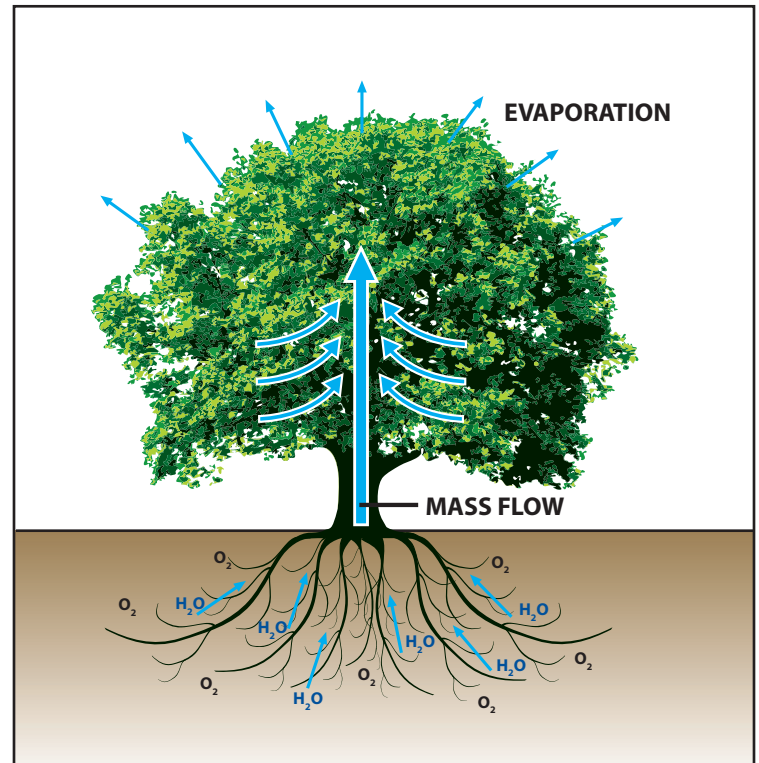


ROOT ZONE MANAGEMENT

PLANT NOURISHMENT

The driving force that creates the natural movement of water from soil to plant and atmosphere is based on the free-energy gradient of the water. This gradient can be equivalent to hundreds of pounds of pressure and causes plants to lose water to the atmosphere. Plant tissue cannot block, for example, water flow. Desert plants have a very effective mechanism to protect themselves and survive, but most crops don't. (Even desert plants, which have various protection systems, are seriously affected.) Most crops actually have little ability to cope with the environmental conditions and are extremely vulnerable to losing water to the atmosphere. A plant will absorb water from the soil to replace the loss of water to the atmosphere. The higher the soil moisture the quicker the plant will be able to replenish itself, avoid stress and recover.



MASS FLOW

The water flow through the plant from roots to leaves is called the mass flow. It is much greater than the amount of water the plant needs for its direct nourishment. The mass flow is a carrier of minerals and other organic compounds which are absorbed from the soil and synthesized in the roots. The mass flow carries these essential elements to the canopy. The uptake of minerals and the metabolism of organic compounds in the root requires energy. In order to generate the energy needed for this process, the plant root must respire. The optimal concentration of air needed in the soil to ensure free breathing of roots is about 10% of soil volume.

SOIL CONTROL

The goal is to ensure maximum moisture in the soil and optimal air concentration, to allow the plant to replenish its water needs and supply minerals and other organic compounds to the canopy. If this goal is achieved, we can maximize yield and quality while shortening growth cycles. Any water or air stress will adversely affect the above. Since we cannot manage the atmosphere, we must try and control the soil. The name of the game is Root Zone Management.



SOIL & IRRIGATION INTERVALS

SOIL

Soil is a porous media. Soil pores can vary greatly in size. Water in the soil is held by capillary forces which are stronger than gravitational pulls. Water can flow in the soil in two basic patterns.

- Saturated flow which equals piston flow
- Non-saturated flow from a point source emitter

Saturation, all pores are full of water and most of the air is pushed out.

Field Capacity (F.C.) is a moisture level where the large pores are full of air and the small pores are full of water. This is the ideal soil/water/plant conditions. In the absence of consumers (plants), this moisture level won't change, establishing an equilibrium.

Wilting Point (W.P.) is a moisture level in the soil where the plant cannot replenish the loss of moisture to the atmosphere and the plant wilts.

Available Water (A.W.) is the amount of water between Field Capacity and Wilting Point which is relatively easy for the plant to absorb.

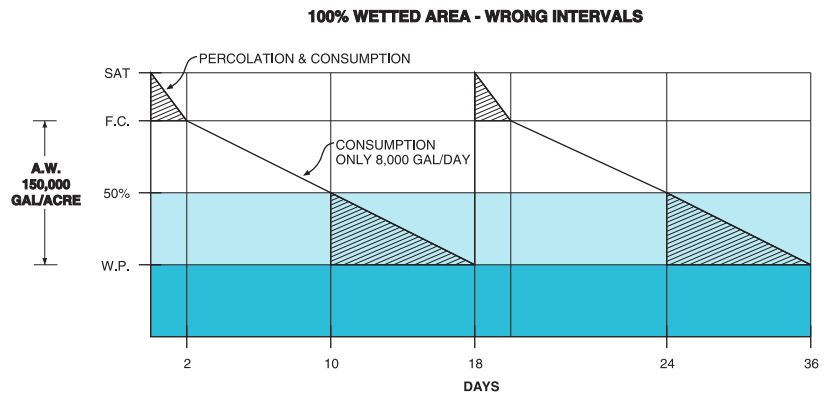
Research and field practices have found that to avoid stress to plants, irrigation should be applied to replenish the moisture when the plant reaches not more than 20% to 50% of available water. Range varies according to crop and soil type.

