Alkaline Soils

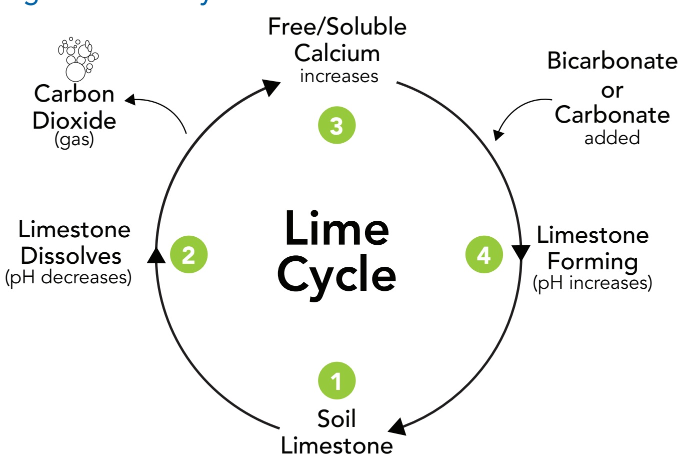
TURF **TIPS**

Soils with a pH greater than 7.0 are considered alkaline. Alkaline soils often occur in arid regions that receive less than 25 inches of rain per year. Geographically, a combination of acid and alkaline soils exists between the Mississippi and Missouri Rivers, and the majority of the soils west of the Missouri River are alkaline. Soil alkalinity is caused by limestone that naturally exists in these arid soils. The effect of limestone and the interaction of irrigation-water minerals on soil pH and soil fertility will be discussed below.

Lime Cycle

Understanding the lime cycle, shown below, is an essential beginning for understanding soil pH in alkaline soils.

Figure 1. Lime Cycle



❶ Beginning at the bottom of the cycle, soils can contain up to 60 percent limestone. In other words, the top three inches of soil would contain 200,000 pounds of limestone. However, most arid soils contain around two to ten percent limestone (7,000 to 33,000 pounds).

❷ Chemically, limestone is calcium carbonate ($CaCO_3$), and as this compound dissolves, the soil pH decreases or becomes more acidic. A product of this reaction is free calcium and carbon dioxide, which is given off as a gas. This can be demonstrated by adding vinegar (acid) to many alkaline soils. You will note a violent effervescence of carbon-dioxide gas as the limestone is dissolved by the acid.

❸ As free, or soluble, levels of soil calcium increase, soil pH will be lowered (7.3 to 7.8). The soil pH will not drop below 7.3 until all of the limestone in the soil has been dissolved.

❹ When bicarbonate or carbonate is added to the soil (i.e., irrigation water), limestone is formed. In this process, free calcium levels in the soil are decreased and the pH increases.

Irrigation Water Quality

Arid soils require irrigation for turf production. Irrigating with poor quality water can result in a buildup of soil salts and high soil pH. The chief minerals in irrigation water are chloride, sulfate, bicarbonate, sodium, calcium and magnesium. These minerals contained in the irrigation water can build up in the soil and cause problems. Sodium, bicarbonate, and chloride are the three minerals that contribute most to soil salinity and alkalinity.

If you have waters that have high levels of bicarbonate and chloride, you almost always have high levels of sodium around. Continued irrigation with sodium water will result in the soil "plugging up." The high sodium concentration in the irrigation water makes the soil clay and organic matter repel each other. This repulsion (dispersion) makes the clay break up and behave as an individual clay particle. These small individual clay particles can now pack themselves in the small soil pores plugging them up. Calcium has

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the opposite effect on soil clay. Calcium makes the clay particles flocculate or come together, behaving as a larger soil particle. Calcium encourages good drainage. Obviously, clay dispersion is not a problem for sandy textured soils with low clay content.

Adding bicarbonate, as previously discussed in the lime cycle, results in soil calcium forming limestone. After repeated use of waters with high bicarbonate, soil calcium (both exchangeable and soluble) will be low and bicarbonate levels in the soil will be high, because there is no more calcium in the soil to hook up with and form limestone. Soil pH levels can be greater than 8.5 when water with bicarbonate is used.

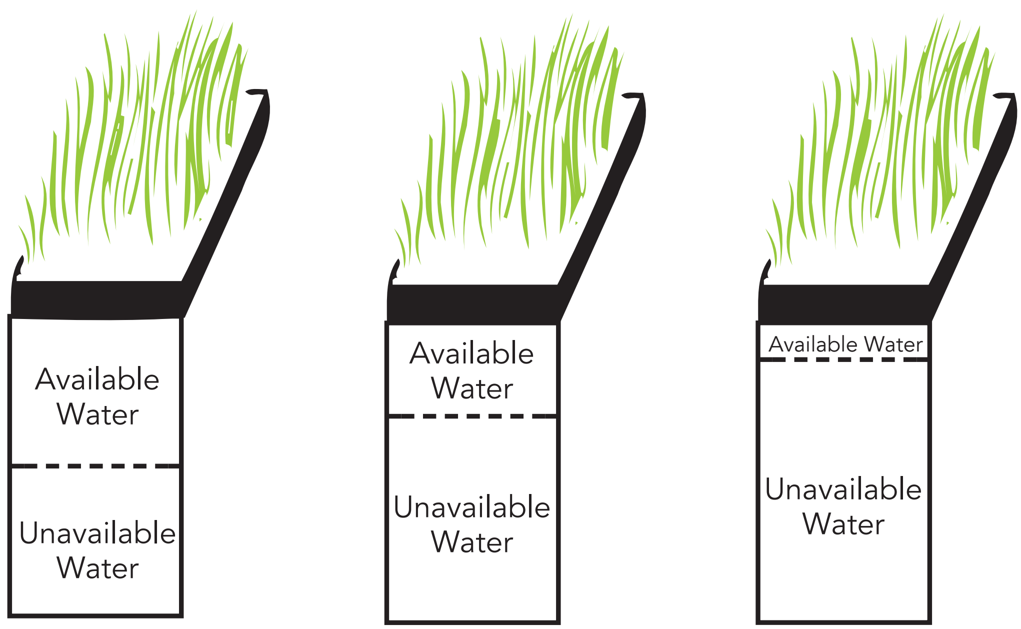
Chloride-containing irrigation waters nearly always have high sodium also. Chloride affects soil productivity by reducing the amount of water available for plant uptake. The effects of salt build-up in the soil on amount of available water is depicted in Figure 2.

More frequent irrigations become necessary to keep up with increasing soil salinity levels. Plants are most sensitive to saline soils during germination. Once established, they have the ability to tolerate higher soil salinity levels. Leaching and/or drainage has to be established to flush the salt levels below the root zone.

Conclusion

Limestone is responsible for alkaline soil pH (7.0-8.5). Soil pH values above 8.5 are the result of irrigation waters containing bicarbonate. Irrigation waters containing high amounts of sodium result in poor drainage of medium and fine textured soils. Salt build-up is common with waters containing sodium chloride. A soluble source of calcium, such as gypsum, is the best way to reclaim these soils.

Figure 2. Effects of salt build-up on available water



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