B. Soil Water Reservoir

Soil Water Holding Capacity

Water in the soil resides within soil pores in close association with soil particles. The largest pores transport water to fill smaller pores. After irrigation, the large pores drain due to gravitational forces leaving water held by the attraction of small pores and soil particles. Soils with small pores (clayey soils) will hold more water per unit volume than soils with large pores (sandy soils). After a complete wetting and time is allowed for the soil to de-water the large pores, a typical soil will have about 50% of the pore space as water and 50% air. This is a condition generally called field capacity or the full point. Soils dry down from field capacity to a point where water becomes too difficult for the root to extract. The remainder of the water held in the soil is unavailable to the plant.

Soil Texture

Soil consists of mineral particles, organic matter, air, and water. The mineral particles are classified by size as sand, silt, and clay. Sand particles are the largest size, and the clay particles, the smallest. The relative proportion of these sizes determines the soil texture.

Soil texture affects the water-storage capacity of soil and the rate at which water infiltrates into and flows through soil—all characteristics important for irrigation water management. Sandy soil stores a relatively small amount of soil moisture but has high infiltration rates. Clay soil stores more moisture, but has slow infiltration rates.

Proportions of sand, silt, and clay in soil are determined by first passing the soil through a series of sieves of progressively smaller sizes and measuring the amount of sand retained on each sieve. Silt and clay particles are not retained on the sieves. Percentages of silt and clay are determined by measuring the settling rates of these particles in water.

Once percentages of sand, silt, and clay categories are determined, *Figure B-1* is used to identify the soil textural classification. For example, soil with 55 percent sand, 15 percent silt, and 30 percent clay would be classified as sandy clay loam.

Soil is frequently designated as “coarse-textured” or “fine-textured.” *Table B-1* assigns the textural classes to broad categories of coarse-, medium-, and fine-textured soil.

Figure B-1 Proportion of sand, silt, and clay in the basic soil-textural classes

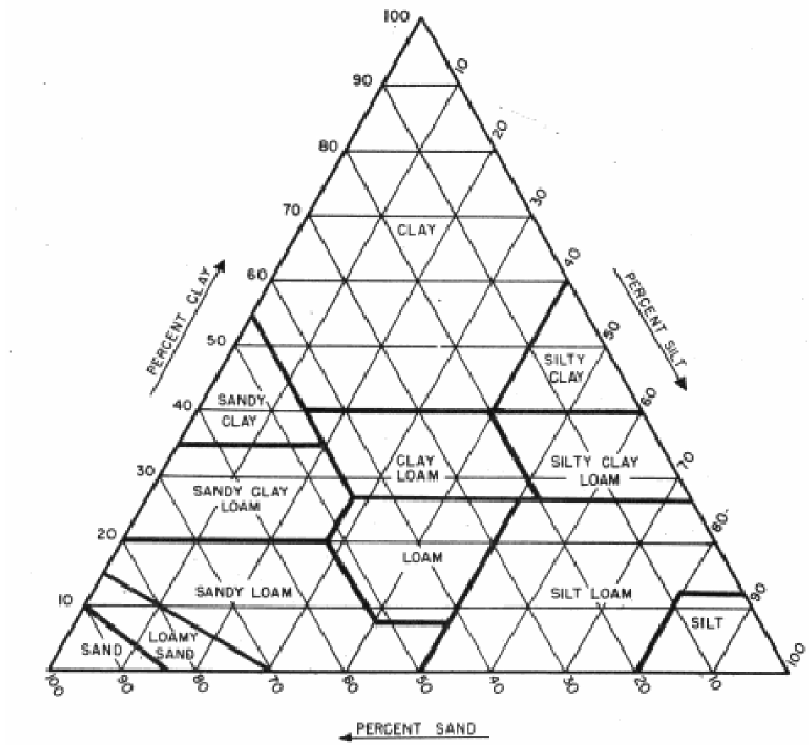


Table B-1. General terms for basic soil textural classes.			
General Terms			Available Water Holding Capacity
Sandy soils	Coarse-textured soils	Sands	0.7
		Loamy sands	1.1
Loamy soils	Moderately coarse-textured soils	Sandy loam	1.4
		Fine sandy loam	1.5
	Medium-textured soils	Very fine sandy loam	1.5
		Loam	1.8
		Silt loam	1.8
		Silt	
	Moderately fine-textured soils	Clay loam	1.6
		Sandy clay loam	1.3
		Silty clay loam	1.9
Clayey soils	Fine-textured soils	Sandy clay	1.6
		Silty clay	2.4
		Clay	2.2

Soil Structure

Structure

Soil structure refers to the arrangement of the soil particles. Sand particles are larger and more spherical than the smaller silt and still smaller plate-like clay particles. The voids between particles (called pores) serve as a conduit to move water and air into the root zone. Cultivation and compaction from farming equipment or that occurred during soil development decreases the total porosity and changes the distribution of pores from predominately macro to micro pores. Compaction causes a decrease in the large pores and an increase in small pores. Soil compaction, and pore plugging which occurs during soil development decreases water holding capacity, infiltration rate, and air reentry.

