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Water Task Force ♦ Report 8

Irrigation Scheduling of Pecan Orchards: The Water Budget Approach

Water Task Force

College of Agriculture and Home Economics
Cooperative Extension Service • Agricultural Experiment Station

Irrigation Scheduling of Pecan Orchards: The Water Budget Approach

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Pecan trees are by nature water-loving plants, and water management is a vital factor in achieving maximum pecan orchard performance and profitability in New Mexico. In the central and eastern parts of the U.S. pecan growing belt, rainfall can meet much of a pecan orchard's water needs. However, in the Desert Southwest fewer than 10 inches of rain fall in a typical year and the largest part of the 60 to 72 inches of water[2] required annually by mature pecan orchards must be supplied through irrigation.

It is not only the *amount* of water but also the *timing* of irrigation events that is important in maximizing your orchard's performance. Two science-based methods, *orchard water budgeting* and *soil moisture monitoring*, are available to assist New Mexico pecan growers with irrigation scheduling. If possible, it is best to use both these methods coupled with frequent soil and tree observations to schedule your pecan orchard irrigations. The purpose of this publication is to familiarize you with the basic principles behind one of these methods, orchard water budgeting.[3] Most New Mexico pecan orchards are flood irrigated, and this publication is written specifically with basin flood irrigation in mind. Nevertheless, many of the principles given here are also applicable to orchards with sprinkler or micro-irrigation systems.

Orchard Water Budgets

With the water budget approach to irrigation scheduling, you should think of water held within the soil as money in a bank checking account. Simple checkbook-type accounting can be used to track the daily balance of water held in your "account." For this to be successful you need to accurately estimate three things:

1) **The total volume of water available to your pecan trees when your orchard soil is at field capacity.**
   This is analogous to a maximum balance for your "checking account" on "payday" (the day you irrigate). An orchard soil is at field capacity after an irrigation when water no longer percolates downward through the soil. The water available when the soil is at field capacity varies from orchard to orchard depending mainly on *soil texture* and tree *rooting depth*. Heavy soils (containing more clay) hold a greater volume of water than do light soils (containing more sand). Average available water-holding capacities for four soil textures are shown in Table 1. Most of a pecan tree's roots are located within the first few feet of the soil; it is generally safe to assume that the rooting depth in a mature orchard is three feet in heavier soils but as much as four feet in lighter soils. You

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[2]Irrigation water volume is measured in acre-inches, which is defined as 1 inch of water covering 1 acre of land and is equal to 27,154 gallons. Acre-inches of water per acre of land will be designated as *inches of water* in this publication.

[3]The topic of soil moisture monitoring is addressed in NMSU Extension Guide H-640, *Measuring Soil Moisture in Pecan Orchards*, available online at http://www.cahe.nmsu.edu/pubs/_h/h-640.pdf

Can I calculate ET for my immature orchard?

Yes, but calculating ET for immature orchards is slightly more complicated. The ET of the orchard is directly related to canopy coverage, which you can estimate by looking at the shadow cast by the canopy at midday. At 50% canopy cover, the ET is 66% of a mature orchard, and at 25% cover the ET is 33% of a mature orchard based on the ET calculated as the depth of water used by the crop over the total area of the orchard. When scheduling irrigations for young orchards, it is also important to remember that the roots of young trees do not fill the entire soil area and, consequently, the total volume of water available to young trees is considerably less than that available to mature trees.

can estimate the total volume of water in the rootzone by multiplying the rooting depth by your soil's average water-holding capacity.

2) **Contributions made to soil moisture by precipitation and irrigation.**
Think of these as "deposits" into your "checking account." You can measure precipitation directly with a rain gauge on your own farm or you can use data taken from a nearby weather station.[4] To measure the volume of irrigation water applied to an orchard, you can install flow meters on your irrigation pumps and circular flumes[5] (or similar devices) in your canals. With each irrigation, apply enough water to fill the entire rootzone in your orchard to field capacity. For example, using Table 1, if 50% of available water was removed by your pecan trees from a sandy soil, then approximately 2 inches of irrigation water would fill the soil pores to a depth of 4 feet, but a loamy soil at 50% depletion would require a 4-inch irrigation to reach field capacity to a 4-foot depth. Also keep in mind that irrigation inefficiencies do exist and in some cases are considerable; so from time to time it is wise to physically double-check, with a shovel or soil probe, that indeed sufficient water is being supplied in an irrigation to wet the entire rootzone.

3) **Loss of soil moisture through transpiration from your pecan trees and evaporation from the surface of your orchard floor.**
Think of these as "withdrawals" from your "checking account." Evaporative and transpirational losses are usually lumped into a single term, *evapotranspiration* or *ET*. New Mexico State University has developed an equation using weather data and crop developmental stage to estimate how much water is being used by mature New Mexico pecan orchards as ET throughout the growing season.

Table 2 gives long-term average ET estimates for pecan orchards in the Las Cruces and Artesia areas. Current season ET data also can be used for pecan orchard water budgets,[6] but in New Mexico's relatively stable climate ET estimates based on a long-term averages of climate data are usually adequate for growers' purposes. Weather anomalies—such as cool spells or excessive heat waves—do occur in New Mexico, and growers should use common sense, as well as soil moisture monitoring, to adjust orchard water use estimates and irrigation scheduling accordingly.

