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IRRIGATION MANAGEMENT FOR PECANS

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Even though irrigation of pecans is a fairly recent practice, except in the far west, water is critical for the survival, growth and economic production of quality pecans.

Careful irrigation is needed so that young trees can grow rapidly to a large size. This has been demonstrated in numerous pecan orchards the past 10 years where young trees have been brought into commercial production in 5 to 7 years (McEachern 1993). A critical component of this rapid overall orchard establishment program has been timely water applications.

Mature trees need water at 5 critical periods; initial spring growth, nut sizing, water stage, kernel filling and shuck split. Early in the growing season bearing pecan trees need water to initiate strong, vigorous growth. In May and June water is necessary for nuts to develop to a satisfactory size. Water stage irrigation is needed to prevent nut drop. Late summer irrigations allow full development of the kernels in August and September. This "filling" irrigation is an important factor in determining the quality of the nuts. The final mature tree water requirement is prior to shuck split in October.

The latest research shows that pecans have a high water requirement just before shuck split (Stein et al. 1989). Leaf drop, poor or impaired shuck opening (sticktights) and vivipary can be decreased by irrigating up until the time of shuck split. This may well require a final irrigation by variety.

Irrigation water management must not only assure that a continuous supply of soil moisture is available to the trees, but also that the water be managed to prevent over-irrigation and water-logging. Roots thrive best when the water is present in soil's oxygen supply that the roots must have to survive and absorb nutrients and is just as detrimental to the tree as drought.

SOIL WATER HOLDING CAPACITY

The first step in irrigation water management should be to determine the soil reservoir that is available for supplying the water needs of the trees. This is controlled by the depth of soil aeration and the water holding capacity of each foot depth of soil into which the roots permeate. This reservoir capacity, together with the water use rate of the trees, controls the frequency and depths of water that should be applied at each irrigation.

The depth of available water that can be retained in the soil for use by the trees is controlled by the soil texture, which is the size of the soil particles. The inches depth of available water that can be stored in each foot depth of soil will vary from 1/2 to 1 inch in sands, 1 to 1-1/2 inches in sandy loams, and 2 to 2-1/2 inches in clays. Consequently, different soil types will hold different amounts of water.

For instance, the upper foot of the Demona series of soils will hold 1.2 inches, whereas, the upper foot of the Hasse series will hold 2.4 inches of available water. Hence, certain soils can have more water available to the trees than other soils. Soil's water holding capacities are generally available at the local soil conservation office.

WATER ABSORPTION

Pecan trees normally extract most of the water they use from the upper 36 inches of the soil profile, even though they are deep rooted plants. They can extract water from deeper profiles; however, they must expend more energy to pull water up from deeper strata.

The deeper the water, the more energy is diverted away from the developing leaves and nuts. The tree compensates by shedding leaves, part of the crop load or only moderately filling the pecans. Prior to shell hardening, nuts are shed, whereas after shell hardening leaves are shed.

Realistically speaking, from the standpoint of irrigation and water use, deep water is survival water and does little to contribute to orchard profitability.

WATER REQUIREMENTS

For the majority of the pecan belt, irrigation is applied on a supplemental basis. Pecans are reported to require about 55 inches of water a year (Miyamota 1983). Some estimates as low as 30 inches have been published (McEachern 1982), and some growers report benefits from amounts as high as 72 inches. Water may fall as rain in some areas, but rainfall is rarely distributed appropriately through the growing season to meet plant needs. Thus, irrigation water is supplied to supplement natural rainfall.

In order to plan irrigation systems, it is necessary to know how much water is required by trees; considering both rain and irrigation water.

