Texas A&M AgriLife Extension

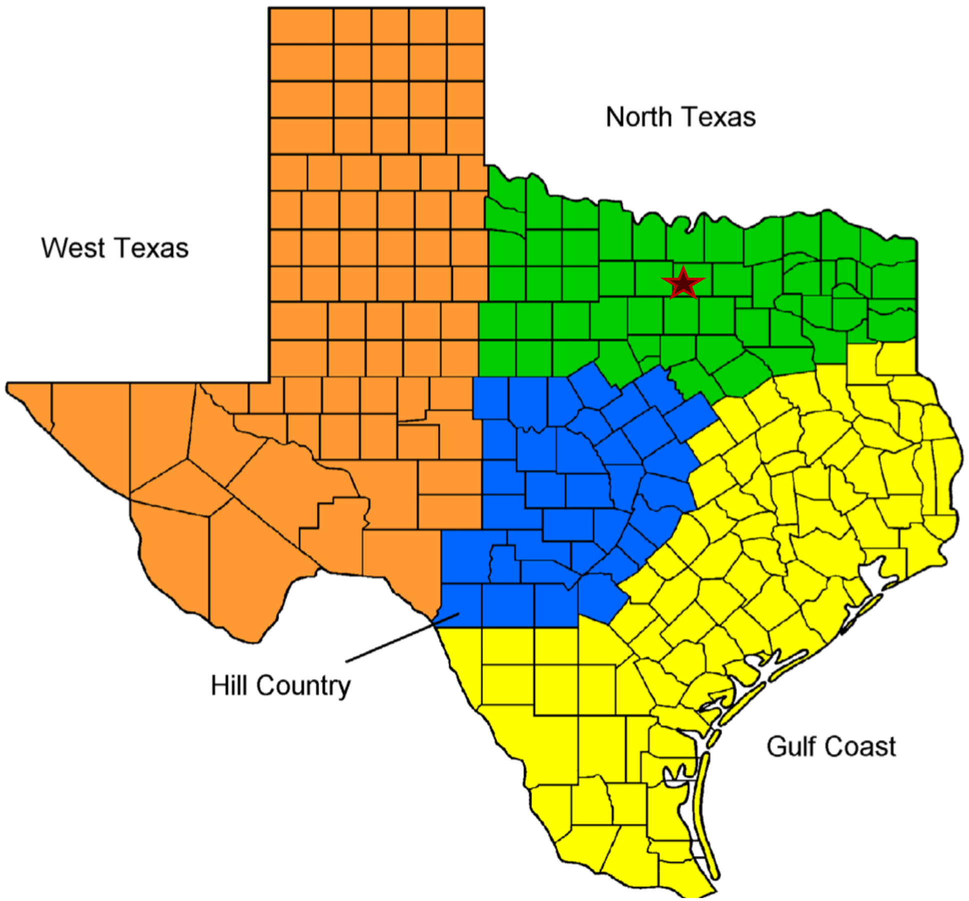
Irrigation Budgeting

Michael Cook

2018

Who is this guy?

Texas Viticulture Regions



Our Goal

Water is the most invigorating input in the vineyard

Utilize an irrigation scheduling method(s) that prevents:

- poor vine balance
- excess or poor vigor
- decreased fruit set
- early berry dehydration
- nutritional imbalances
- inconsistent yield and quality of fruit

The BIG question: when to irrigate, how much, how many times, and for how long

General Vine Water Needs

General rule of thumb

- **24”** water a year for mature vineyard (i.e. 2 acre ’)
  - precipitation & supplemental
  - one acre-inch = **27,154 gallons/acre**

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How much do I need to water my vines?

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Factors you need to keep in mind

Climate

Seasonal Weather Fluctuations

Phenological Stage of Vine

Soil Properties

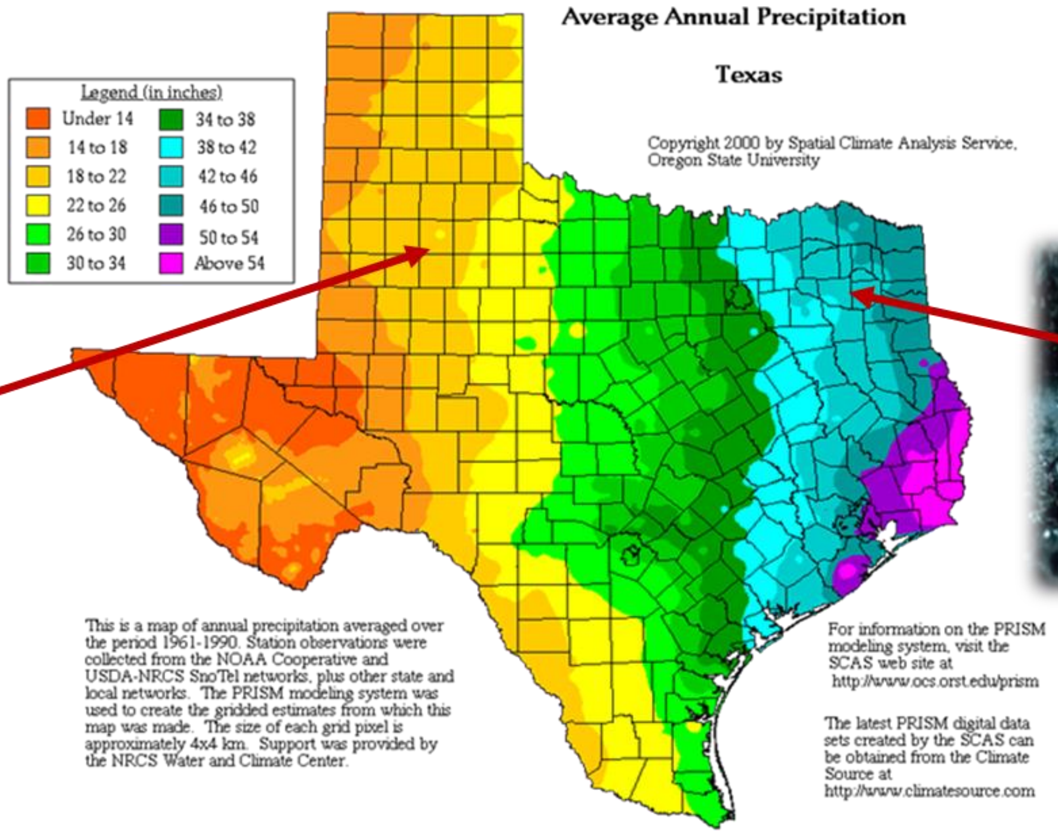
Variety/Rootstock

Age of Vineyard

Irrigation System

Climate (mean)

Precipitation Rate



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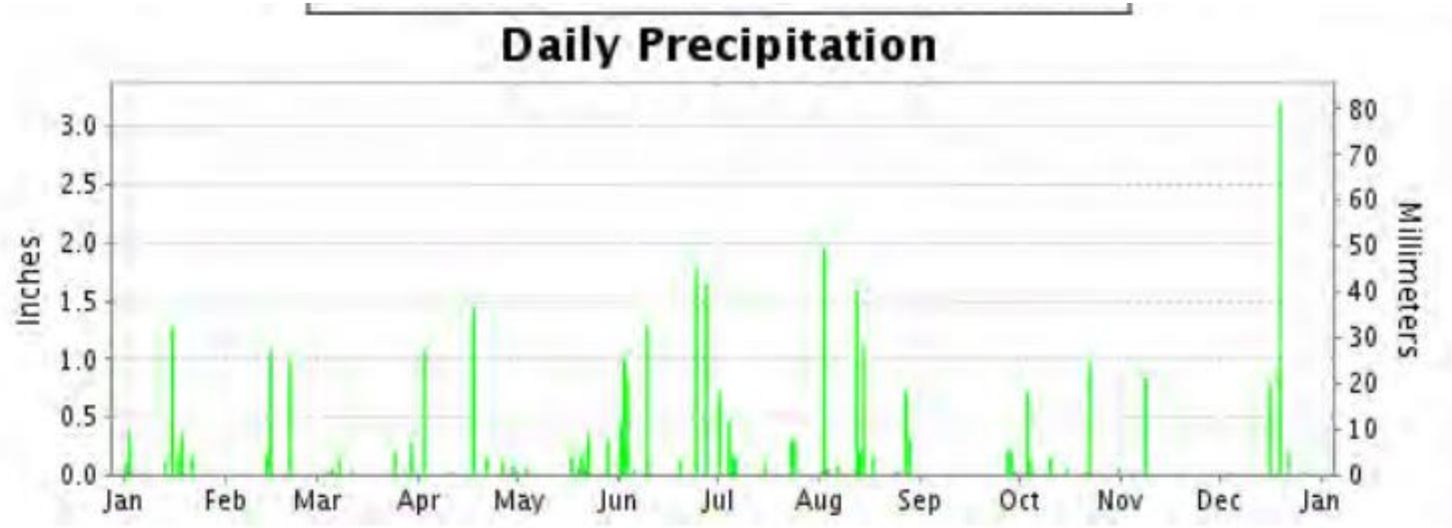
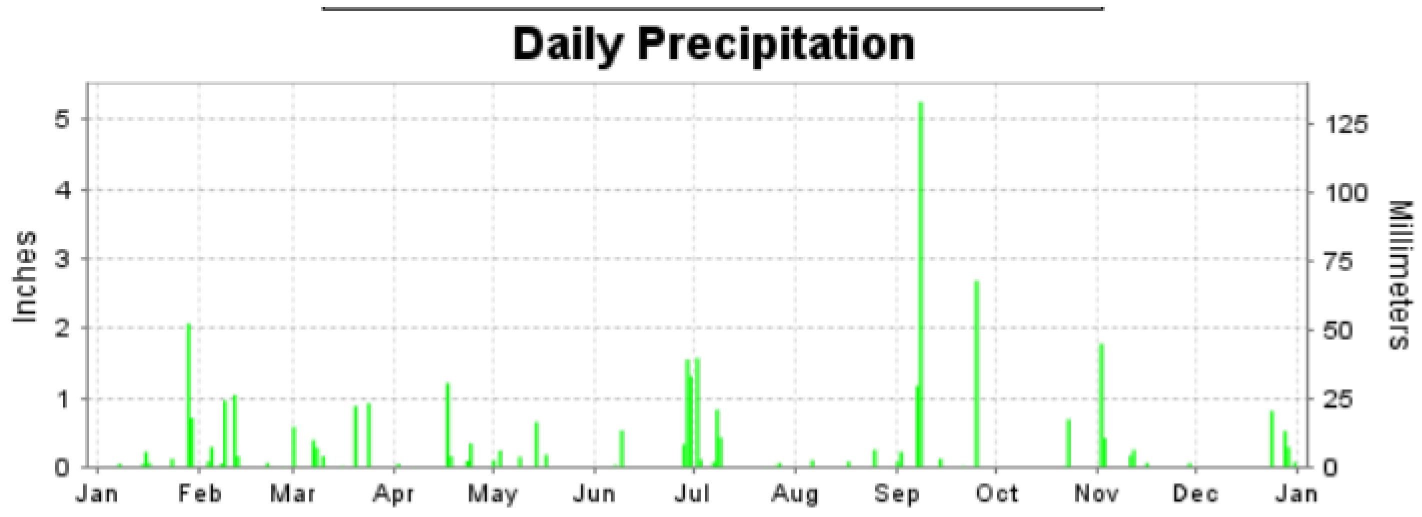
Seasonal Weather Fluctuations