EXAMPLE:

How can we calculate the proper intervals between irrigation cycles in tree crops?

- The crop: peach trees 20' by 12'
- The soil: medium to heavy
- Available water: 50,000 gallons per acre per foot of depth of soil
- Effective root zone depth: 3'
- Daily consumption of peach orchard: 8,000 gallons/acre per day in peak season
- Irrigation threshold: 50% of A.W.

The maximum amount of water available for trees in the given root zone is 50,000 gallons per acre/per foot. 3' x 50% provides 75,000 gallons per acre.



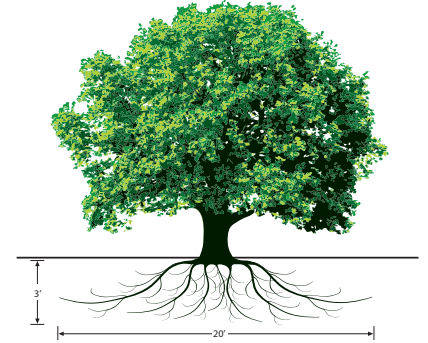
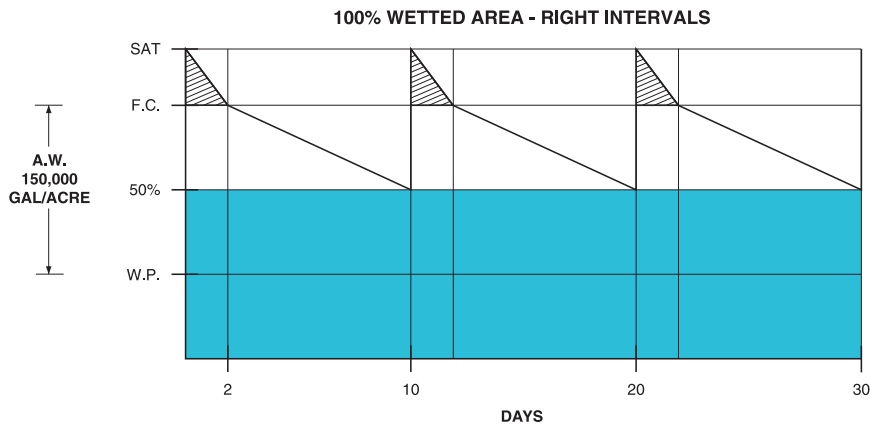
PRIMARY REASONS WHY A CONCENTRATED ROOT ZONE IS MORE EFFECTIVE

- Superior Aeration - Drip irrigation allows the optimum combination of air and water. Other irrigation methods which create saturation or piston flow, push the air from the effective root zone for a period of a few hours to a few days, depending upon the type of soil, effectively suffocating the plant. Under these conditions the plant is unable to generate the needed energy to take in minerals and synthesize essential organic compounds. Aeration difficulty is typical in medium to heavy soils where infiltration could last several days.
- Micro-conditions in the root zone can be very different from the macro conditions. If we examine one rootlet in the soil, we will find that the soil moisture surrounding it is much lower than the soil moisture between the rootlets. An envelope of dry soil is covering the rootlet and slows the ability of the rootlet to absorb water and minerals. In light soils, this phenomenon happens very quickly and it can create a situation where average measured moisture is relatively wet while the plant cannot absorb water. Concentrated root zone has a much higher density of roots and rootlets in any given unit of soil and the effectiveness of the fertigation supplied to the soil is much greater.

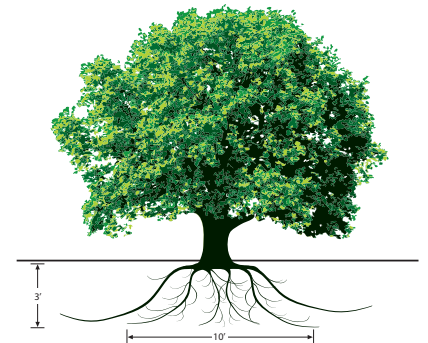
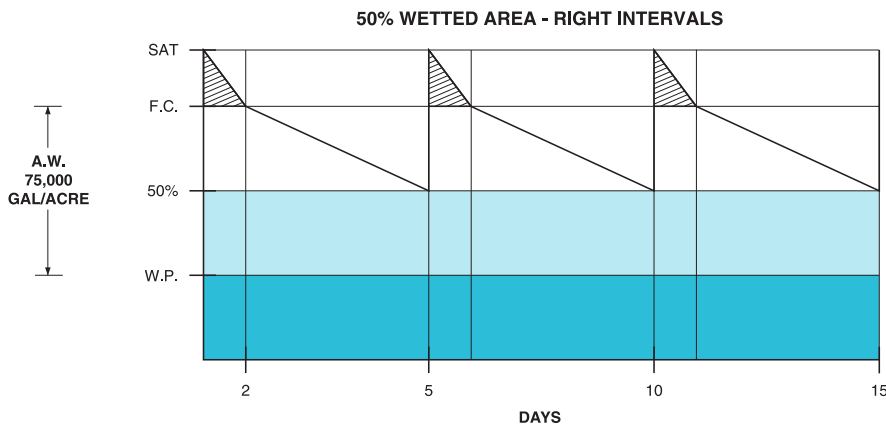
These two factors, aeration and micro conditions, vary according to soil type, but both play an important roll in all types of soils.