The current balance of available water is calculated as the volume of water in your orchard soil at field capacity minus the volume of water lost as ET since the last irrigation plus rainfall occurring since the last irrigation.[7] *Pecan orchards should be irrigated when 45–50% of the available soil water has been depleted*. For example, if 4 inches of water are required to completely fill the pore space of your orchard soil, the next irrigation should be scheduled when about 2 inches of water have been used through ET.

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[4]Access weather station data online at http://weather.nmsu.edu.

[5]To read more about using circular flumes for monitoring flow in canals, consult NMSU Extension Guide M-226, *A Low-Cost Water Measuring Device*, available online at http://cahe.nmsu.edu/pubs/_m/m-226.pdf.

[6]Orchard ET estimates based on current season climate data may be obtained online at http://www.weather.nmsu.edu. This website is, at present, cumbersome to use. NMSU researchers and Extension personnel are now developing a more user-friendly website for pecan growers to get current season orchard ET estimates.

[7]Remember that rainfall, like irrigation, cannot bring your orchard's soil water balance above its maximum at field capacity.

Table 1. Available water-holding capacity of soil texture classes common in New Mexico pecan orchards.

	Available Water (inches per foot depth)	**Available Water in Root Zone (inches)**
Silty Clay Loam	2.53	7.59 (assumes 3 ft)
Loam	2.02	7.07 (assumes 3.5 ft)
Sandy Loam	1.41	4.93 (assumes 3.5 ft)
Sand	1.02	4.08 (assumes 4 ft)

Table 2. Average estimated daily evapotranspiration (ET) for mature pecan orchards in the Las Cruces and Artesia areas.

	Estimated ET (inches per day)[1]	
	Las Cruces	Artesia
Jan 1–15	0.04	0.04
Jan 16–31	0.04	0.05
Feb 1–15	0.05	0.06
Feb 16–28	0.06	0.06
Mar 1–15	0.07	0.08
Mar 16–31	0.09	0.10
Apr 1–15	0.11	0.13
Apr 16–30	0.14	0.17
May 1–15	0.19	0.24
May 16–31	0.25	0.28
Jun 1–15	0.30	0.34
Jun 16–30	0.33	0.33
Jul 1–15	0.29	0.32
Jul 16–31	0.28	0.31
Aug 1–15	0.27	0.31
Aug 16–31	0.28	0.32
Sep 1–15	0.26	0.26
Sep 16–30	0.22	0.19
Oct 1–15	0.18	0.15
Oct 16–31	0.12	0.11
Nov 1–15	0.07	0.06
Nov 16–30	0.04	0.05
Dec 1–15	0.04	0.04
Dec 16–31	0.03	0.03

[1] Estimated ET data are 14- and 9-year averages for Las Cruces and Artesia, NM, respectively.

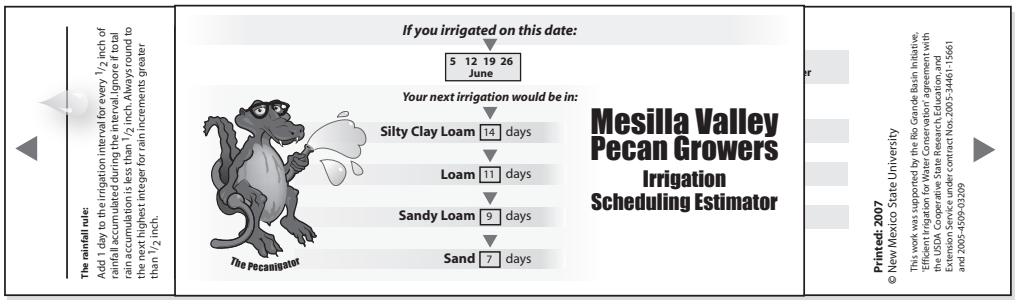

Figure 1. The Pecanigator.

The Pecanigator

The *Pecanigator* is a handheld Pecan Irrigation Calculator designed by NMSU researchers to simplify irrigation scheduling of flood-irrigated pecan orchards according to the water budget approach (Figure 1). Average daily ET for mature pecan orchards was calculated using 14 years of weather data from NMSU's Leyendecker Plant Science Research Center in the Mesilla Valley. These data were used to determine when 45% of the available soil moisture would be depleted for four basic soil types and to estimate when the next irrigation should be scheduled. Similar to a slide rule, the *Pecanigator* displays those data in an easy-to-use, tabular format. The *Pecanigator* assumes lighter soils (sand and sandy loam) will receive 1.5–3.0 inches per irrigation and heavier soils (clay and silty clay) will receive 4–5 inches per irrigation. It includes guidelines for adjusting for water quality and rainfall. While the *Pecanigator* is based on weather data from the Mesilla Valley and has not been tested elsewhere, it may also be useful for irrigation scheduling of pecan orchards in other parts of southern New Mexico with similar climate patterns.

If you would like to learn more about the cultural requirements for pecan trees or obtain a *Pecanigator*, contact your county Extension office. The NMSU College of Agriculture and Home Economics website at www.cahe.nmsu.edu also provides numerous helpful viewable/printable pecan publications and links in addition to those cited here.

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