2017



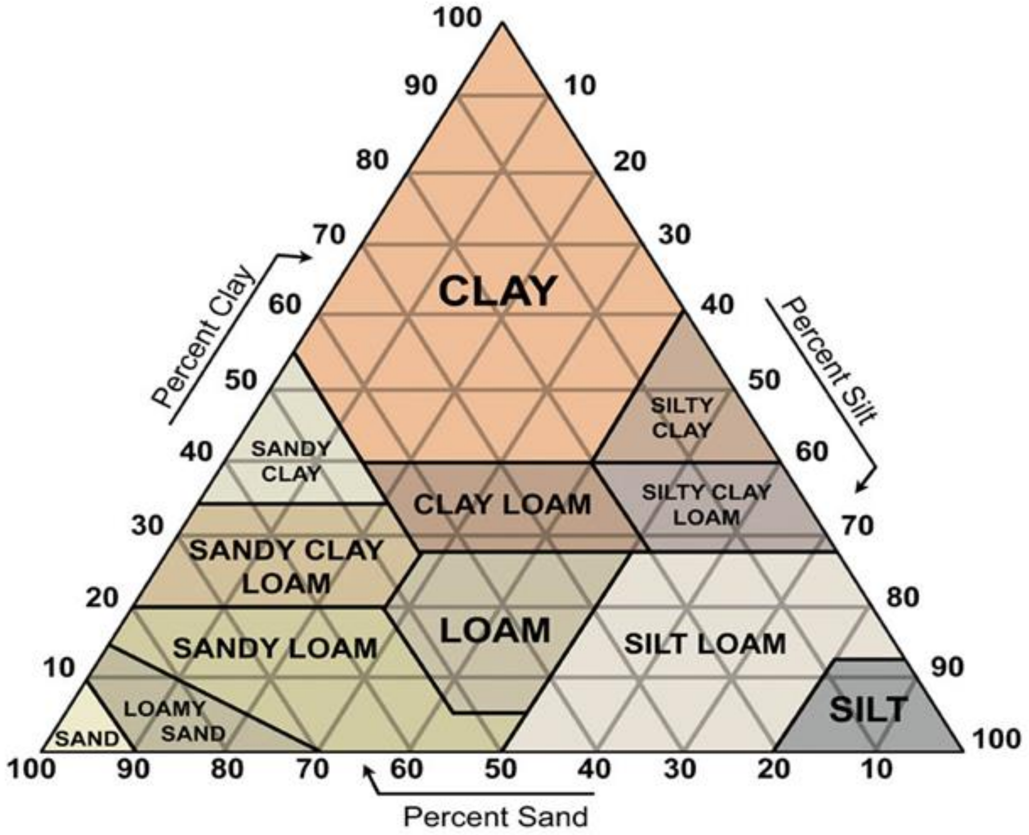
Dallas, TX

2010

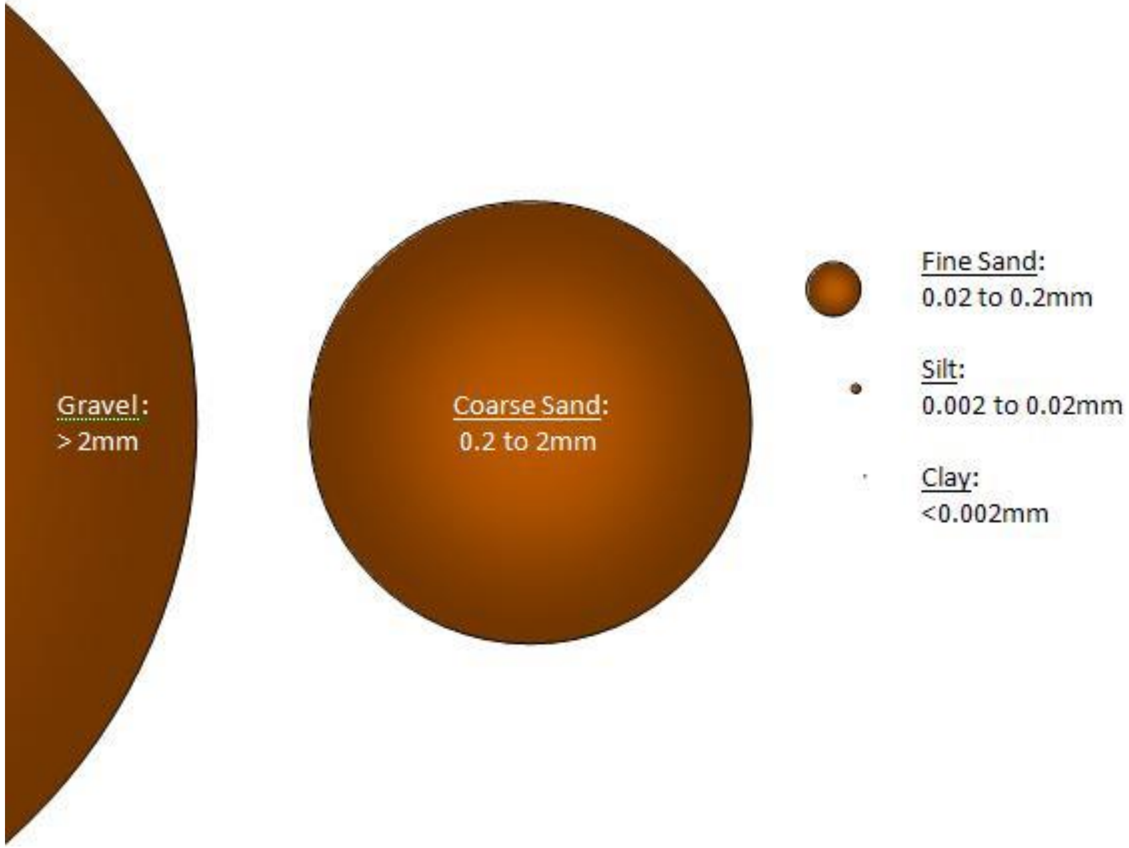


Drought or Deluge

Water Holding Capacity

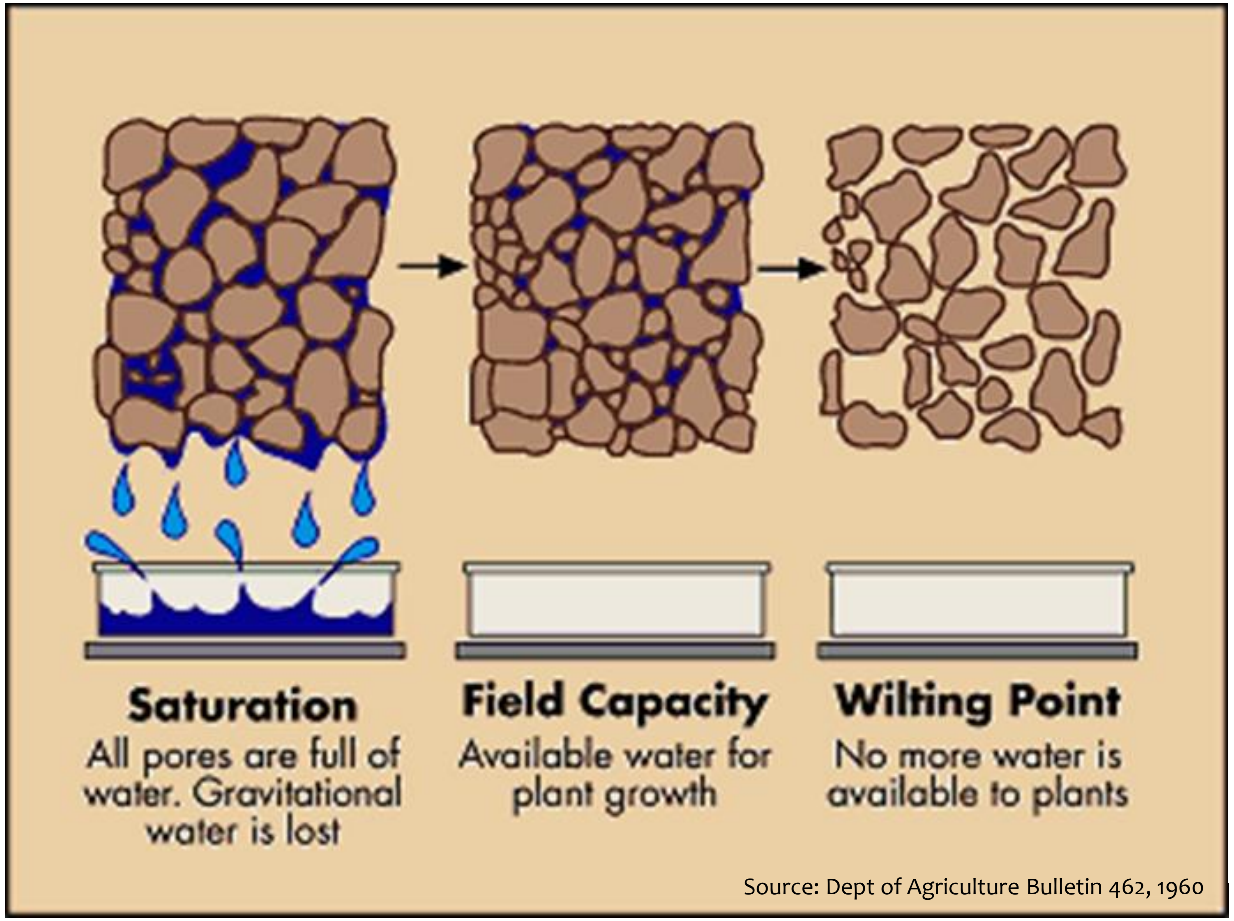


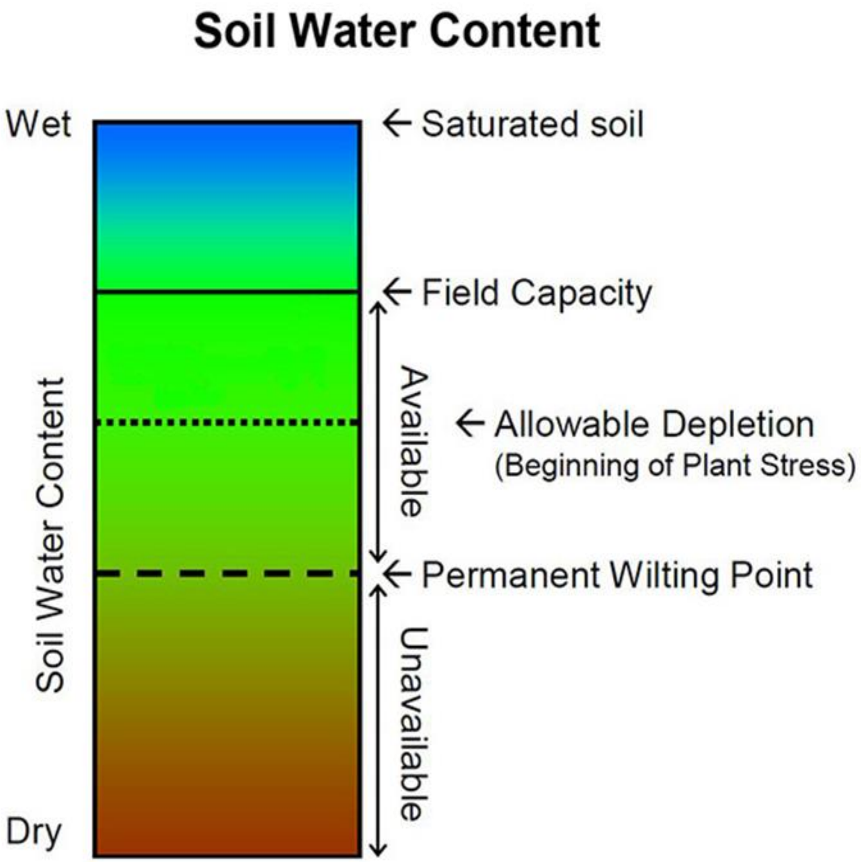
Courtesy of USDA-NCRS



Courtesy of Measurement Engineering Australia

Water Holding Capacity





Courtesy of Utah State University

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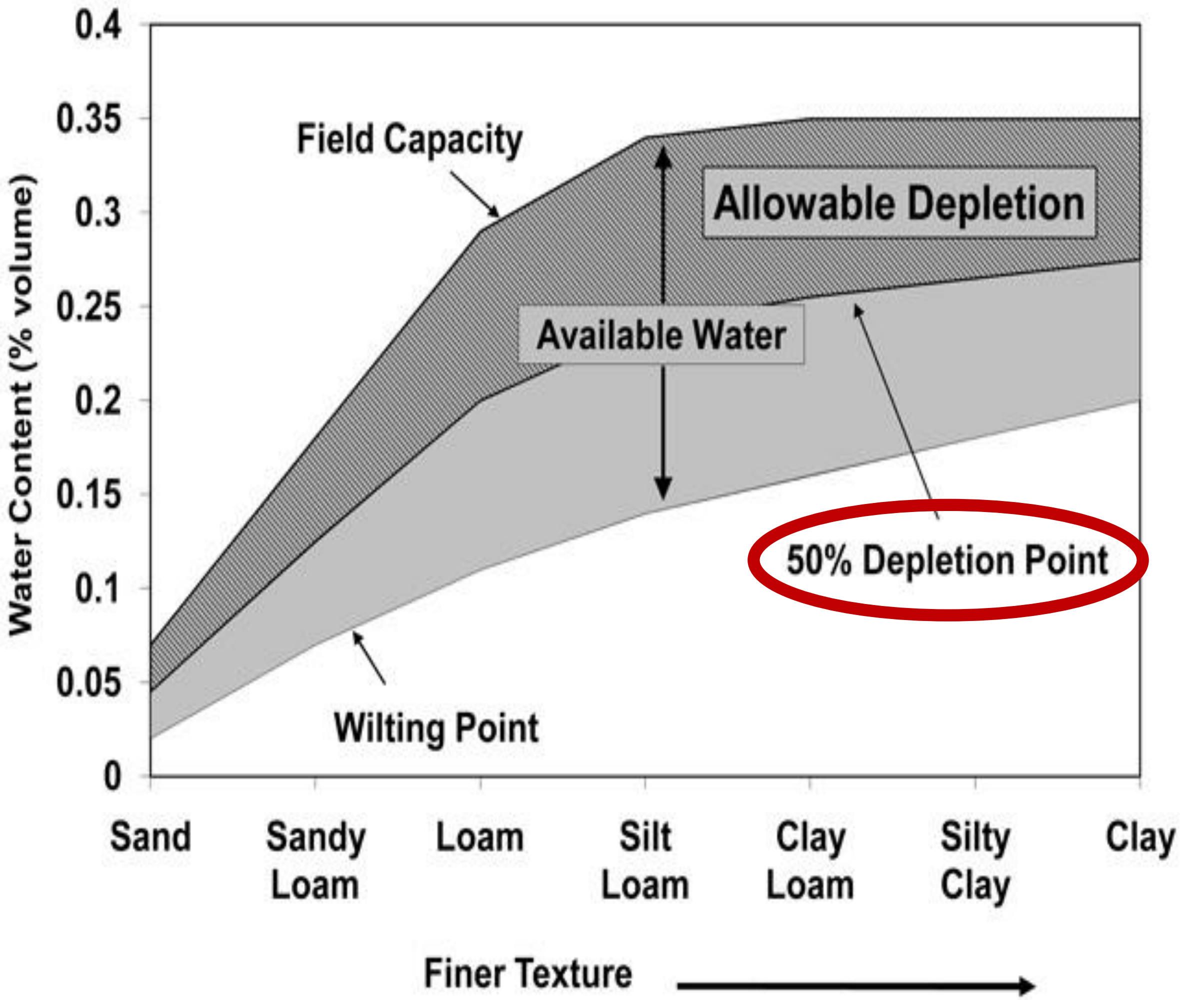
Water Holding Capacity