Root Zone Depth

Root Distribution

Vine roots can explore deeply into soils if limiting layers are not encountered. Vine water use in deep, well-aerated soils has been reported to depths of 20 feet. Rooting depth in vineyards located in shallow soils or those with root zone limiting conditions can be much less. In low rainfall areas and irrigated frequently with micro-irrigation systems, vines may not develop a deep root system even if soil conditions are not limiting.

Root Limiting Conditions

Root depth limitations caused by soil texture and structure can be grouped into three categories:

- Fine textured soils with poor internal drainage characteristics and/or poor structure
- Soils with dense, compact, or cemented sub-soils
- Layered or stratified soils where abrupt, significant changes in soil texture may disrupt water movement in the vicinity of the interface

Other root limiting conditions:

- Rock
- The existence of a water table whether static or fluctuating can limit the depth of the root zone. Roots may grow into the deeper depths when the water recedes however, they may die back when the water table rises.

Rootstock

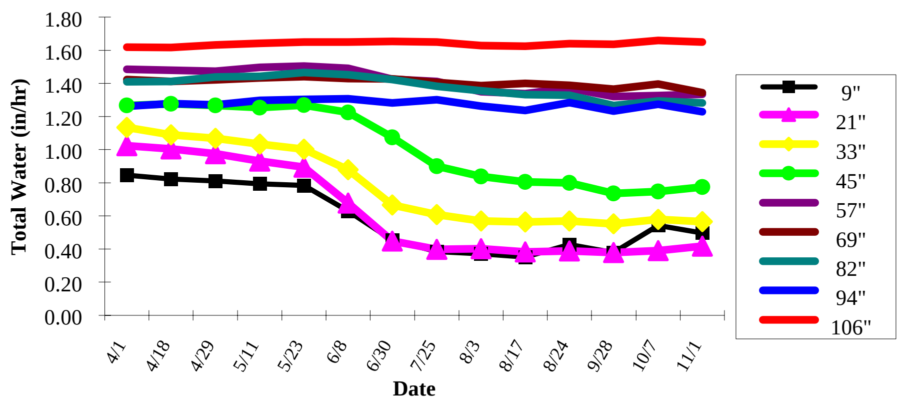
Rootstocks vary in their rooting habit. Some have an extensive, shallow root system and therefore are very effective in removing shallow moisture but will be less effective in extracting deep moisture. Water deficits can occur more quickly on rootstocks such as 5C, 5BB and 1103. Rootstocks such as Dog Ridge, St. George, Freedom, and 110R are reported to be more effective in scavenging for deep moisture.

Determining the Vineyard's Effective Root Zone

Excavating the soil between the rows with a backhoe is commonly used to both physically view the root distribution and check for the cause of a root-limiting factor. All vines have a greater root density in the shallow soil depths declining with depth. It is easy to be convinced that the root zone is shallower than it is when only a few roots are found at the deeper depths. The root density is normally less at deeper depths but they are still functional if moisture is available. The use of moisture measuring devices can help define the root zone over the season by monitoring the soil water disappearance at soil depths in and below the suspected root zone. Drought conditions and or continued deficit irrigation where the deep soil is never wetted can reduce the number of deep roots over time. Young vineyards will increase the size of the root zone over time and will be influenced by the type of irrigation system and irrigation frequency and th e amount of winter rainfall. If these conditions exist, a reevaluation of the effective root zone is necessary to confirm the current rooting depth.

Soil moisture measuring devices can be used to determine effective root zone depth. Care should be taken to monitor at depths deeper than the expected root zone depth. *Figure B-2* shows the water content in soil depths from 9 to 108 inches from bud break to leaf drop in a non-irrigated vineyard. Results show very little water extraction at or below the 57-inch level.

Figure B-2. Winegrape non-irrigated in/ft by depth



Water Tables

Static water tables can limit root growth due to saturated soil conditions. Fluctuating water tables can allow growth when the soil is not saturated then kill roots when re-saturated. Shallow water tables whether static or fluctuating can contribute water to the vines water use. As the soil dries above the saturated soil, water moves up into the unsaturated portion of the root zone by capillary action. This process makes it difficult to determine the amount of water contained in the root zone that will be available for vine use.