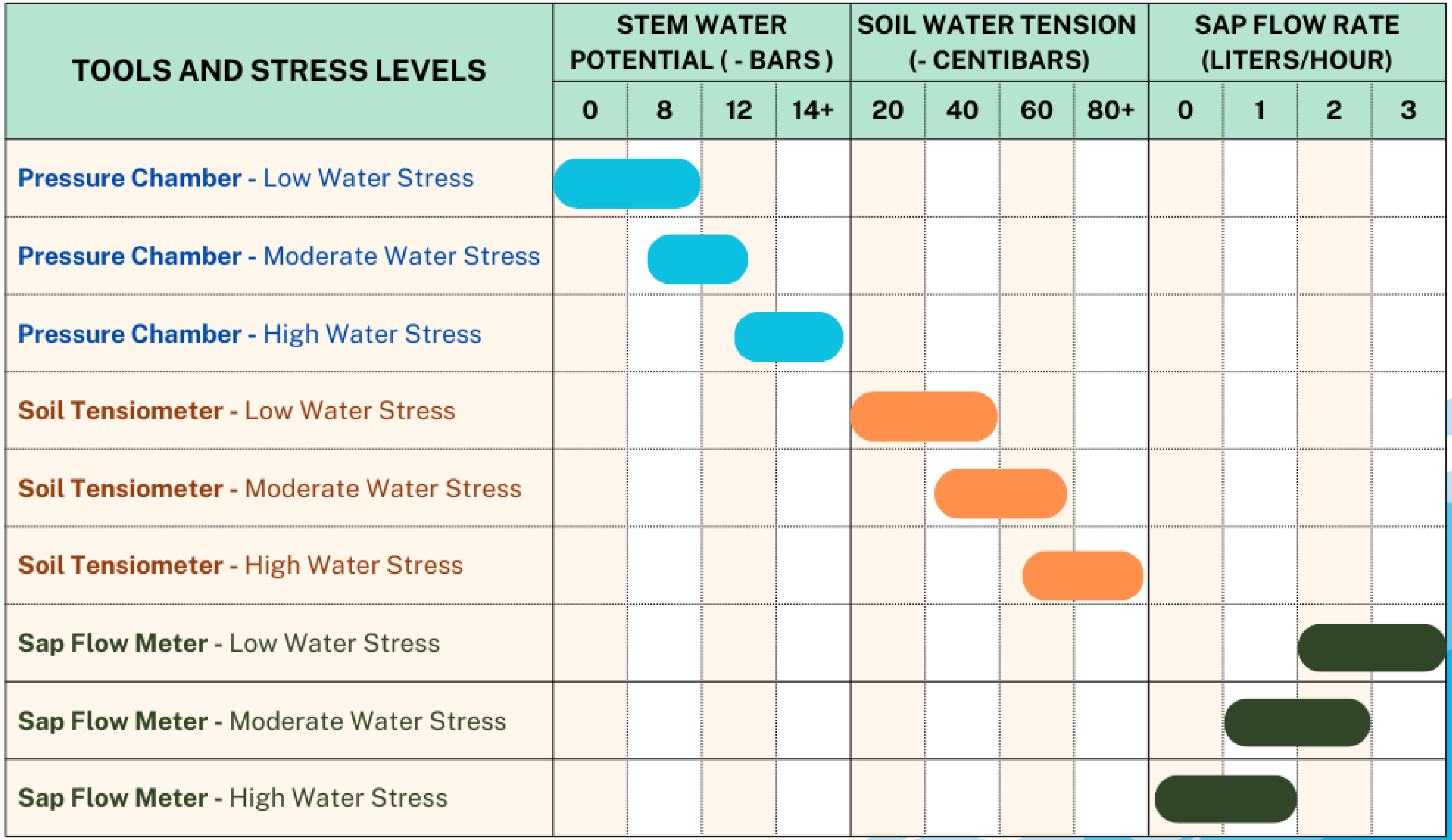

Irrigation System Design

– *Irrigation Scheduling* –

How much water do we need to apply?

Depends on your irrigation strategy, systems, and the time of year

Do you employ deficit irrigation?

What is your water output rate or pump capability (gpm)?

Are your emitters providing the expected gallons of water per hour?