Courtesy of Utah State University

Courtesy of Noble Foundation

Available Water Capacity by Soil Texture	
Textural Class	Available Water Capacity (Inches/Foot of Depth)
Coarse sand	0.25–0.75
Fine sand	0.75–1.00
Loamy sand	1.10–1.20
Sandy loam	1.25–1.40
Fine sandy loam	1.50–2.00
Silt loam	2.00–2.50
Silty clay loam	1.80–2.00
Silty clay	1.50–1.70
Clay	1.20–1.50

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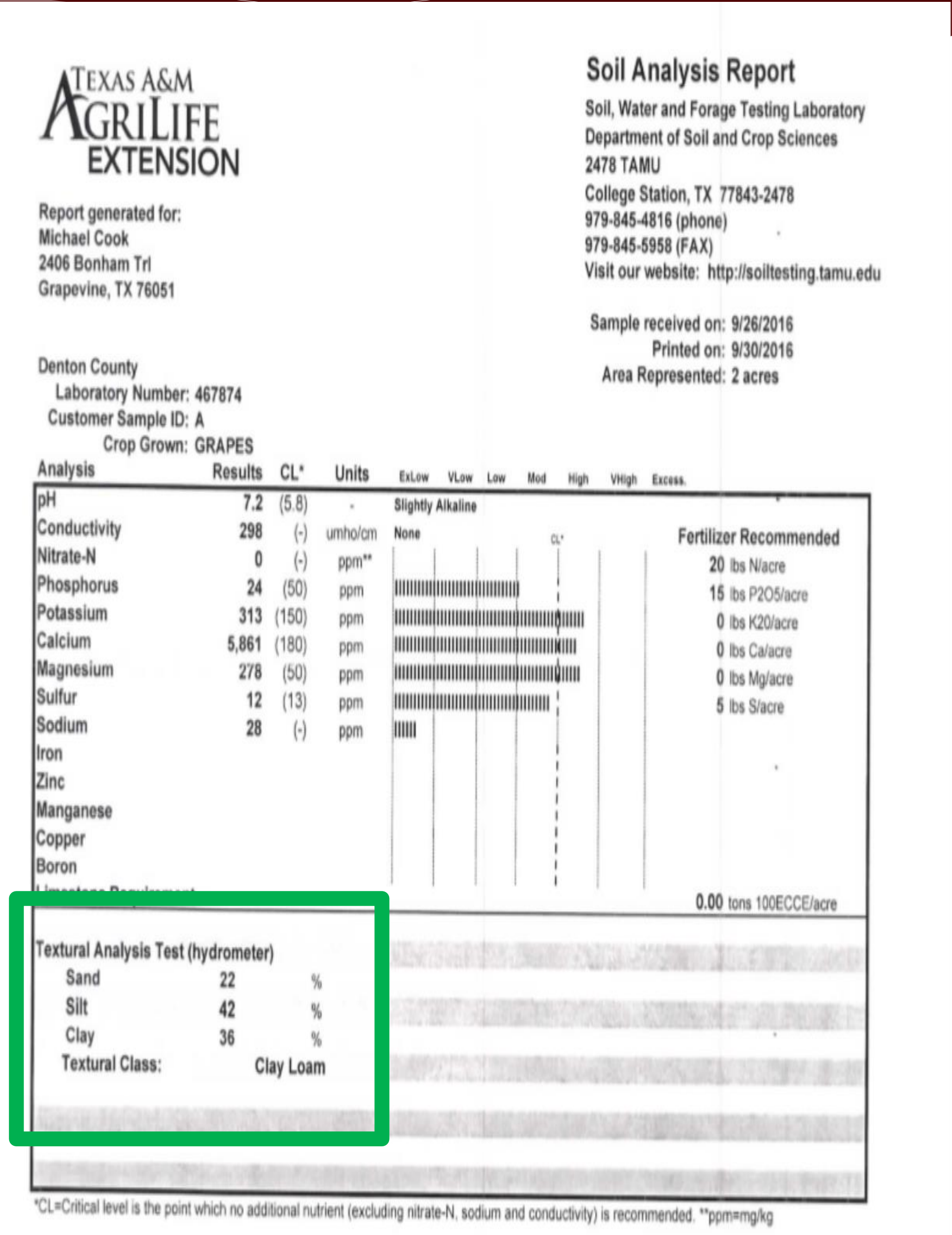
Don’t know what you have?



