Poor Soil Drainage

By Bruce Lindsay
April 10, 2020

Beware of causes and signs

Many factors can cause drainage problems in soil. One of the main causes is soil compaction. Water moves through pores of various sizes when they are connected. Compaction crushes the pores and disrupts their continuity and water cannot flow through resulting in ponding and/or saturated zones in the subsoil that become depleted of oxygen. Some plants are adapted to periodically or continuously wet soil, but most food crops are not. Rice is the big exception and is grown in ponded soils for weed suppression.

Most unnatural causes of poor drainage is heavy farm equipment and soil engineers. Soil engineering focuses on achieving maximum compaction to achieve a stable construction base. If a site is not compacted first, a heavy structure (a building, driveway, concrete pad, etc.) will cause compaction with negative results.

The weight of farm equipment causes compaction. Wide tires can help distribute the weight and compaction in farm fields can be broken up using a ripper tool. Cultivation should not be done if the soil is damp enough to form and maintain a ball when squeezed in the hand.

Natural causes of compaction are very common. In this part of Washington, glaciation has been a major influence. Glacial till can be a variety of textures from pure sand and gravel to clay. In most local areas, however, clay is not a real issue. The real issue is that natural processes have caused a compacted zone that is very impermeable to water and can be many different textures.

In the Midwest, glaciation has also been a major influence. In their case a zone of compaction is referred to as "basal till." It is caused by the weight of the glacier itself. An ice sheet several thousand feet in thickness is very heavy and directly compacts soil particles.

In our case the glaciers were overriding areas that were underwater or some of the islands and shore line areas were pushed underwater by the weight of the glacier. This does not apply to the mountainous areas, of course.

Saturated sediments cannot be compressed, because water is self-supporting. The water in the pores of the particles keeps the particles from being pushed together. This is why sediments at the bottom of lakes and the ocean are not hard but can be easily stirred up. Saturated sediments, however, or soils having a fluctuating water table, can be compacted when smaller particles are washed down and fill in the pores between larger particles. This is called hydrologic packing.

The ripper tool can reach down to three feet, but it takes a heavy-duty tractor to pull it and the process uses a lot of fuel. *Photo courtesy of Viva Farms.*

In some places such as the Midwest and Southeast, compacted zones from hydrologic packing, called fragipans, can be fairly uniform, although they follow certain topographic positions. In contrast, the compacted layers in our glacial moraines can be highly erratic as the result of the large variation in textures as a result of glacial processes. These compacted areas, or “densic horizons,” can be seen in the escarpments of bluffs along beaches throughout the Puget Sound.

In some fields where water accumulates above the soil surface, ponding occurs. In upland areas, this is usually the result of a compacted zone at some depth. In the Skagit River floodplain, however, it is usually the result of compaction from farm machinery. Topography is also a major factor in that low concave positions receive more runoff from higher positions. In these situations, soils can be wet for long periods of time.

Many chemical reactions can happen in a saturated soil. Water displaces all the air in the soil pores causing it to become anaerobic. Organisms that need oxygen (such as us) use it to remove the used-up electrons and carbon as the result of metabolizing food. Some bacteria can use either oxygen or iron, and some only use iron for the same thing

When iron accepts an electron, it becomes "reduced," is more soluble in water, and accumulates in various places in the soil. When iron is reduced, it is blue or grey. Iron that is "oxidized" is red or yellow. Soils that are continuously wet are various shades of blue. This can be seen in muddy shorelines right below the surface. When one digs into a soil and finds blue-ish and grey colors, this is a sign the soils are continuously wet, although there are always exceptions). If a soil is sandy, however, the colors may not be present.

Left: All around Puget Sound there are bluff escarpments showing what is below the surface, which is a highly erratic distribution of densic horizons. **Right:** When soils become ponded they become anaerobic which is damaging to many plants that are not adapted to those conditions. *Photos by Bruce Lindsay / WSU Skagit County Extension Master Gardeners.*

In the subsurface of some soils, the water table may fluctuate because of rainfall and causing the subsurface alternates between to become saturated and aerated. This can result in "mottles" of red, orange or yellow colors in various patterns. When the subsurface is saturated, the iron becomes reduced it can move where it becomes concentrated. When the soil dries out the iron oxidizes and turns red again; these mottles are called "redoximorphc features."

The depth to these "redox" features indicate where the top of the water table is and is one of the criteria for determining the drainage class. Information about soil uses and restrictions can be found on the USDA Web Soil Survey

Left: Even if a soil is not ponded it can have a saturated zone from a water table indicated by red and orange patterns called redoximorphic features. *Photo courtesy of the Soil Survey Staff.*

RESOURCES:

- Field Indicators of Hydric Soils in the United States. USDA, NRCS.
- ” Fragipan Formation in Peoria Loess in Louisiana.” Lindsay, B.A. MS Thesis; Department of Agronomy, Louisiana State University. Baton Rouge, LA. 1987.
- Soil Survey Manual. USDA, NRCS.