Water Infiltration Problems in Tree Fruit and Nut Crops

Robert H. Beede, U.C. Farm Advisor
Kings and Tulare Counties

Many tree fruit and nut growers find that the slow infiltration characteristics of their soil make it difficult to properly irrigate their trees during the summer months. Water stress limits the development of young trees and reduces fruit size and nut development in bearing orchards. Water stress also raises leaf temperature, which increases the likelihood of severe spider mite infestations. Mites are difficult to impossible to control in orchards under water stress. Slow water intake can result in prolonged standing water, which reduces the needed oxygen required for good root health. Nemaguard, the primary peach rootstock used for tree fruit and almonds, is very susceptible to root and crown rot disease and micronutrient deficiencies such as iron and zinc when subjected to prolonged standing water. Both Northern California black and Paradox, the two walnut rootstocks, are also very susceptible to low oxygen levels created by prolonged soil saturation. Slow water intake reduces irrigation efficiency since a greater portion of the water applied is lost to evaporation. Finally, slow water intake increases the potential for compaction since cultural practices such as pruning, spraying and harvesting are often performed before the soil is sufficiently dry. Combined, these factors can reduce farming efficiency, increase production costs, limit yields and shorten the economic life of the orchard.

Some of the common causes for slow water intake (infiltration) are:

1. Poor soil structure at the surface resulting in few large cracks or pores into which water initially flows rapidly. This is most frequently the problem in fine sandy loam soils.
2. Compaction of surface soil from traffic is a major problem, especially in surface irrigated orchards where irrigation between harvests is used to size fruit. Soils with naturally slow infiltration are very easily compacted because cultrual practices must often be performed on excessively wet soil.
3. Inadequate salt content of the surface soil is just as big a factor in slow infiltration as high content. Irrigating with low salt water (less than 250ppm) can affect soil structure and reduce infiltration. Most tree fruit growers rely heavily upon ditch water which originates from the Sierra snow melt. This water source is very low in salt content. Its repeated use eventually leaches enough salts from the surface soil to reduce its structure from losses in chemical bonding of the soil particles. Large pore spaces are then converted to many small pores which have higher surface tension and less permeability.
4. High sodium content (Na) also causes soil particles to be forced apart chemically (called deflocculation). This can result in surface sealing by reducing pore size.
5. Subsurface soil layering or stratification (soils with distinctly different texture) is often overlooked as a water related problem because it usually does not cause slow infiltration at the soil surface. Rather, it limits downward movement of water into the lower root zone. This is quite common in San Joaquin Valley soils due to their alluvial origin (soils washed from mountain ranges). Soils of different texture vary greatly in the number and size of pores (air spaces) through which water travels. When downward moving water encounters a zone of different soil texture, it

must overcome the surface tension created by the different pore size. Saturated soil conditions occur above the layer until sufficient pressure (head) builds up to overcome this.

6. Too much water applied during any single irrigation. Some soils really are not as poorly infiltrated as growers think judging from how long the water stands. Instead, the amount of water applied per irrigation is too great relative to soil water content and crop requirement. Detailed studies of some soils have revealed that as much as 90 percent of the total water intake occurs in the first hour and 15 minutes of application! In one study, the intake rate went from 6.0 inches/hour initially (very fast) to only 0.7 inches/hour after only 1.25 hours of irrigation. Why? Because the cracks and larger pores found in dry soil fill up quickly with water and/or small soil particles. This resulted in an intake rate of only 0.02 inches/hour after 6 and 8 hours of irrigation on the above soil. Is it possible that you are exceeding the amount of water your soil can adsorb in a reasonable amount of time? After 8 hours, only 3.44 inches of water had infiltrated in the above soil. If a 5 inch irrigation was applied, 86 hours (3.6 days) would pass before penetration was complete at 0.02 in/hr. This is too long for tree roots needing oxygen to remain active and disease-free. Do you really know how much water you actually apply per irrigation? Tests show many growers error by 25% in their estimates!

