CMG GardenNotes #262

Water Movement through the Landscape

Soil-Plant-Water System

Water constantly moves in and out of landscapes. Scientists use the concept of the soil–plant–water system to explain the complex ways water moves in landscapes. The ***soil–plant–water system*** describes water entries, storage and exits in a landscape from the plant's perspective. Understanding how water moves through a landscape is important when designing or using an irrigation system.

Most plants constantly use water, but store little in their tissues. Therefore, plants rely on the soil water reserves being periodically replenished through entries of water into the soil–plant–water system.

Water Entries

Water enters the landscape in several ways. First, water enters through **precipitation**, such as rain or snow. Second, gardeners may add water through **irrigation**. Third, water may run over the surface of the landscape from a neighboring area (**run-on**). Fourth, water may enter as **seepage** from groundwater.

In different landscapes, some entry methods are more important than others. For example, in a wet climate most water enters through precipitation. Alternatively, in dry climates like many areas of Colorado and the West, most water enters via irrigation. If a landscape is located below a heavily irrigated property or below a melting snowfield, run-on or seepage may be the most important entry. Taking water entries into account helps gardeners determine how much water must be added through irrigation to keep plants healthy.

Water Storage

In most landscapes, soil is the major water storage site for plants. Once water has entered the landscape through precipitation, irrigation, run-on, or seepage, water penetrates the soil surface through **infiltration**.

Water infiltrates into sandy soils much more quickly than into clayey soils. For example, a sandy soil may take in 4 inches per hour, but a clayey soil may take in only 0.5 inches of water per hour—8 times more slowly. To prevent water waste via runoff, gardeners should take the soil's infiltration rate into account when scheduling landscape irrigation.

Once water infiltrates the soil surface, it **percolates** downward and sideways through the soil profile. Water moves rapidly through large soil pores, and slowly through small pores. Therefore, sandy soils with primarily large pores will accept and release water readily, holding little. On the other hand, clayey soils with primarily small pores will wet and dry slowly.

After water percolates through the soil profile, some of the water will be stored in small pores, and a water films surrounding soil particles. Plants can use some of the stored water (called plant**-available water)** by extracting it with their roots. However, some of the water is held so tightly by small pores or particle surfaces that plant roots cannot extract it. This water is **unavailable** to plants.

When plants need more water than is available in the soil, they experience **water stress**. Because water is a component of photosynthates, photosynthesis stops and growth stops. Furthermore, water stress compromises plant defense systems, making them more susceptible to abiotic stress factors as well as insect and disease problems.

Some soils store more water than others. The amount of water held in the soil and available to plant depends on the following factors:

- Clay content (the amount of small pore space) to hold water.
- Soil organic content – Organic matter holds ten times more water than sand.
- Rooting depth – Plants with deeper roots reach a larger water supply.

Water Exits

Water eventually leaves the landscape. Water may exit by running over the land surface (**runoff**). It may leave the system through **off-target application**, such as sprinklers that apply water to the sidewalk rather than the soil. Sometimes, water percolates below the plant's root zone (**leaching**).

Water **evaporates** from the soil surface, causing soils to dry from the top downwards. Mulches help ameliorate water loss by reducing evaporation from the soil surface. Mulches also improve plant growth by helping to maintain moisture in the top layer of soil, thereby stabilizing soil moisture around roots.

Some water is taken up by plant roots, transported through plant tissues and used in photosynthesis for plant growth. Most of the water taken up by plants is **transpired** out leaf surfaces. Because evaporation and transpiration are often the two most important water exits in landscapes, scientists combine these two pathways into one term called *evapotranspiration*.

Evapotranspiration (abbreviated as **ET**) is a measurement of water use combining water used by plants for transpiration, photosynthesis, and growth, plus water lost from the soil surface evaporation. It is most often defined as a rate of water loss, such as 1/4 inch per day. In this example, an ET of 1/4 inch per day means that a 1/4 inch depth of water was lost from the soil–plant–water system through evaporation and transpiration.

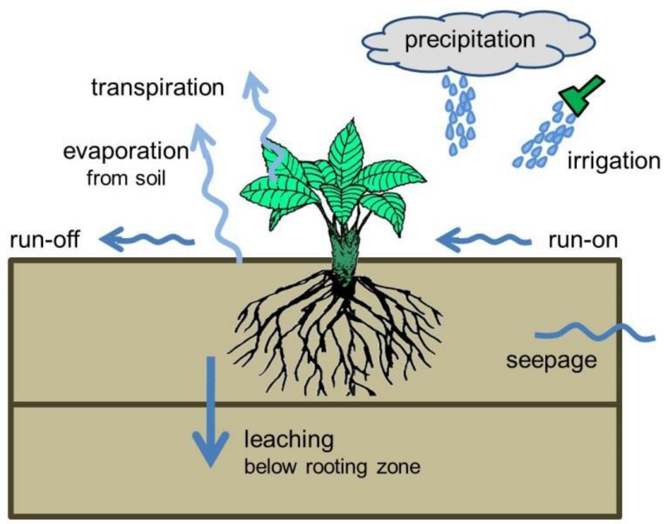
ET measurements help gardeners make informed decisions about how much irrigation water to add. In some Colorado communities, ET rates are available on-line through weather stations or water utilities.

ET rates change daily through the growing season. High ET rates occur when there is 1) bright sunshine, 2) high wind, 3) high temperature, and/or 4) low humidity.

Summary

Water entries and exits are summarized in Figure 1. In order to maximize plant health in dry climates of Colorado and the West, gardeners can take two approaches. First, they can apply soil management practices to increase soil water storage. This helps ensure adequate water supplies for plants when needed. Second, gardeners can use effective irrigation management practices to ensure that irrigation water is made available to plants and not wasted.

Figure 1: Typical water entries and exits in the soil – plant – water system.



Authors: Catherine Moravec, Colorado Springs Utilities and David Whiting, Colorado State University Extension (retired). Artwork by David Whiting; used by permission.
Revision: Kurt M. Jones, Chaffee County Extension Director (9/2017).

Revised October 2014 & September, 2017