MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #219

Soil Drainage

Outline:

Pore Space Controls Soil Drainage Characteristics

Pore space controls soil drainage characteristics. In other words, drainage problems often arise from lack of large-sized pores in the soil substrate.

In soils dominated by large pores (i.e., sandy soils), water moves rapidly. Soils that allow rapid leaching (water movement down through the soil profile) also pose environmental hazards because rain or irrigation water moving through the soil profile can transport water-soluble pollutants with it. Ground water pollution is a sensitive issue in coarse-textured sandy soils.

In comparison, soils dominated by small-sized pores (i.e., compacted soils and soils with greater than 20% clay content), water is slow to move or may not move at all. Soils easily saturate or become waterlogged.

Roots must have oxygen to survive and root activity shuts down in waterlogged soils. Plants growing in wet soils are typically shallow rooted. Many plants are prone to root rot in wet soils. Prolonged periods of waterlogged soil conditions lead to the decline or even death of most plants.

When water does not leach through the soil profile, salts left behind by surface evaporation can accumulate and create a white crust on the soil. This is frequently observed as a white deposit on low spots of pastures and fields. High soil salt content limits plant growth in some areas of Colorado.

Poor drainage is a common problem in many Colorado soils. In some areas, the upper layers of soil allow water infiltration only to have the water stopped as it reaches a less permeable subsurface soil layer.

A simple test to evaluate soil drainage is to dig a hole twelve inches deep and fill it with water. If the water fails to drain in thirty minutes, the soil has a drainage problem. If the hole fails to drain in twenty-four hours, waterlogged soils may affect plant growth.

Correcting Drainage Problems

Managing Soil Tilth

The term soil tilth refers to the soil's general suitability to support plant growth, or more specifically to support plant root growth. A soil with good tilth has large pore spaces for adequate air infiltration and water movement.

Attention to managing soil tilth plays a key role in soil drainage. On coarse-textured sandy soils, routine applications of organic matter increase the water holding capacity. On compacted and fine-textured clayey soils, application of organic matter forms aggregates of the fine textured clay particles, which create larger pore space, improving drainage.

French Drains

In some situations, a French drain facilitates water drainage. A French drain is a lined ditch-like trench that is filled with rock or gravel, typically with a pipe in the bottom. It catches water runoff and directs it away from structures that can be damaged. The rock should meet grade to prevent soil from covering the drain. The trench must slope at least 1-3% and flow to an outlet. [**Figure 1**]

Figure 1.
A French drain is a ditch-like trench filled with rock. Water must flow downhill to an outlet.

Surface Drainage and Runoff

To minimize surface runoff and soil erosion, sloping areas should be planted with perennial ground covers or turf. Mowed lawns or un-mowed naturalized grass areas make the best ground cover for slowing runoff. Some landscapes may be terraced to control runoff.

To improve surface drainage problems, first identify, and then correct, the contributing factors.

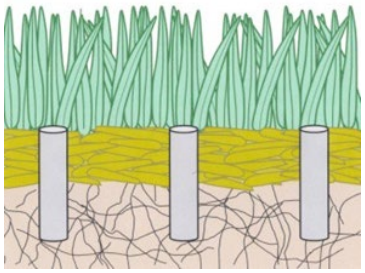
Irrigation – Many surface drainage problems arise from over-irrigation (too much and/or too often).

Compaction – Compaction is difficult to deal with; so, prevention is the key. Soils around new homes is typically compacted from construction traffic. Break up compacted layers by tilling, adding organic matter and planting ground cover. Adding organic matter and organic cover encourages earthworms and beneficial soil organisms, which creates larger pore spaces, improving drainage.

Organic mulches, like wood/bark chips, help manage compaction around trees and shrubs, perennials, small fruits, and garden paths.

Thatch in lawn – A heavy thatch layer in a lawn slows water infiltration. Improve by aerating the lawn, making enough passes so that plugs are at two-inch intervals. See lawn care information for additional details. [**Figure 2**]

Figure 2.
A heavy thatch layer slows water infiltration. Routine aeration may be needed on compacted clayey soil to help reduce thatch and open the soil to air and water.



Grading – Sometimes the grade may be deceiving. Make sure areas are properly graded so there are not low spots and all drainage heads in the right direction.

Standing water – It is common to find standing water in low spots. Fill in the low spot or install a French or underground drain with a gravity-flow outlet. Look at the irrigation schedule; is the area being over-watered? If so, or if irrigation is running off instead of soaking in, aerate and use multiple shorter irrigation cycles.

High water table – Some areas of Colorado have high water tables. The only solution may be to raise the soil level such as raised beds or berm gardening.

Impervious subsoil – In Colorado, we find many soil profiles with an impervious soil layer under the surface. This can be caused by many years of tillage at the same depth, also known as hardpan. Refer to the subsequent discussion on subsurface drainage.

Subsurface Drainage

Subsurface drainage problems are generally correctable only to the extent that large soil pore spaces can be increased to allow for better water movement. Use of soil drainage tiles are only effective to the extent that the soil will allow water to flow through it to the drain tile, and water in the drain tile can flow downhill to an outlet. It is more important to prevent poor drainage and compaction. This can be achieved through reducing traffic, managing soil load, and choosing appropriate equipment when working on soil.

To improve subsurface drainage problems, due to compaction, first identify, and then correct, the contributing factors.

Impervious/Compacted Subsoil Layer Underlain With Permeable Soil

- If less than two feet thick, rip or double dig when soil is dry enough to work.
- Irrigate to settle and do final grade when soil re-dries.
- If greater than two feet thick, bore holes through layer.
- Holes are typically four to six inches in diameter, at six-foot intervals.
- Fill with coarse sand or fine gravel.

Compacted/Impermeable Subsoil

- Increase soil depth through processes such as cultivation, ripping, double digging, or core aeration.
- Use of deep-rooted cover crops depending on depth of compaction layer.
- Select shallow-rooted and water-tolerant plants.

- These soils may have a salt problem.

Change in Soil Texture
A change in soil texture creates water movement problems called a soil textural interface. Even if the pores on the lower layer (such as large rocks in the bottom of a pot) are larger, the upper layer must saturate completely before water can move into the lower layer. This is a common problem when soils are added to a raised-bed box or applied as a top dressing. Cultivate to mix layers.

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Reviewed September 2022