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Soil Analysis Report

Soil, Water and Forage Testing Laboratory
Department of Soil and Crop Sciences
2478 TAMU
College Station, TX 77843-2478
979-845-4816 (phone)
979-845-5958 (FAX)
Visit our website: http://soiltesting.tamu.edu

Report generated for:
Michael Cook
2406 Bonham Trl
Grapevine, TX 76051

Sample received on: 9/26/2016
Printed on: 9/30/2016
Area Represented: 2 acres

Denton County
Laboratory Number: 467874
Customer Sample ID: A
Crop Grown: GRAPES

Analysis	Results	CL*	Units	ExLow VLow Low Mod High VHigh Excess.	Fertilizer Recommended
pH	7.2	(5.8)	-	Slightly Alkaline	
Conductivity	298	(-)	umho/cm	None	
Nitrate-N	0	(-)	ppm**		20 lbs N/acre
Phosphorus	24	(50)	ppm		15 lbs P2O5/acre
Potassium	313	(150)	ppm		0 lbs K20/acre
Calcium	5,861	(180)	ppm		0 lbs Ca/acre
Magnesium	278	(50)	ppm		0 lbs Mg/acre
Sulfur	12	(13)	ppm		5 lbs S/acre
Sodium	28	(-)	ppm		
Iron					
Zinc					
Manganese					
Copper					
Boron					
Limestone Requirement					0.00 tons 100ECCE/acre

Textural Analysis Test (hydrometer)

Sand	22	%
Silt	42	%
Clay	36	%
Textural Class:	Clay Loam	

*CL=Critical level is the point which no additional nutrient (excluding nitrate-N, sodium and conductivity) is recommended. **ppm=mg/kg

Vine Root Zone

- 80% of root mass is in top 18”
- Feeder roots in row middles
- In drip irrigated vineyards, majority of root zone is concentrated near the emitter(s)

Does it matter if I leave the irrigation on all night?

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Water Demand based on Phenology

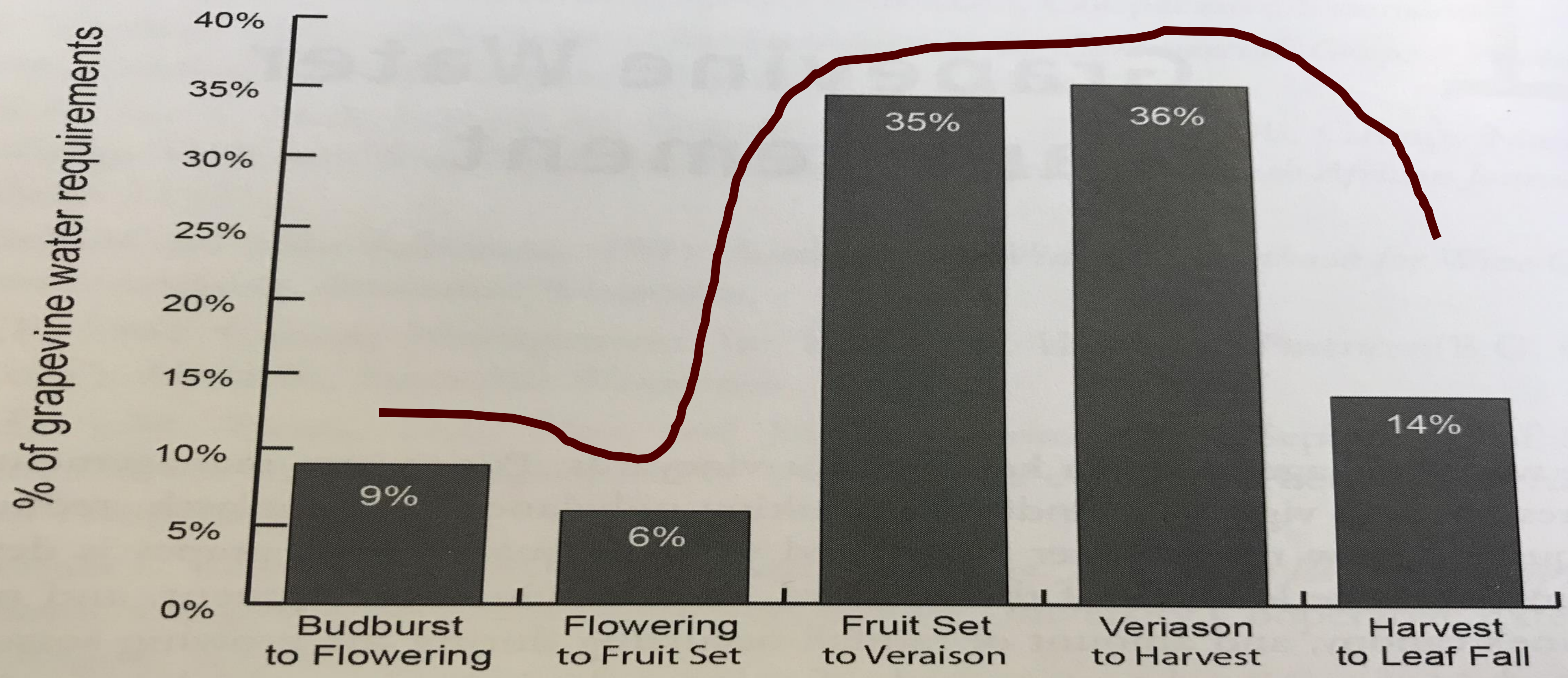

Figure 11.1
Approximate Grapevine Water Requirements by Growth Stage

Graph courtesy of Ted Goldammer 2017

Phenology

Dormancy – grapes still need water to maintain root function and overall health of vine. Also, a saturated soil may aid in mitigating winter injury.

Phenology

Bud break to Flowering – critical stage for root growth, even budbreak, establishing vine canopy, and potential yield for current and following season.

Vines are undergoing:

- **rapid shoot growth**
- **bud initiation and differentiation**
  - **inflorescence primordia or tendril primordia**

In a ***<u>normal</u>*** year, soil moisture from winter rains often meet evapotranspirational needs for first months

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Phenology

Flowering to Fruit-Set – ***most sensitive period to water stress***

Severe and prolonged stress can:

- lead to poor flower-cluster development
- reduce pistil and pollen viability
- reduce berry set
- reduce canopy development (i.e. insufficient leaf area)

Phenology

Fruit-Set to Veraison – Vines less susceptible to water stress, common practice to initiate RDI, BUT….

Insufficient watering can lead to:

- limited canopy
- reduced photosynthetic capacity
- restricted fruit development and quality
- Sun burning of fruit
  - increase in browning and bitterness in wine

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Phenology

Veraison to Harvest – irrigation should maintain canopy health and avoid any stress

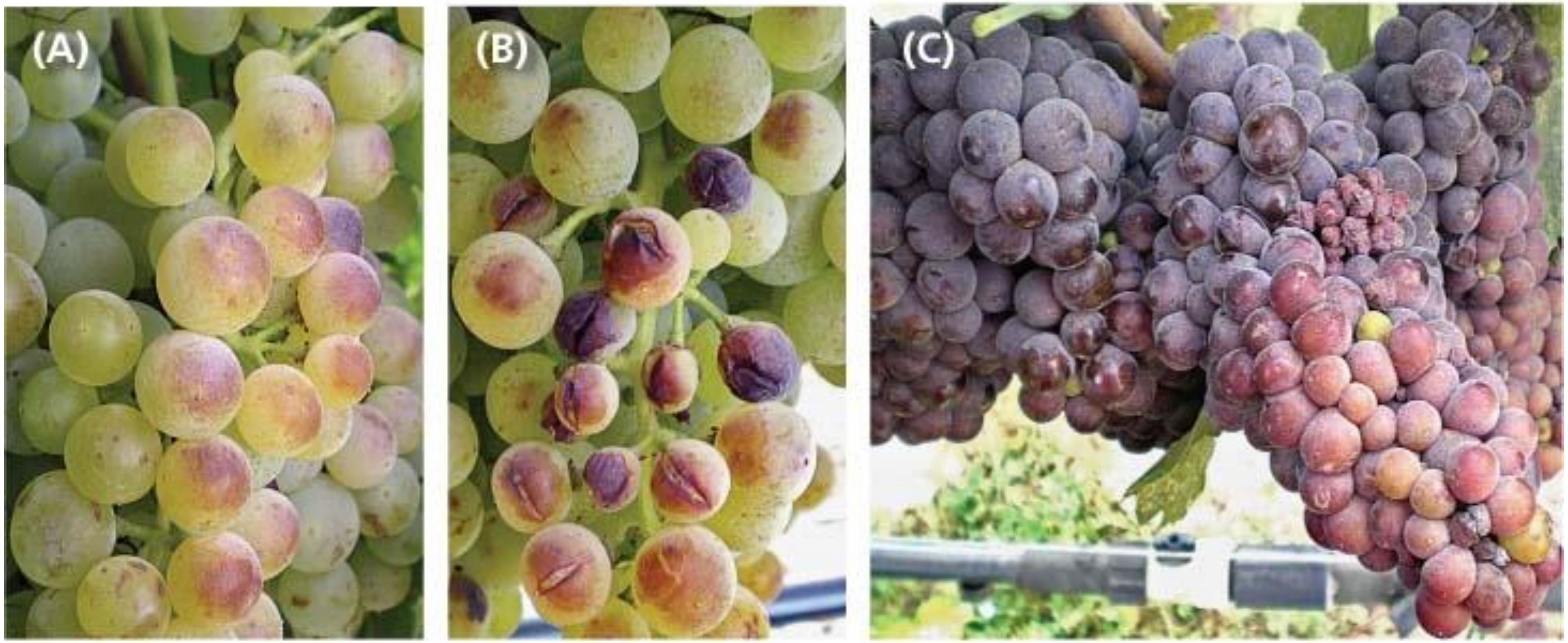
Courtesy of Krasnow *et al.*, 2010

Underwatering can:

