Irrigation Scheduling of Grapevines with Evapotranspiration Data

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Water management is a critical aspect of successful winegrape production in Texas. Even the higher rainfall regions of Texas commonly experience drought conditions at some time during the season, so supplemental water application through irrigation is necessary. Water applied at the proper time and quantity can influence grape yields and fruit quality. In addition, water can be a scarce resource in many areas and its efficient use must be a high priority. Thus, methods for scheduling irrigation are an important aspect of good vineyard management. Irrigation scheduling is concerned with determining when to irrigate and how much water to apply.

When to Irrigate

The timing of irrigation can be determined by monitoring soil moisture and starting irrigation when soil moisture has been depleted to a predetermined amount. There are many different types of soil moisture sensors available and the critical values vary with the type of sensor. Soil characteristics have a great influence on the moisture-holding capacity and the rate of soil water depletion is also dependent on other site characteristics, such as the presence of a cover crop. It is important to understand the characteristics of your vineyard soil and site to effectively manage water. See References for articles on soil moisture sensors and their use.

Alternatively, grapevine water status can be monitored to determine when the vine is beginning to experience a water deficit (about -10 bars). Grapevine water status is determined with the use of a pressure chamber (pressure bomb), a simple but somewhat expensive instrument that may only be appropriate for large vineyards. See References for articles on the use of pressure bombs for monitoring grapevine water status and irrigation scheduling.

How Much Water to Apply

One good method for determining how much water to apply is through the use of Reference Evapotranspiration (ETo), also known as Potential Evapotranspiration (PET). Evapotranspiration is the sum of water loss from evaporation from the soil surface and a plant's loss of water through transpiration (water vapor moving out of leaf stomata). Evapotranspiration is estimated for an area with the use of local weather data and a reference crop - a standard plot of irrigated grass. Daily ETo rates of the reference crop are adjusted for grapevines by multiplying by a crop coefficient (Kc) for grapevines. A simple calculation provides an estimate of grapevine water use as a guideline for irrigation scheduling.

Water Requirement Formula

Estimated water requirement = [ETo X Kc] divided by the irrigation system efficiency

A local weather station is consulted for the daily ETo rates and these can be summed over a one-week period or other duration that is appropriate for the vineyard's irrigation schedule. The Texas Evapotranspiration website provides ETo data and an interactive Crop Water Requirement Calculator to quickly perform the computations. See References for additional sources of PET data.

The crop coefficient (Kc) for grapevines can be estimated by the method described below.

Irrigation system efficiency is estimated for the type of system used. Drip irrigation is the most efficient and values range from 0.85 to 0.95 (i.e., 85-95% efficient). Use a value between 0.60 to 0.75 for sprinkler irrigation and a value between 0.40 - 0.50 for furrow irrigation.

Typically, water use is estimated for a given time period such as one week. Thus, daily ETo is summed for the given time period.

Example Calculation

Cumulative one-week reference ETo = 1.69 inches
Crop coefficient = 0.51
Drip irrigation system efficiency = 0.90

Estimated water use (one week) = [(sum of daily ETo) X (Kc)] divided by the system efficiency

Estimated water use (one week) = [1.69 X 0.51] divided by 0.90

0.862 inches divided by 0.90 = 0.96 inches

Estimated water use (one week) = 0.96 inches

Finally, to determine how much water to apply, inches must be converted to gallons for determining how long to run the irrigation system. This calculation uses the acre-inch conversion factor and the square footage occupied by a single vine in your vineyard. We will assume a vine X row spacing of 4 X 8 for this example.

1 acre-inch = 27,152 gallons
vine spacing = 4 ft
row spacing = 8 ft
square footage per vine = 4 X 8 = 32 sq.ft.

<u>Calculate</u>

0.96 inches X 27,152 gal/acre-inch = 26,066 gal/acre

26,066 gal/acre X (32 sq.ft. divided by 43,560 sq.ft./acre)

26,066 gal/acre X 0.000735

Water Requirement = 19.16 gallons per vine

Thus, to replace 100% of the water lost through evapotranspiration in the previous week, irrigation should be applied to deliver 0.96 inches of water or 19.16 gallons per vine. Water deficits can be used to influence grapevine growth and perhaps influence fruit quality. The term **deficit irrigation** is used to describe irrigation strategies that replace much less than 100% of the water lost through evapotranspiration. Caution: deficit irrigation should be practiced with care, and only after considerable experience with replacement irrigation strategies. The stage of fruit development and the extent of water deficit both influence whether the deficit is beneficial or detrimental to grapevines and fruit. Typically, deficit irrigation is imposed between fruit set and veraison. Deficit irrigation amounts may range from 30-50% replacement of full water use. Again, caution is advised.

Determining a Crop Coefficient

Grapevine crop coefficients (Kc) are a function of the size of the grape canopy and how much of it is exposed to direct sunlight. The relationship of canopy size and sunlight exposure to grapevine water consumption has been extensively studied by Dr. Larry Williams in California. His research has shown that grapevine crop coefficients can be readily estimated for a vineyard by estimating the percentage of the vineyard area that is shaded. The percent shaded area (PSA) must be estimated during the solar noon hour (between 12:30 and 1:30 pm,) by one of several methods: 1.) measure the average width of shaded area (Figure 1) beneath the vine row, 2.) estimate the canopy shaded area from a 4X4 board with 6 in. gridlines (Figure 2) placed in the shade beneath the vine row, or 3.) determine the canopy shaded area from pixel analysis of a digital photograph of a plain white 4X4 board placed in the shade beneath the vine row.