A well-accepted value for figuring the water use of mature pecans is 55 acre inches per year. It is safe to say that most of that water will be used during the growing season (225

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days). This being the case, daily water use can be predicted as follows:

55 acre inches per year x 27,154 gallons per acre inch = 1,493,470 gallons per acre, per year

1,493,470 gallons/225 days = 6,638 gallons/acre/day\

6,638 gallons/35 trees per acre = 190 gallons per tree, per day

The standard Texas Agricultural Extension Service recommendation of 1 to 2 inches per week can be calculated into daily water requirements in much the same way:

1 acre inch x 27,154 gallons per acre inch/7 days = 3,879 gallons/acre/day

3,879 gallons per day/35 trees per acre = 111 gallons per tree, per day

Two inches per week computed is twice the amount above or 222 gallons per tree, per day.

Both of these systems generate very plausible numbers for daily pecan water use.

Using a third system, the pecan tree water requirements can be based on the area of a tree's canopy and the evaporation of water from a U.S. Weather Bureau Class "A" Pan. This works well because the same forces that affect evaporation from a tree's leaves operate on an open body of water.

Dr. J.W. Worthington at the TAMU Center at Stephenville has shown with lysimeters, that young pecan trees use water at a rate that is proportional to the water evaporating from a Class "A" Pan (Worthington et al. 1988). In May and September, pecans use about half (50 percent) as much water as evaporates from the pan. In June 80 percent, August 90 percent, and in July pecans use 100 percent of pan evaporation. Based on our data (Stein et al. 1989), mature trees with a heavy crop probably use water at 100% in July, August, September and even part of October.

Water use in pecan trees is controlled by the leaves, hence larger trees (with more leaves) will use more water. The following formula is used to determine the exact pecan tree water requirements: Water use = pan evaporation (inches) percent appropriate to month x the area covered by the tree's canopy (acres).

If we assume a mature orchard (planted 35 x 35) has trees with canopies 20 feet in diameter, and July pan evaporation of .44 inches, the following calculations can be used to determine tree water use in gallons per tree. There are 27,154 gallons of water in an acre inch. If the pan evaporation = .44 acre inches, .44 x 27,154 gallons/acre inch = 11,047.8 gallons. The area of the pecan trees is computed as if they were a circle, _ x r^2. Trees with 20 feet diameters have a 10' radius. Hence 10' x 10' x 3.1416 = 317 ft^2 per tree. Dividing 314/43,560 ft^2/acre = .0072 acres. The final step is to multiply .0072 acres x 11,947.8 gallons/acre = 86 gallons per tree per day. Worthington has developed a computer program to make these calculations, simplifying the process.

The most practical way to predict water use is by location pan evaporation. Most weather stations record pan evaporation and as demand for this information increases, it should become more accessible.

Tables have been developed to help growers design their irrigation systems in Texas. These tables are published in the Texas Pecan Handbook.

SCHEDULING IRRIGATION

Pecan irrigation is designed to relieve water stress, and water needs to be applied often enough to meet this goal. This is relatively simple for young trees because the root and top is smaller.

During the first year after transplanting, most of the new root growth is at the cut surface of the tap root and/or large root laterals, with little new lateral root development. Trees can absorb some water through the old roots, but most of the water uptake is from these new, developing roots, that develop at the new cut surfaces made when the tree was planted. Thus, daily watering would tend to saturate the soil near the surface where absorption is limited. For new trees, it is better to apply water once a week.

Seven gallons of water applied once a week will give the tree 1 gallon per day for sustenance and allows ample time for air to re-enter the soil spaces encouraging more root growth. Continue weekly watering for the first 2 years, according to Table 1 if the trees are making good growth.

By the third year, watering by canopy size formulas will be more accurate and better meet the trees' needs.

Irrigation frequency of bearing size pecan trees is often determined by cost, water availability, type system employed, soil type and depth, crop value and weed control practices.

However, the most common methods of scheduling irrigation are as follows: feeling the soil 6 to 12 inches below the surface; by the calendar; tensiometers; gypsum blocks; water mark sensors; neutron probe; infra-red gun; indicator plants; by season or drought; and when one can obtain water or get to it. All methods have pluses and minuses, but all have different variations that are modified by growers. In fact, there are as many different irrigation scheduling techniques as there are growers.