- senescence of lower and interior foliage
- sun burning of fruit
- Reduced photosynthetic capacity
- Reduction in yield (dehydration)
- **Overwatering** = split berries & dilution

Sunburn

Courtesy of Krasnow *et al.*, 2010



A Burger grape cluster exhibits (A) slight browning due to sunburn and (B) more severe sunburn and cracking. (C) *Left*, A healthy Barbera cluster and, *right*, a sunburned cluster with poor coloration and raisining.

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Phenology

Post-Harvest – need to water to ensure a lasting canopy that will allow the vine to maximize carbohydrate storage over dormancy.

Water stress at this time can:

- restrict second flush of root growth
- reduced carbohydrate storage
- increase susceptibility to winter injury

Overirrigating can lead to new shoot growth

Vineyard Age

Young Vines

- water frequently, ensure emitters are reaching vine
- avoid overwatering but never stress a vine
- keep 3’ weed free strip under trellis

Vineyard Age

Mature Vines

- utilize soil and/or plant based methods to determine irrigation needs
  - suitable for large and small vineyards

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Determining Irrigation Needs

How to measure?

Soil-based scheduling Methods

- hand-feel
- soil moisture sensors

Plant-based scheduling methods

- Visual observations
- Leaf and stem water potential
- Evapotranspiration

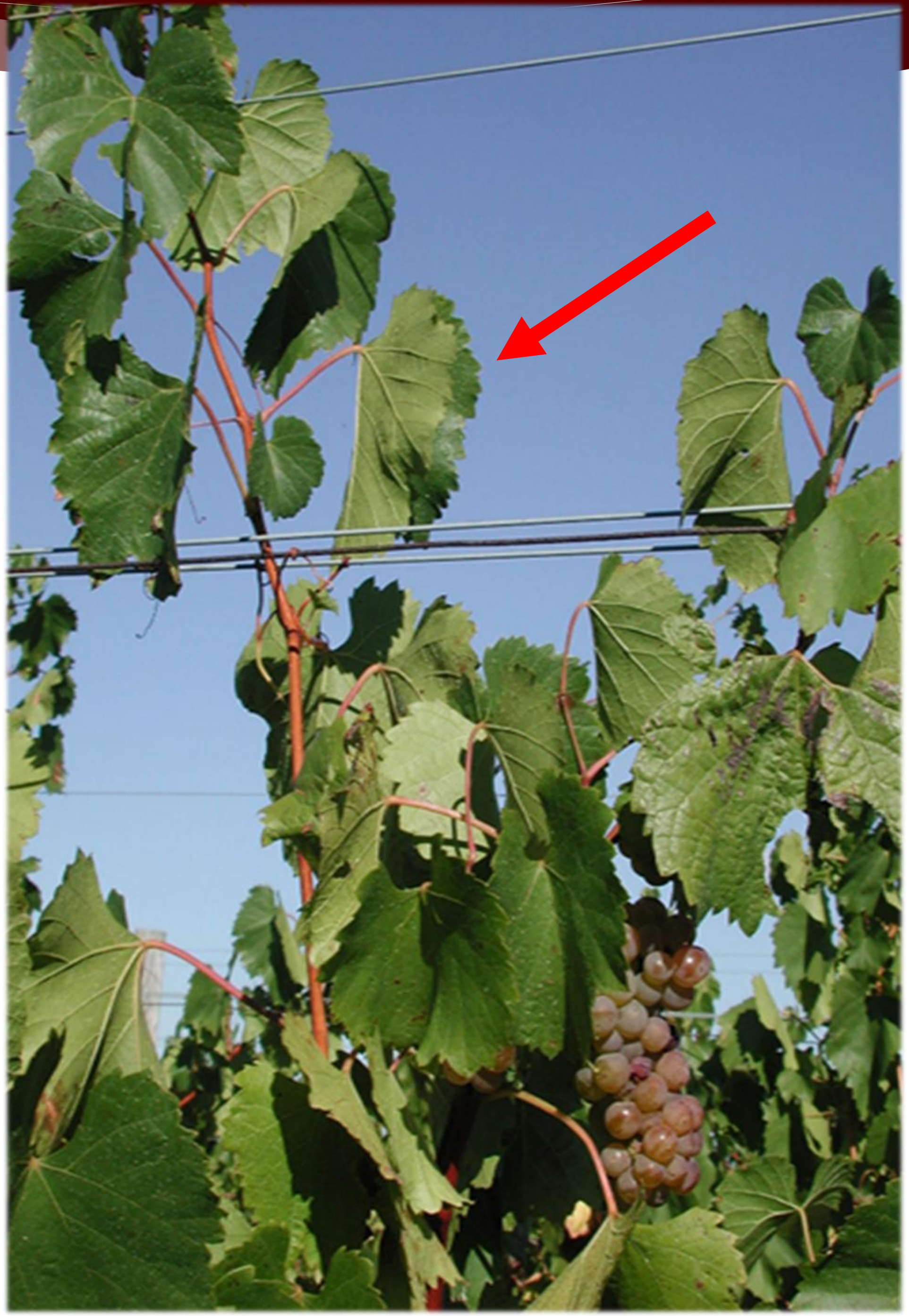
Hand-feel

Soil Sensor Technology
- Dr. Pierre Helwi

Plant-based Scheduling Methods

Visual Cues

Observation	Surplus	Slight-mod	Severe
Tendrils	Turgid	Drooping/wilted	Yellow, dried, abscised
Shoot tips	Active	Compressed	Dead
Leaf orientation	Blade perpendicular	Blades oriented away from sun (cupped)	Leaves curling or dried
Leaf color	Vibrant green	Grayish-green to light green	Light green, yellowing
Fruit clutser	Normal and turgid	Set may be reduced	Cluster rachis may dry, flaccid berries



Often too late….

Pressure Chamber
(physiological)

Dr. Justin Scheiner

Scheduling Irrigation with ETc

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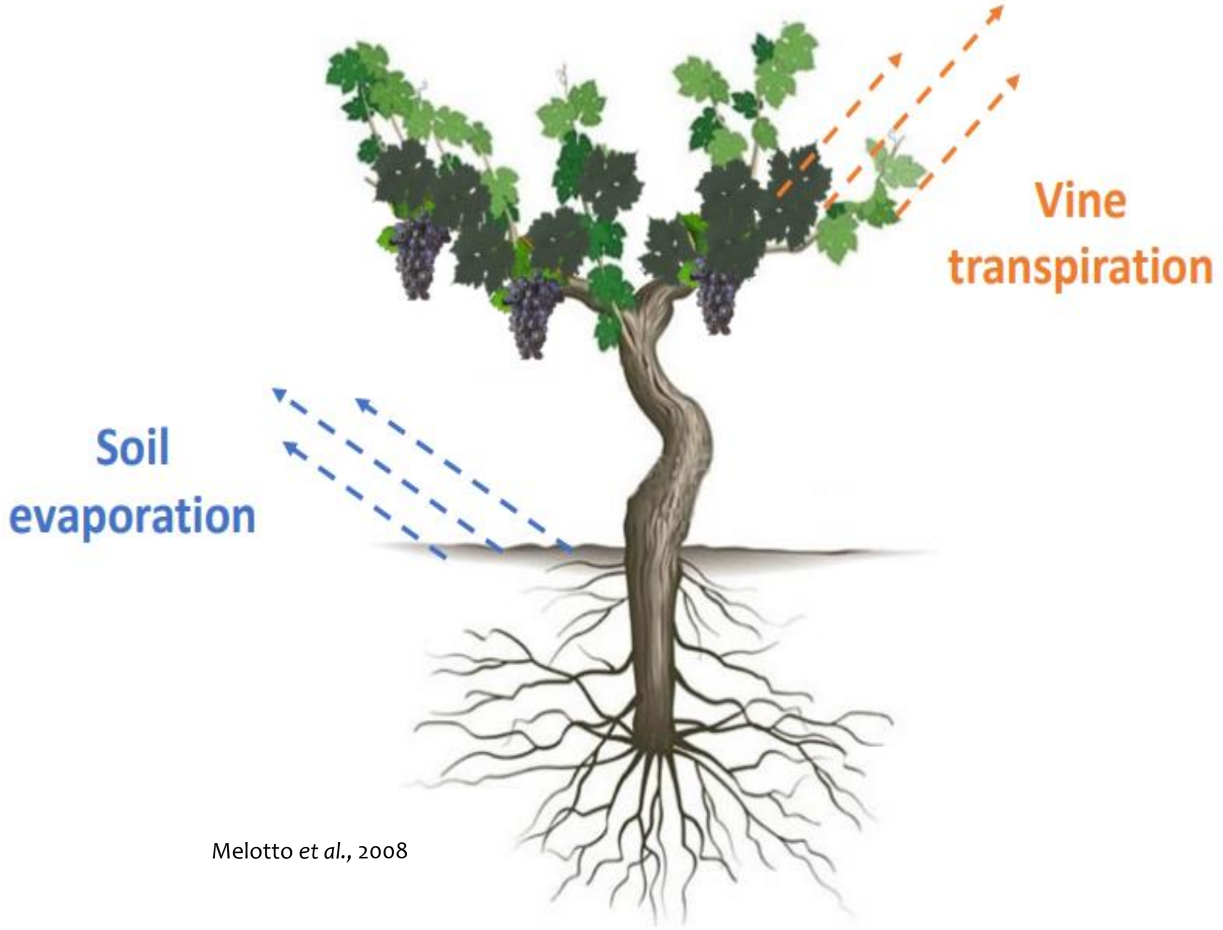
Evapotranspiration (Eto)



