

Leaching Requirements of Pecan and Fruit Trees

Guide H-644

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Irrigation water contains dissolved salts that can accumulate in the root zone as evapotranspiration (E_t) removes irrigation water and leaves the salts behind. As excess quantities of soluble salt accumulate in the root zone, trees have difficulty in extracting water from the salty soil water solution, and transpiration and the resulting growth are reduced.

Excessive salinity build-up can be controlled by applying an additional amount of irrigation water often referred to as the "leaching requirement."

The Leaching Requirement

The leaching requirement (LR) is the extra water needed for leaching expressed as a fraction or percentage (leaching percentage) of the total water penetrating the soil (D_D). It has been defined by the U.S. Salinity Laboratory as the fraction of the irrigation water (D_I) that must penetrate below the root zone to maintain salinity at a specified level.

$$LR = \frac{D_D}{D_I}$$

LR varies with the salinity tolerance of the crop and the salinity of the irrigation water. For general use, it is based on quantitative salinity measurements, although leaching requirements for specific salts may also be computed. The sodium content of some irrigation waters may impose serious limitations on its use on certain soils and must be considered in an overall leaching program.

Slow soil permeability, shallow water tables, or restricted subsurface drainages may interfere with adequate leaching. Where these conditions exist, drainage must be improved before soil salinity can be reduced by leaching. In fact, poor drainage often causes excessive accumulations of salt in soil even when relatively good-quality water is used.

The LR Equation

LR can also be calculated by dividing the electrical conductivity of the irrigation water (EC_{iw}) by the electrical conductivity of water draining from the bottom of the root zone (EC_{dw}). In practice, the EC_{dw} value is not readily available, and the U.S. Salinity Laboratory recommends using the average electrical conductivity of the soil solution extract (EC_e) and the EC_{iw} to determine LR.

$$LR = \frac{EC_{iw}}{5(EC_e) - EC_{iw}}$$

Fig. 1 shows the relationship between the salinity of the applied water and the salinity of the soil water saturation extract for different LRs.

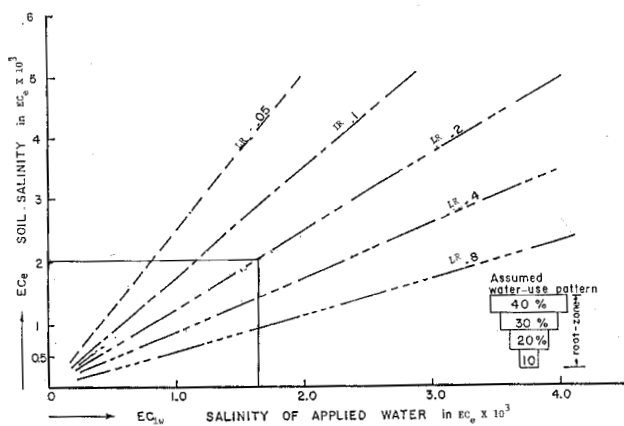


Fig. 1. Effect of salinity of irrigation water (EC_{iw}) on soil salinity of the soil saturation extract (EC_e) in the root zone under varying leaching requirements (LR) (after Ayers and Wescot, 1976).

Growth reduction does not occur in a tree until a threshold level of salinity is reached, and then growth decreases in a linear amount with increasing salinity. Relative growth rate (RGR) reduction for selected soil salinity levels in trees is presented in table 1.

Table 1. Salinity (measured as electrical conductivity) tolerance of trees as a function of (EC x 10³) in soil saturation extract.

Representative species	Conductivity of medium (μS/m) ^a			
	0% RGR	10% RGR	25% RGR	50% RGR
Apricot	1.6	2.0	2.6	3.7
Peach	1.7	2.2	2.9	4.1
Almond	1.5	2.0	2.8	4.1
Plum	1.5	2.1	2.9	4.3
Pecans	2.0	3.0	4.5	7.0
Grapes	1.5	2.6	4.1	6.7

^a=Electrical conductivity of a saturation extract (EC_e) of the growing medium, measured in microSiemens per centimeter (=micromhos per centimeter).

Source: modified from Ayers (1977) and Handreck and Black (1984).

Applying the LR Concept

To compute the LR, the salinity of the irrigation water and the salinity tolerance of the crop must be known. These values are furnished by the NMSU Co-operative Extension Service Soil and Water Testing Laboratory as EC x 10⁶. These values should be divided by 1,000 to be equivalent units, with values for EC_e normally given as EC x 10³ (table 1).

Example: To grow pecans irrigated with well water with an electrical conductivity of 1,700 x 10⁶ mhos:

$$EC \times 10^6 \text{ of irrigation water} = 1,700.$$

To convert to

$$EC_{iw} \times 10^3 = \frac{1,700}{1,000} = 1.7 \text{ irrigation water}$$

$$EC \times 10^3 = 2.0 \text{ soil (from table 1).}$$

From fig. 1, the leaching fraction should be 0.2. Therefore, in addition to the water supplied for consumptive use (E_t) (the amount of water absorbed by the plants and lost by evaporation), an additional amount equal to 0.2 E_t should be applied for leaching.

Assuming uniform water application, if the irrigation efficiency (the water stored in the root zone divided by the applied water) is greater than (1 - LR), then the LR should be used to calculate depth of irrigation water. If the application efficiency is less than (1 - LR), then the LR is already being satisfied.

Assuming an irrigation efficiency greater than (1 - LR), the depth of irrigation water (D_{iw}) to maintain a steady-state salt balance is

$$D_{iw} = \frac{E_t - D_r}{1 - LR},$$

where D_r is runoff of applied irrigation water. It is assumed that all of the LR will be satisfied by irrigation water exclusive of any leaching by rainfall. If the value of D_r is assumed to be 0 and the intended E_t for this irrigation is 3.0", then the depth of irrigation water is

$$3.75" = (3.0 - 0) / (1 - 0.2)$$

This amount of water must be applied to the portion of the field receiving the smallest water application amount so that the LR over the rest of the field is 0.2 or more.