The following are practical suggestions for improving the infiltration rate of problem soils:

1. Soil sample the orchard floor surface. Include only the first inch from several locations. Sample areas with good and bad intake rates separately. Request a basic salinity analysis including a SAR (sodium adsorption ratio) or ESP (exchangeable sodium percentage). Also ask that the gypsum requirement be calculated. Soils with total salt content (EC_e) less than about 1.0 mmho/cm often benefit from gypsum application. This raises the beneficial salt content of the surface soil and improves structure. Soils with SAR or ESP values greater than about 7 can also benefit from gypsum application by displacing sodium salts with calcium from the gypsum. If you do not understand the results of your soil analysis, take it to someone knowledgeable such as your U.C. soils advisor for interpretation.

2. Sample your main water source. Some well and most ditch water is very low in salts. Continual use flushes the beneficial salts from the surface soil causing it to loose structure. Big pore spaces necessary for rapid intake become small resulting in "tight" soils. Gypsum application through the water or on the soil during June (NOT winter!) will restore needed salts and often improve water intake. Although gypsum application during the fall and winter is more convenient, it results in low economic return from your investment since the gypsum is usually leached from the surface by winter rain and spring irrigation. Hence, it is no longer present to improve surface soil structure in June and July when improved infiltration is most needed. Remember, gypsum applied at 1-2 tons per acre will benefit infiltration for only 3-5 irrigations.

3. After an irrigation, dig in several locations to test for compacted soils 8-10 inches below the surface. If you can stand on the shovel without it penetrating, consider chiseling the soil after harvest when it is dry. Most growers irrigate immediately after chiseling to reduce any effect root pruning might have on tree stress. Chiseling will correct surface soil compaction from traffic and can markedly improve water infiltration for several irrigations. Depending upon the soil type, some growers find this practice provides an effective solution. Others discover chiseling lasts only two or

three irrigations. Thus, soil analysis, amendments and winter cover cropping were used for longer term management.

4. Soils passing the above test may require investigation at greater depths with a backhoe. Have an individual knowledgeable about soils and roots present to assist you in their evaluation. Obvious things to look for include major changes in soil texture and/or water content and root decay. Soil layering creates resistance to water movement and root development. Such conditions discovered after orchard establishment are difficult to impossible to correct. Deep ripping with the intent of modifying subsoils lacking truly cemented layers (hardpan) will not solve a soil stratification problem. The benefit of deep ripping is usually gone by the next season as the soil reassumes its original structure. Adjustments in irrigation management or investment in a low volume system allowing more precise water application is usually of greatest benefit.

5. Soils with poor surface structure often improve with winter barley cropping. Barley produces 7-8 tons of dry matter per planted acre if allowed to grow until the soft dough stage. As it decomposes during the season, it creates humus which is important to improving soil structure. Great numbers of pores are also created from the decayed roots. This is not a quick fix! Research and growers show three years of regular winter barley is needed before improvements were noticeable. A winter cover crop allows growers the option of managing their orchard floor in any manner they chose during the season. It also reduces compaction and improves orchard access during the winter.

6. Permanent cover crops derived from planting or through native vegetation may also improve infiltration. Reseeding annual clovers have become popular with some tree fruit growers who suggest benefits such as increased predators and parasitic wasps, increased organic matter, reduced dust and less synthetic nitrogen application. Others report increased spider mite problems, higher power bills and irrigation labor costs, gopher outbreaks and dead trees from over-irrigation. In addition, the cost to establish and manage the legume can be as high as $125 per acre annually. Growers electing to disc in the spring and manage summer watergrasses with Roundup or mechanical mowing have the option of changing systems quickly without significant investment loss if they observe little benefit in water intake or orchard performance.

7. Compare lightly disced or springtoothed rows to nontillage. Some soils benefit from cultivation if properly timed to minimize compaction. This is easier said than done. Mites and orchard access can also become limitations.

8. LAST BUT NOT LEAST, evaluate your present irrigation program relative to method, timing and amount applied. Test the concept of lighter but more frequent watering. Some growers have success with applying water more frequently over a more limited area such as deep furrows next to the tree or through crowned middles. Others have been successful with alternate middle irrigation, especially if iron chlorosis is a problem. Such practices, if properly managed, provide adequate solutions to poor infiltration and still allow frequent access. Applying more water than your soil can readily adsorb wastes your time, our water and costs you in orchard health and power. Increased irrigation frequency is not nearly as expensive as dead tree removal. A study in Kings County on walnuts showed lighter, more frequent irrigation of a poorly infiltrated soil netted the grower almost $300 more per acre annually.

Solving water intake problems is not easy. Hopefully this article provides you some useful, practical guidelines.