Melotto *et al.*, 2008

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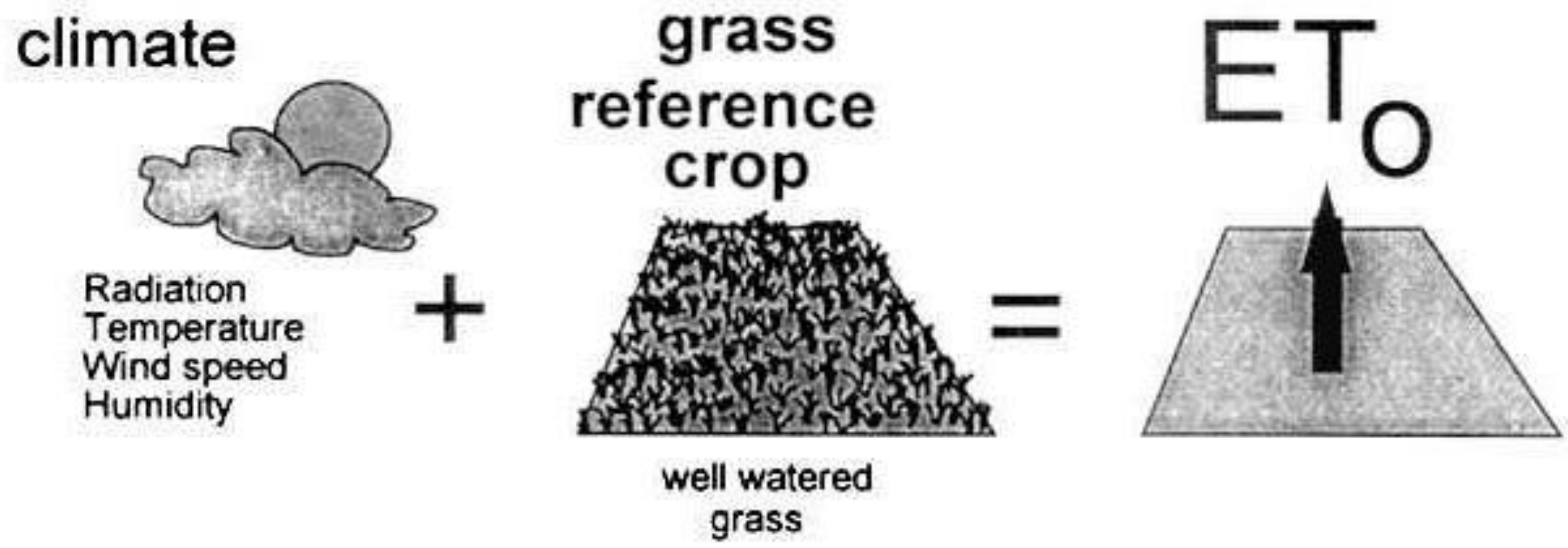
How is ETo measured?

Calculated in inches per time period



Warm, Sunny, Long, and Windy days = **higher ET value**
Cool, Cloudy, Short, and Calm days = **lower ET value**

Penman Monteith (FAO-56) equation

$$ET_o = \frac{0.408\Delta\,(R_n - G) + \gamma \frac{900}{T + 273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34\,u_2)}$$

But this is just a reference crop, not grapes….

The Formula

$$Et_c = Et_o \times K_c$$

Eto = reference evapotranspiration (fescue)

Kc = crop coefficient

Etc = grapevine evapotranspiration

K_c & %SA

- Changes throughout the year and is based upon
  - development of canopy
  - vine water demand
    - lower early in season and increases

How to estimate Kc

- 4x4' white board with 6" gridlines
- 12:30-1:30pm (solar noon)
- then Kc = %SA x 0.017
- Ex. 30% shaded area will have a Kc of 0.51
- Row middle cover multiply Kc x 1.2

Courtesy of aggie-horticulture.tamu.edu

Avg. Full Canopy Kc is 0.65 (Moyer *et al* 2013).

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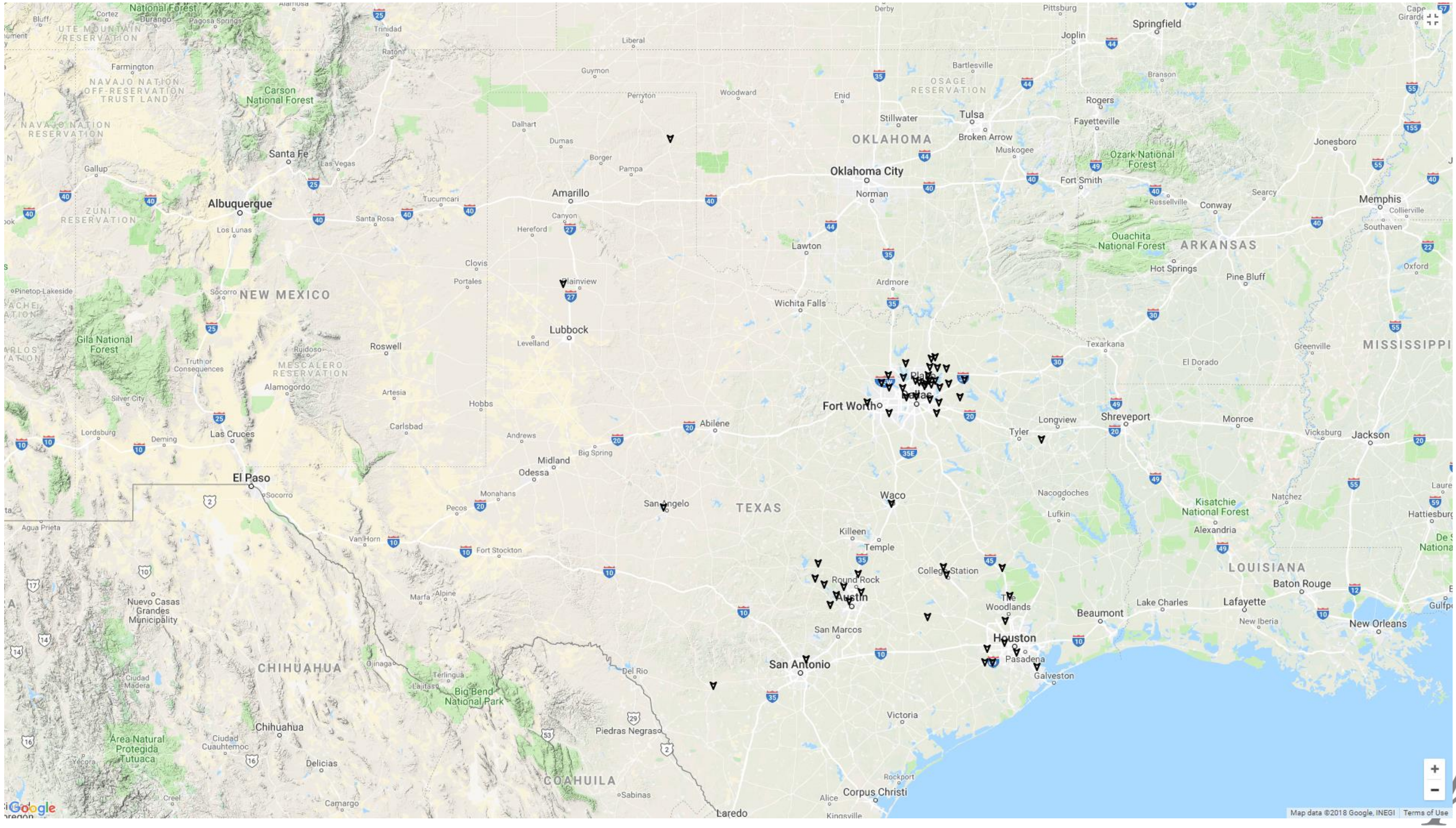
Public Access ET data

http://texaset.tamu.edu/



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http://texaset.tamu.edu/

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Search TexasET ...