Although the best irrigation schedule for a grower is one that works for his or her situation, a good irrigation scheduling program would give consideration to the following practices:

First, the water holding capacity would be determined in the top 36 inches of the orchard soil. Based on tree canopy size and pan evaporation data, the trees' daily water use values are known. Water use is then subtracted from the available water and irrigation is applied prior to depletion.

This system works well on irrigation systems, such as flood or sprinkler, that wet the entire orchard floor or at least large volumes of soil. In this way, enough water is placed in the top 36 inches of the soil to meet the trees' needs. Generally, high frequency irrigation systems only wet a small portion of soil.

Also, prior to spring growth, make sure that the soil has been wetted to the full depth of rooting of the trees. If winter rainfall has not replenished the soil moisture to this depth, a late winter or early spring irrigation should be applied.

High-frequency irrigation systems such as drip or microsprinkler are generally designed to supply the trees' daily water requirement, hence many operate every day. The amount of soil wetted would generally determine frequency of application. The trick is to keep the water in the top 36 inches of the soil profile.

Tensiometers, gypsum blocks, neutron probes and devices that measure the water status of the trees should be used to check irrigation performance. Such devices are often used to schedule irrigation.

However, a good system for scheduling irrigation is simply feeling the soil as outlined in Table 2. Although not a precise or scientific method, it can be extremely effective if the results are observed carefully.

Depth of water penetration into the soil should also be determined. A soil probe, sharpshooter or one of the soil moisture measuring devices can be used. Water should have penetrated 3 feet after the irrigation. If penetration depth is more or less than 3 feet, the irrigation schedule or amount of water applied should be adjusted.

Regardless of system used, one must correlate soil condition with the instrumentation used. If the soil feels wet then the device should also indicate such. If not, one must make adjustments for the inaccuracy. The key is to know what is happening before and after irrigation.

LITERATURE CITED

Anonymous. 1955. Yearbook of agriculture. U.S. Government Printing Office. Washington, D.C.

McEachern, G.R. 1982. Pecan water requirements, p. 112. **In:** G.R. McEachern (ed.) Texas Pecan Handbook. Texas Agricultural Extension Service, College Station.

McEachern, G.R. 1993. Planting and establishing pecan orchards, pp. IV 5-9. **In:** G.R. McEachern and L.A. Stein (eds.) Texas Pecan Handbook. Texas Agricultural Extension Service, College Station.

Miyamota, S. 1983. Consumptive water use of irrigated pecans. J. Am. Soc. Hort. Sci. 108:676-681.

Stein, L.A., G.R. McEachern and J.B. Storey. 1989. Summer and fall moisture stress and irrigation scheduleing influence pecan growth and production. HortScience 24:607-611.

Worthington, J.W., J. Laswell, L.A. Stein and M.J. McFarland. 1988. Now that you've decided to irrigate, how?, how much?, when? Pecan South 22(2):6-14.

Table 1. General water rate guide for pecans on well-drained soil

	Volume per week (gallons) Tree						
Age	April	May	June	July	August	Sept.	October
1	7	7	14	28	28	14	7[1]
2	14	14	28	56	56	28	14

[1] If extremely dry

Table 2. Soil moisture values based on feel[1]

Moisture sensor reading	Soil Type			Amount of irrigation water to apply
(Bars)	Coarse	Light	Medium	
0	Free water appears when soil is bounced in hand	Free water released with kneading	Can squeeze out free water	System off
0.2				25% of required
0.3	Wet outline of ball is left on hand upon squeezing	Same as coarse	Same as coarse	50% of required
0.35				75% of required
0.4	Tends to stick together forms a weak ball under pressure	Forms weak ball, breaks easily will not stick	Forms ball, very pliable, sticks readily if high in clay	100% of required

[1] Table adapted from USDA 1955 Yearbook of Agriculture