Soil Alkalinity

Arizona soils present many challenges to gardeners and landscapers unfamiliar with the area. It is important to realize some of these challenges so that we can spend our time efficiently and be productive in trying to improve them. Soil alkalinity, or rather the effects of it on plants, vexes landscapers and home gardeners alike.

Alkalinity is measured using the pH scale. The pH scale goes from 1 to 14 where 1 is highly acidic, 14 is highly alkaline and 7 is neutral (having a balance between acidity and alkalinity). The abbreviation "pH" stands for "potential of hydrogen" and refers the amount of hydrogen ions in a solution. The pH scale is not linear but logarithmic. That is, a soil with a pH of 8.5 is ten times more alkaline than a soil with a pH of 7.5 and a soil with a pH of 6.5 is a hundred times more acid than a soil with a pH of 8.5. To give some points of reference using common liquids, lemon juice has a pH of 2, vinegar is 3, milk is 7, baking soda and sea water are 8.5, milk of magnesia is 10.5, ammonia is 12, and lye is 13.

The pH of soil refers to the way the saturated soil solution interacts with other soil compounds and nutrients. A near-neutral or slightly acidic soil is generally considered ideal for most plants. With some notable exceptions, a soil pH of 6.0 to 7.0 requires no special cultural practices to improve plant growth. Most soils in Arizona are alkaline and have a pH of between 7 and 8.5. Native plants are adapted to these conditions. However, introduced landscape and garden plants often struggle as the pH approaches 8.5.

Soil pH is most critical with respect to nutrient availability. Nutrients such as iron and zinc tend to become less available to many plants in alkaline soils. In our area, iron deficiency is most common. Symptoms of iron deficiency are chlorosis (green veins with yellow or whitish areas in between) on the new growth. Older leaves remain green. Iron deficiency is most common in the spring when daytime temperatures climb, but soil temperatures remain cool. Additions of soil sulfur can help acidify soils to overcome these deficiencies, but it is very difficult to apply enough to make a significant difference, especially over the long term. Soil sulfur should be applied to alkaline soils where annual crops are grown. This can be repeated each season.

The fastest way to overcome iron deficiency is to apply chelated (pronounced kee-lated) iron to the foliage. Chelated iron products have been prepared in a specific way to keep them readily available for absorption once they are introduced into the soil. The chelation process prevents them from being rendered unavailable by alkaline compounds in soil.

Zinc deficiency is most common on deciduous fruit and nut trees. Zinc deficiency is characterized by small leaves that are curved, have wavy edges, have dark veins and yellowish blades, or leaves only in small bunches at the ends of the branches. To correct this, apply a zinc sulfate solution to the foliage when leaves first emerge, and two or more times until all new leaves have developed. The zinc sulfate only affects the young leaves it contacts. As the leaves mature, the thickened leaf cuticle will prevent the zinc from entering.

Organic matter also helps with soil alkalinity. If you grow annual flowers or vegetables, ample quantities of organic matter must be incorporated into the soil prior to planting each year. Omission of organic matter results in poor plant performance and/or crop yields. Gardeners that make compost have their own ready source of organic matter on site. Non-composting gardeners often rely on outside sources of organic matter that are purchased or hauled in from elsewhere.

Organic matter is raw or partially decomposed plant and/or animal residues. Organic matter binds soil particles, granules and aggregates together. It aids water penetration and aeration of plant roots in clayey soils and increases moisture-holding capacity of sandy soils. It also provides some nutrients for plants and food for beneficial soil microorganisms. Organic matter must be replenished each year because our summer temperatures and soil alkalinity cause rapid decomposition.

Peat moss is a commonly available source of organic matter, but it does not usually contain essential plant nutrients like nitrogen and phosphorus. Most nurseries have dried peat moss in plastic bags or bales. It is highly variable in color (reddish brown to black) and texture (fibrous or non-fibrous) depending upon its state of decomposition. Water-holding capacity ranges from 150 to 3,000 percent of its dry weight. Some nurseries sell moist peat moss, so be aware that you may be purchasing water. The dry form is an economical way to purchase peat moss on a pound basis. However, dry peat moss can blow away if not incorporated into the soil immediately after application. Peat moss is mined from peat deposits and is usually considered a non-renewable resource.

Animal manures are another source of organic matter and contain relatively larger amounts of essential plant nutrients than peat moss. Animal manures should be dried, aged or composted before being used in garden or flower beds. Manure quality varies depending on animal species and its diet. Bagged steer manure often contains salts that accumulated from urine during confinement. Horse manures can contain weed seeds. This can be a major disadvantage and should be considered before using horse manure in a garden or flower bed. Well-composted horse manure can be weed-free.

Rabbit, goat, sheep, and llama manures are excellent for use in gardens and can be incorporated without composting to planting (note: USDA Food Safety Guidelines recommend applying raw manures 120 days prior to harvest). These animal species digest their foods completely and weed seeds will not be viable. Another advantage is that these manures are produced in pellets and have little odor which makes them easy to handle, gather, and transport. Cattle also digest their food completely, but it is usually not as easy to gather. Chicken manure is too high in nitrogen to be directly incorporated and should be composted. It is often mixed with bedding which should also be composted before use.

Wood shavings, straw, and dead leaves are certainly sources of organic matter. However, they require additional nitrogen to break them down. These materials are best composted with plenty of green waste or added nitrogen fertilizer before adding to the soil.

When using peat moss or well-decomposed compost, two to three inches can be applied to the soil surface and incorporated by tilling or hand spading. Manures are higher in nitrogen and it is possible to provide too much of nitrogen for “fruit producing” vegetable (tomatoes, squash, eggplant) and flowers. This can result in lots of foliage and little food or fewer flowers. Corn is an exception and requires larger amounts of nitrogen. Phosphorus fertilizer should also be applied when growing all vegetables and flowers.

Another option for organic matter is growing a cover crop that is turned under three to four weeks before planting. Cover crop plants can be a single species or a combination of species suited to your climate and gardening objectives. Legumes such as alfalfa, peas, beans, clover, vetch, and their relatives are commonly used as green manure cover crops because of their ability to convert atmospheric nitrogen into plant-available nitrogen in the soil .

For garden soils, a simple soil analysis should be conducted which includes a soil pH test. If your soil has a high pH, the recommendation will most likely be to periodically amend with soil sulfur (moderate amounts every few years). Once understood, we can make alkaline soils more productive by applying the appropriate nutrients or planting less susceptible, drought adapted landscape species.

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