TexasET Network | Latest Data | ET and Weather Data | Useful Information | Profile

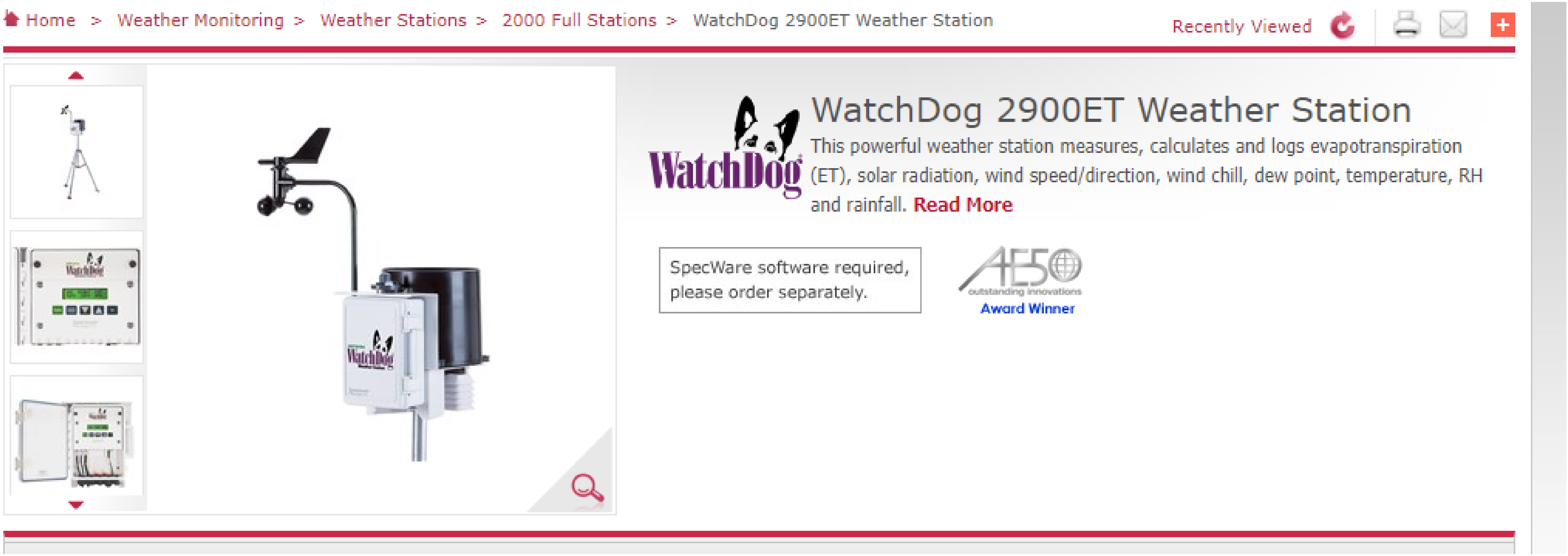
Dallas AgriLife Center's 7 Day Weather Summary

Detailed Weather Data and Heat Units

Date	ETo (in)	Max Temp (f)	Min Temp (f)	Min RH (%)	Solar Rad. (MJ/m2)	Rainfall (in)	Wind 4am (mph)	Wind 4pm (mph)	Battery (v)
Apr 18, 2018 - Wed	0.25	74	63	17	18.99	0.00	12.53	9.73	
Apr 17, 2018 - Tue	0.31	82	59	31	17.32	0.00	12.69	16.69	
Apr 16, 2018 - Mon	0.23	78	45	26	18.93	0.00	1.00	12.66	
Apr 15, 2018 - Sun	0.20	60	36	17	19.42	0.00	13.00	8.25	
Apr 14, 2018 - Sat	0.26	67	44	21	16.76	0.00	10.94	12.86	
Apr 13, 2018 - Fri	0.29	82	69	22	8.72	0.01	18.43	16.14	
Apr 12, 2018 - Thu	0.25	80	61	46	15.70	0.00	13.83	17.98	
Data Summary	1.80	82	36	25	115.85	0.01	11.77	13.47	

3-Day Summary | 5-Day Summary | 7-Day Summary | 2-Week Summary

Your own ET calculator



The ET Water Budget Approach

Example

Et Scheduling Calculator_Cook - Excel

Denair leaf removal irrigation

Station#206 Denair II

Date	Prior week Eto (in/wk)	%PSA	Kc	Etc (in)	Water lost per acre (gallons)	ET replaced	Gallons to replace/acre	SE	Pump hr	Acre inches replaced	gallons applied
5/6/2013	1.77	18	0.306	0.54162	14707.14948	1	14707.14948	0.9	24.07377	0.541540227	14704.98332

Irrigation | ML-acre applied | Output | 2014 Winter Irr Applied | conversion | Water Relations Graph

May 27, 2018 - Sun	0.24	92	73	37	28.00	0.00	1.30	2.90
May 26, 2018 - Sat	0.25	91	73	42	27.38	0.00	0.15	4.25
Data Summary	1.81	93	71	39	187.78	0.00	1.93	5.88

3-Day Summary | 5-Day Summary | 7-Day Summary | 2-Week Summary

Calculators

Home Owner | Landscape | Crop

Crop Watering Calculator

1.) ETo value from weather data: 1.81

2.) Select a crop coefficient

FAO Coefficients: Grapes- Wine

Or

Texas High Plains Coefficients: Select a crop...

3.) Select a crop growth stage: Mid Season

4.) Crop coefficient from growth stage: 0.70

5.) Enter your system efficiency: 90

6.) Effective Rainfall: 0

7.) Calculate Water Req: 1.40

Precipitation Rate: 1

Total Run Time: 84

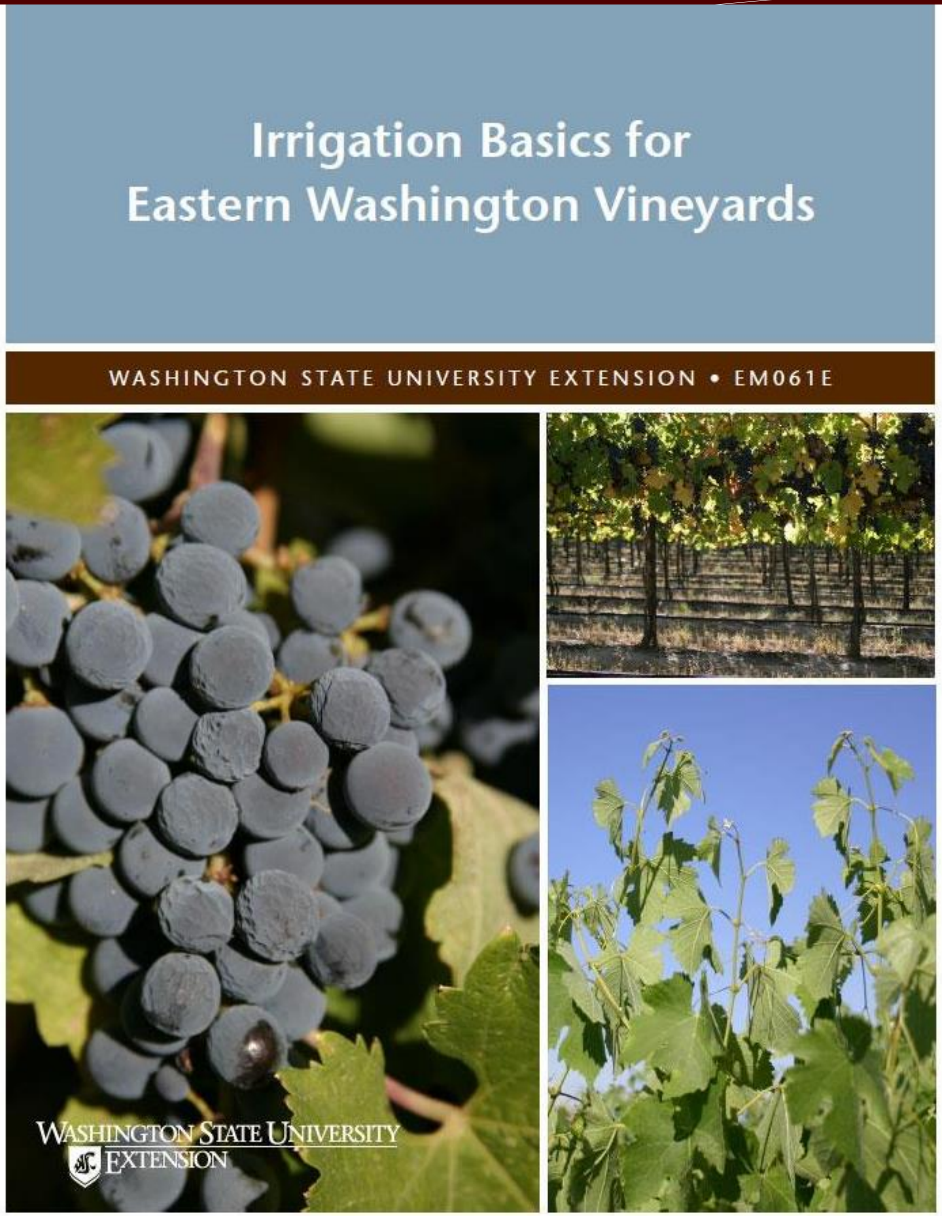
Irrigations/Week: 3

Run Time/Irrigation: 28

Calculate Run Time

Contact

http://cru.cahe.wsu.edu/CEPublications/EM061E/EM061E.pdf



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How long to irrigate during each application?