IRRIGATION INTERVALS

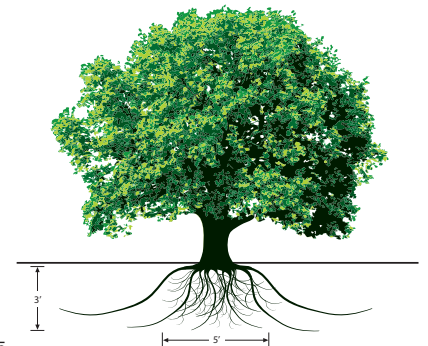
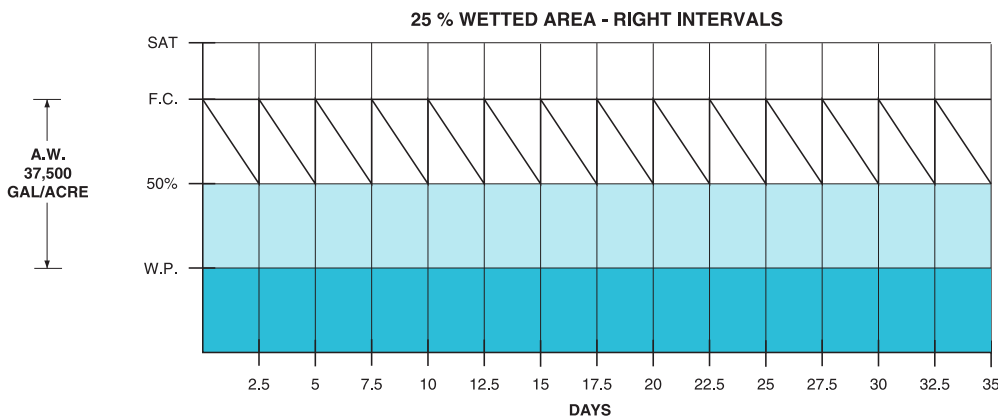
OPTION 1 - If we irrigate 100% of an area (flood or sprinkler) the interval will be: $75,000 \div 8,000$ (nine to ten day interval between irrigation cycles)



OPTION 2 - If we irrigate 50% of an area (mini sprinkler) the interval will be: $75,000 \times 50\% \div 8,000$ (approximately a five day interval)



OPTION 3 - If we irrigate 25% of area (drip) the interval will be: $75,000 \times 25\% \div 8,000$ (three day interval)



In all three options we are irrigating the orchard at intervals that keep the trees from being stressed. Will the result of each option be the same? The more concentrated the root zone, the more effective the root system.

SUMMARY

ADVANTAGES OF CONCENTRATED ROOT VOLUME

- Frequent irrigation cycles result in minimum fluctuation in soil-moisture levels, providing the optimal water supply to the plant.
- Non-saturated water flow in the soil guarantees the proper aeration needed for all energy requiring activity in the roots, including the active uptake of minerals and metabolism of organic compounds essential to the canopy.
- The combination of optimal water supply and proper aeration produces the highest quality development. This applies to all crop yield.
- Valuable minerals have difficulty reaching the root zone because of lower mobility in the soil. The concentration of roots in a limited wetted volume greatly increases the effectiveness of fertigation.
- Increasing the efficiency of fertigation and the precise control of irrigation, helps prevent the leaching of minerals from the root zone into the ground water.
- Precise root zone management allows us to create and control conditions. Sometimes stressing a plant is a needed management technique. A limited root zone allows this technique to be accomplished quicker and with greater control.

BE AWARE

- The reservoir of the plant, which holds water and minerals, is smaller and frequent applications are needed.
- The system must be more reliable since failure margins are very narrow and mistakes are more difficult to overcome.

Limiting the root zone enables us to manage it better and increases the effectiveness of the water and minerals supplied to the plants. Your understanding and application of these concepts through the correct irrigation system will allow you to achieve the highest return for your investment.

AGRITECHNICAL BENEFITS THAT SAVE TIME AND MONEY

- With the use of drip irrigation, the wetted surface is limited. This leads to the reduction of weed development, which reduces tilling and spraying.
- The dry area between rows allows the use of heavy machinery at any time without destroying the soil structure due to compaction.
- Fertigation can continue without interruption. Multiple operations can take place simultaneously.



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