Managing Irrigation Water for Different Soil Types in the Same Field

WASHINGTON STATE UNIVERSITY EXTENSION FACT SHEET • FS086E

Some growers manage soils with very different textures (sand to silt to clay) and/or different depths (shallow to deep), all within the same field. These types of highly variable soils make irrigation water management difficult. This publication provides some practical suggestions for irrigation managers who maintain fields with highly variable soils.

Soil Water

Soil serves as a reservoir that stores water and nutrients for later use by plants. The size of this reservoir, that is, the total water-holding capacity of the soil (measured in inches of water) depends on the soil type and the depth of the plant root zone. For example, sandy soils cannot hold as much water as silts or clays (per unit volume of soil). The available water-holding capacity of a soil (AW) can be multiplied by the root zone depth (Rz) to obtain an estimate of the total water-holding capacity of the soil. The root zone depth (Rz) depends primarily on the plant but may be limited by a compacted restrictive soil layer or bedrock.

In Figure 1, the soil water reservoir is represented by a bucket. The size of the bucket, or the total water-holding capacity in the root zone, equals the available water-holding capacity of the soil multiplied by the root zone depth (AW × Rz). If the soil reservoir is completely full, the soil is at field capacity. If more water is added to the soil than the soil can hold, water will leach out past the bottom of the root zone and will be lost to deep percolation (represented in this analogy by overflow). If the plants can no longer pull water from the soil (wilting point), then our metaphorical bucket is empty.

How Big is Your Bucket?

In Figure 2, various soils and depths are represented by different bucket sizes. Deep silts will have a comparatively large bucket (or reservoir) and can store a larger amount of water and nutrients. Consequently, in deep silt soils, large amounts of irrigation water can be applied at infrequent intervals without causing plant water stress. However, sandier or shallower root zones have a much smaller bucket or reservoir, so they cannot store as much water and consequently will run out of water much more quickly than other soils. Predictably, these areas will be the first to show water stress, and they will experience stress to a greater degree than other areas of the field. This fact leads to the common misconception that sandy soils require more water, but this is not necessarily true. Healthy plants use water (ET) at the same rate across a field, regardless of what type of soil they are grown in. A sandy soil or shallow root zone means that the bucket or reservoir is smaller and will hold less water, so it does not need more water. What it needs is to be filled more often but with smaller amounts of water (Figure 3).

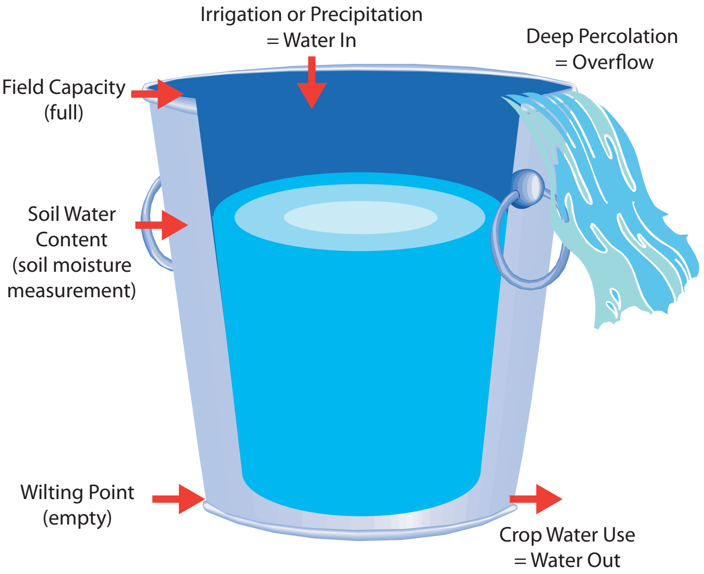

Figure 1. Soil can be thought of as a reservoir, or bucket, for storing water and nutrients. Water is removed through evaporation and plant transpiration (known as evapotranspiration or ET), or through deep percolation. Water is added to the bucket through irrigation or precipitation. Field capacity and wilting point are represented by a full and empty bucket, respectively.

Multiple Soil Types in the Same Field

If a field with many soil types is managed based on the average soil type, plants in sandy areas will be water stressed for a significant portion of the season since they

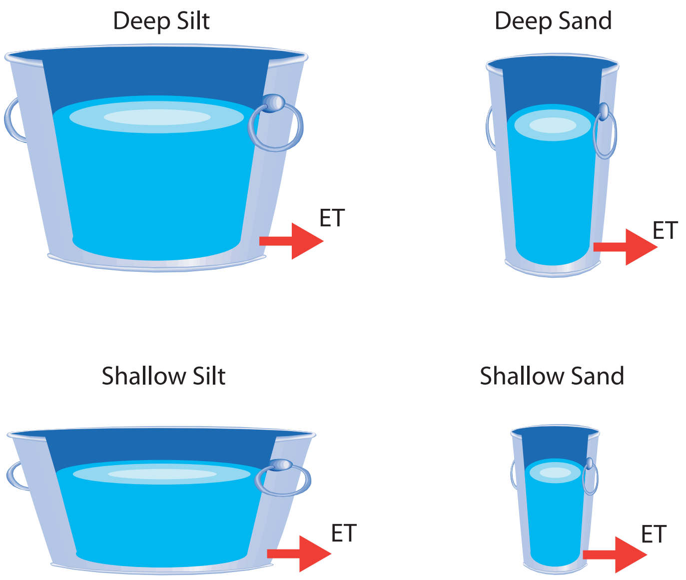

Figure 2. The water-holding capacity of the soil (AW, indicated by width), and the plant root depth (Rz, indicated by depth) dictate the size of the reservoir. Crop water requirements (evapotranspiration or ET) are roughly the same, regardless of soil type or depth.

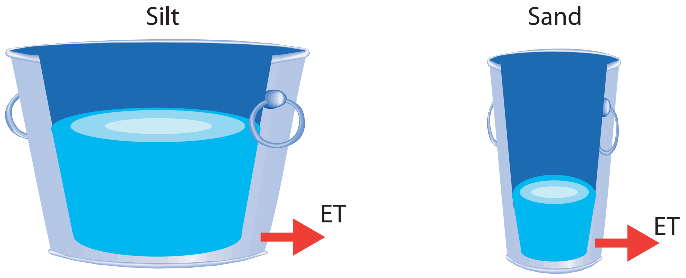

Figure 3. Starting with a full profile over the same given period, the sandy soil is water depleted but the silt soil still has plenty of water. Refilling both soils to field capacity will require the same amount of water. However, applying more water to the sandy soil will result in water loss and consequently nutrient loss to deep percolation.

will run out of water much sooner than other soil types. However, if the entire field is managed for optimal production in the sandy or shallow soil areas, then crops planted in all of the other soil types will receive the water they need.

Therefore, the best recommendation is to manage the entire field based on the needs of the areas of the field with the lowest water-holding capacity and doing this by tailoring the timing and amounts of irrigation water so that these areas do not lose water to deep percolation or experience water stress. It is in the location of these sandier or shallower soil areas that the soil moisture sensors should be placed and soil water monitoring should be done. Drip and pivot irrigation systems are better able to irrigate in smaller amounts with more frequency as compared to surface (furrow), hand-line, or wheel-line irrigation systems. For this reason, fields converted to center pivot or drip irrigation systems often see increased crop uniformity and overall yields.

If the entire field is managed based on the needs of the soil with the lowest water-holding capacity, the other areas of the field will receive enough water as well.

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