Fast Infiltration

water more freq. but for shorter duration

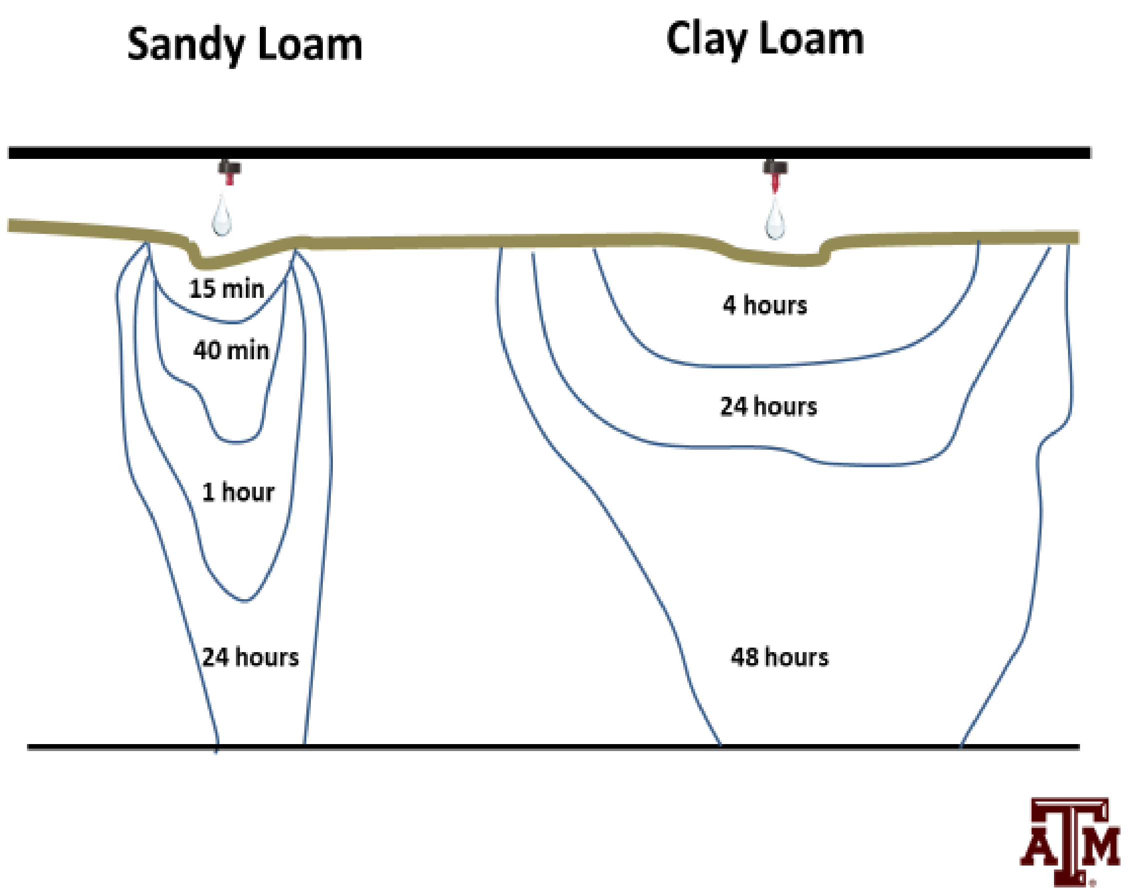


Image courtesy of Dr. Justin Scheiner

Slow Infiltration

water less freq. but longer duration

Check Book Approach

Utilization of outputs (Etc) plus inputs (rainfall and irrigation) to soil moisture

- Begin recording at *Field Capacity* (100% Plant Available Water)
- 50% Allowable depletion of Plant Available Water is often target

Example

You have a Loamy Sand (1.0 in. per foot) and is 5 ft. d

Plant Available Water = 5.0 inches of water

50% Allowable Depletion = **2.5 inches of water**

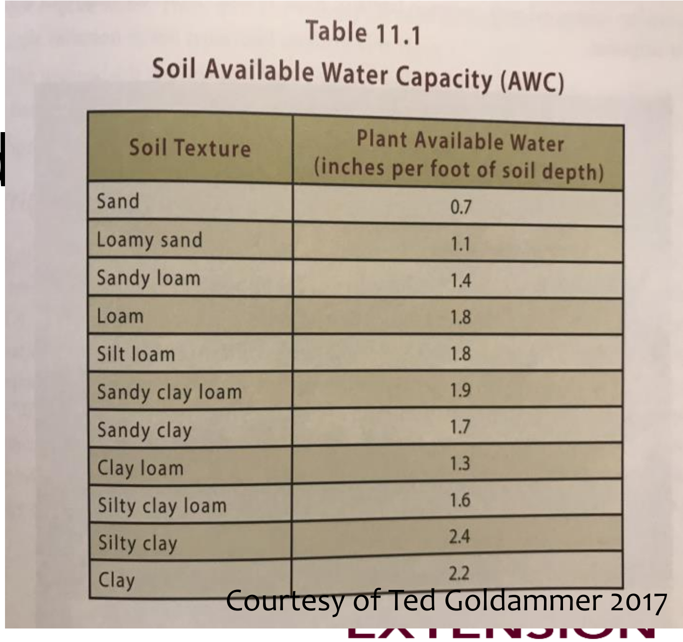


Table 11.1
Soil Available Water Capacity (AWC)

Soil Texture	Plant Available Water (inches per foot of soil depth)
Sand	0.7
Loamy sand	1.1
Sandy loam	1.4
Loam	1.8
Silt loam	1.8
Sandy clay loam	1.9
Sandy clay	1.7
Clay loam	1.3
Silty clay loam	1.6
Silty clay	2.4
Clay	2.2

Courtesy of Ted Goldammer 2017

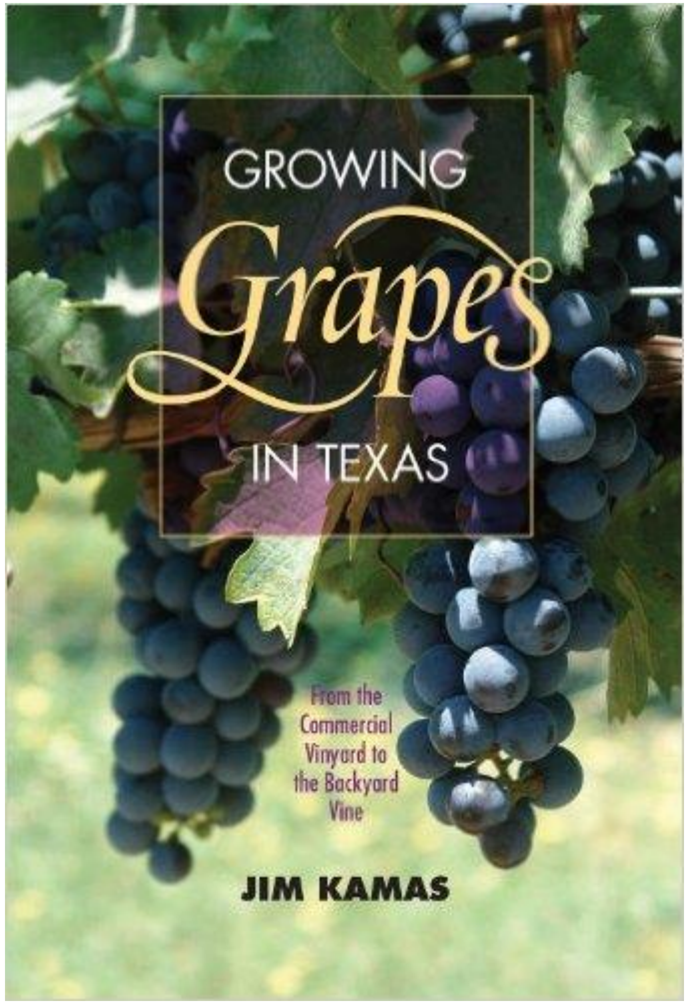
Table 12.3
Water Budget Scheduling Example for Grapevines

Date	Effective Rainfall (in)	Irrigation (in)	Crop ETc (daily)	Crop ETc (cumulative)	Depletion
June 30	0.00	0.00	0.30	0.30	2.20
June 31	0.00	0.00	0.19	0.49	2.01
July 1	0.00	0.00	0.22	0.71	1.79
July 2	0.00	0.00	0.28	0.99	1.15
July 3	0.00	0.00	0.25	1.24	1.26
July 4	0.00	0.00	0.26	1.50	1.00
July 5	0.00	0.00	0.28	1.78	0.72
July 6	0.00	0.00	0.32	2.10	0.40
July 7	0.00	0.00	0.36	2.46	0.04
July 8	0.00	2.50	0.40	0.36	2.14
July 9	0.00	0.00	0.22	0.58	1.92
July 10	0.42	0.00	0.11	0.27	2.23
July 11	0.25	0.00	0.15	0.17	2.33
July 12	0.00	0.00	0.25	0.42	2.08

Table courtesy of Ted Goldammer 2017

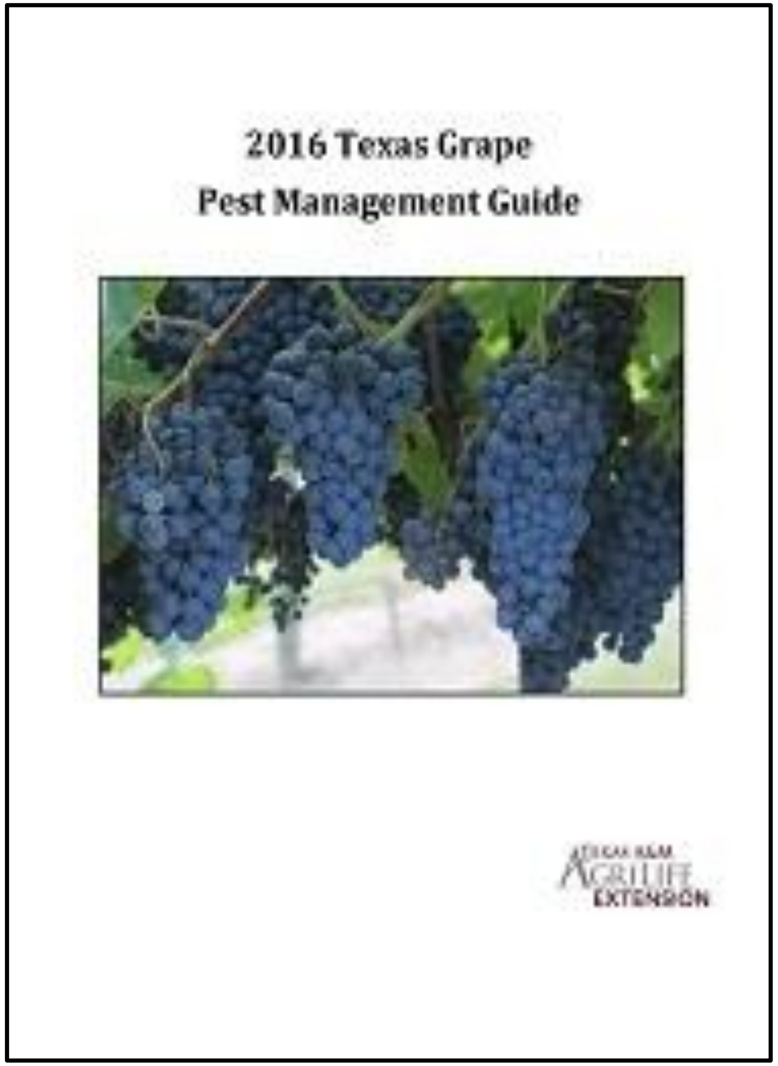
Start with 2.5 inches in the bank

When we approach 0.00 (i.e. 50% PAW) we need to irrigate



Questions?

m.cook@tamu.edu



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