Row and vine spacing must be known to determine the PSA. The example below shows the simple calculations used to estimate PSA by measuring the average width of the canopy shaded area (method 1).

Example Calculation

A = Row Width = 10 feet

B = Vine Spacing within row = 6 feet

C = Area per vine = A X B = 10 X 6 = 60 sq. ft.

D = Average width of measured shaded area between two vines = 3 ft.

E = Shaded area per vine = B X D

E = 6 X 3 = 18 sq. ft.

PSA = E/C = 18/60

PSA = 0.30 = 30%

The grapevine crop coefficient is calculated with the following equation.

Kc = PSA X 0.017

Kc = 30% X 0.017 = 0.51

It must be reemphasized that crop water use is a function of canopy size and sunlight exposure, so it can vary considerably from vineyard to vineyard. Texas grape growers are encouraged to determine their own crop coefficients by estimating the percent shaded area of their grapevine canopy periodically through the season, and using the simple calculation described above. Estimates should be repeated through the season because values will increase as the canopy grows larger. Probably the easiest method to estimate canopy shade for most people is to measure the average width of the canopy shade (method 1 above) during the solar noon hour.

Figure 1. Measuring the average width of canopy shade.

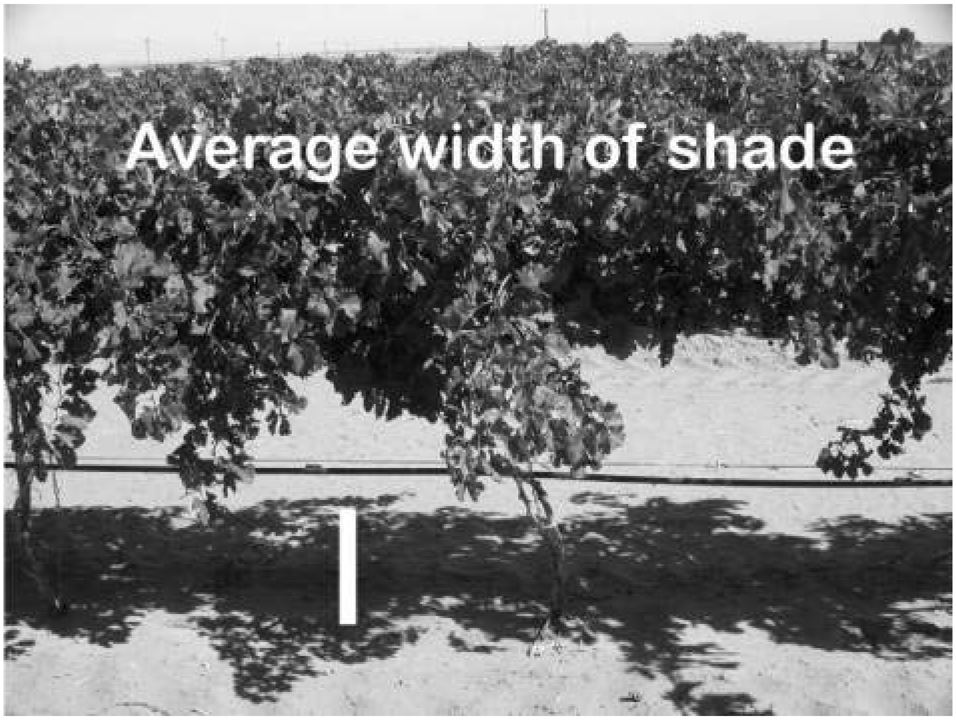
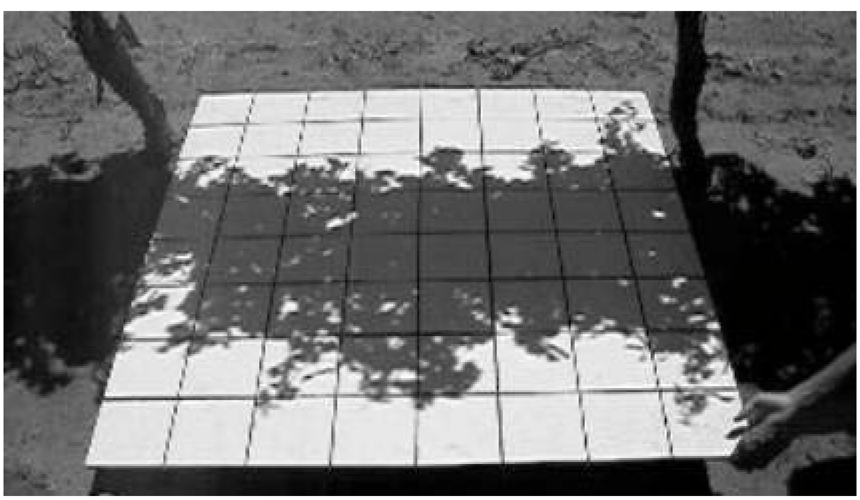


Figure 2. Estimating canopy shade with the use of a 4X4 board with 6 in. gridlines.



References

Soil Moisture Sensors

Practical Use of Soil Moisture Sensors for Irrigation Scheduling
Washington State University

Soil Moisture Sensors
eXtension - Grapes

Irrigation Scheduling

Irrigation of Winegrapes in California
Dr. Larry Williams, University of California
Practical Winery and Vineyard

The Pressure Chamber, a.k.a. "The Bomb"
Dr. Ken Shackel, University of California

Evapotranspiration Data

Using PET for Determining Crop Water Requirements and Irrigation Scheduling

Texas ET Network