Key Components of an Irrigation System

Design

- Accurate
- Flexible Operation
- Tested
- Easily Reparable/Modular

Maintenance

- Properly Installed
- Regularly Inspected
- Maintained Regularly
- Accessible Repair Components

Operation

- Defined Irrigation Regime/Strategy (Full irrigation / RDI / SDI / etc.)
- Consistent Irrigation Scheduling (One method to schedule)
- Accurate Irrigation Control Systems (Easy-to-use control box)
- System Feedback (Flow rate meters)

Source: Daniele Zaccaria

Irrigation System Components

Size the different system's components from **downstream** (end point) to **upstream** (source of the water)

downstream pipe size ≥ upstream pipe size

Ensures your materials have the best flow rate and minimal friction losses; also try to make the system flexible when problems arise (e.g., easily replaceable sections or components; not a 1000ft pipe)

Select components to ensure the system can handle **flow rate & pressure** at **routine** levels and **maximum** levels (material quality)

Irrigation System Flexibility

Vines need different water amounts at different life stages and times of year:

- Young vines are small and require less water than older vines
- Vines early in the growing season require less water due to small canopy

Account for the demands of the vine at every life stage and time of year when designing your vineyard irrigation system

- This is a function of **average/routine** and **maximum** water demands
- Also account for changes in annual precipitation and groundwater levels

Distribution Uniformity

How “evenly” water is applied to each grapevine across the whole vineyard

Equipment like drip emitters may not function exactly as labelled:

- Clogging of water pathways or emitters (algae, salts, soil particles, etc.)
- Improper installation or maintenance
- Changes in head pressure at emitters due to elevation gain/loss

If D.U. is not conducted regularly, some vines may be over/under irrigated

Distribution Uniformity

Application Rate (AR)

- The average amount of water that is delivered to the vineyard block (acre-inches per hour) or individual vine (gallons per hour per vine) over a period of time.

Distribution Uniformity field testing will identify if there are problem areas in the irrigation system that reduce efficiency

DU field tests should be performed every few years

Distribution Uniformity - Materials

- Select from16 to 40 sample sites located throughout the block
- Choose sample sites as you would for fruit sampling and where you might expect to find the highest or lowest pressures
- Basic tools needed are:
  - Pressure gauge (0-60 PSI, liquid filled) connected to pitot tube
  - 25, 50 or 100ml graduated cylinder
  - Stop watch, hole punch, goof plugs, nylon paint
  - Strainer socks or bags
  - Drip emitters to replace clogged emitters you come across
  - Tape measure
  - Clip board and field data sheets

Distribution Uniformity - Steps

- **Measure Vine & Row Spacing:** Measure and record the distance between vines and rows on the field data sheet. Note number of emitters per vine.

- **Measure and Record Line Pressures:** Pressure testing of emitters is performed with a pressure gauge fitted with a pitot tube. Near each of your 16 to 40 sample sites, make a hole in the drip hose with the hole punch, insert the pitot tube/pressure gauge into the hole to get the PSI reading, remove the gauge, insert a goof plug, and record pressure on the data sheet

- **Catch, Measure and Record Emitter Flows:** At each of the sample sites, hold the graduated cylinder under the emitter and record the volume of water captured for 30 seconds

- **Check Lateral Lines / Hoses for Debris:** Open the ends of a few lateral lines and place the nylon sock over the end of the hose to check for debris in the water.

Distribution Uniformity

Should be at least 85% accurate to what the emitter rate is labelled as

- 95 – 85% = Acceptable
- 85 -75% = Should be improved
- < 75% = Needs repair or improvement

$$D.U = \frac{Average\ flow\ of\ lowest\ 25\%\ emitters\ measured}{Average\ flow\ of\ all\ emitters\ measured}$$

Example D.U. Calculation

0.98 gph	0.89 gph	0.95 gph	0.94 gph
0.99 gph	1.05 gph	0.99 gph	1.00 gph
1.15 gph	0.70 gph	1.05 gph	1.01 gph
0.98 gph	0.97 gph	0.96 gph	0.94 gph

The total number of emitters measured: 16
(=> 25% * 16 emitters = 4 emitters)

The average flow of all emitters measured: 0.97 gph

The average flow of the lowest 4 emitters measured (25%): 0.87 gph

The Distribution Uniformity = 0.87/0.97 = 90%

Causes of poor D.U. values

- Clogged drip emitters
  - Physical, chemical, or biological buildup
- Insufficient Maintenance
  - Flush, adjust, or replace components
- Pressure Variations
  - Non-compensating emitters
  - Poorly installed or designed systems
  - Extreme elevation changes
  - Faulty or incorrect equipment installed (e.g., pressure-regulating valves)

Takeaway – Vineyard Distribution Uniformity

- Irrigation design should be
  - Accurate and tested or inspected regularly
  - Easily reparable
  - Provide systems feedback
- DU testing over several years provides growers with an indication of their irrigation system's "health"
- Irrigation systems should:
  - Have a DU ≥85% accurate (for drip systems)
  - Be designed to properly address pressure and elevation changes
  - Have components that decrease friction and improve water flow rates
  - Regularly maintained and repaired

Downloadable Presentation

- You can find this presentation at:
  1. https://ucanr.edu/sites/chenlab
  2. Speaker Presentations

- Accompanying article published in Wine Business Monthly Online

Some original images created by OpenAI Labs Dall-E 3 Program and in https://BioRender.com

Thanks for Listening

Contact me: codchen@ucanr.edu

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