SOUTHWEST TREES & TURF

Volume 14 Number 3 March, 2006

Success with Desert Soils

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Many soils of Southwest's deserts are fertile and can be very productive if managed properly. But desert soils differ from those of temperate regions in several important ways, and require adapted management techniques.

ALKALINITY

Desert soils tend to be alkaline, or to have a high pH. This is because sodium, calcium, and magnesium carbonates and bicarbonates that wash out of soils in wetter climates tend to build up in desert soils. These are alkaline compounds that keep soil pH between 7.5 and 8.5 in most desert soils. When they solidify, these salts can form caliche, a rock-like deposit that can make soil impenetrable to both roots and water. Caliche must generally be physically broken to allow water and roots to move into affected soil layers.

Alkaline soil conditions also affect nutrient supply to plants. Phosphorus, copper, zinc, manganese, and iron are among the fourteen "essential nutrients" required by all growing plants. Availability of these five elements is restricted in high pH soils, because they are less soluble in these soils than in lower pH soils of temperate regions.

Plants from tropical climates tend to have particular difficulty absorbing zinc and iron from high pH soils, and symptoms showing deficiencies of these nutrients are often seen. Symptoms of zinc and iron deficiency show up as bleached tissue between the veins of the youngest leaves Affected leaves will be stunted, and remain pale in color. Notably susceptible horticultural plants include gardenias, tea roses, azaleas and crape myrtles.

While desert soils are fertile, they must be treated properly in order to produce optimum plant growth. Photo of the Desert Botanical Garden by Helen M. Stone

There are several ways of dealing with alkaline soils. First, soil pH can be lowered by adding acid-forming additives, including elemental sulfur and aluminum sulfate. This can be effective in pots, containers, and beds, where a small quantity of soils are treated, but is less practical on larger scales.

Second, iron and zinc fertilizers can be applied to the soil. The disadvantage of this approach is that the nutrients you mix into the soil will quickly be converted to unavailable forms. Availability can be increased by using "chelated" nutrients, which are complexed by cage-like molecules (chelates) that keep the nutrients from reacting with the soil. The label of iron and zinc fertilizers will list the nutrient form on

Continued on page 14

Soils, *continued from page 1.*

the label. Common chelates include EDTA, EDDHA, and DTPA.

Third, these nutrients can be sprayed directly on to plant leaves. Because iron and zinc have very little ability to move within the plant, this treatment may have to be repeated periodically to supply new tissues with adequate nutrition. Either chelated, or non-chelated fertilizers (such as sulfates) can be used for this purpose. However, spraying plant leaves can cause considerable leaf damage.

Be sure to follow label directions, and avoid over-application. Spraying in the evening or during cool or cloudy weather will help avoid damage to plant tissues. It is a good idea to spray a small branch, and observe for a couple of days to make sure damage does not occur, before spraying an entire plant.

SALINITY

Just as the alkaline salts discussed above can accumulate in desert soils, so can "soluble salts" such as sodium chloride. Because these salts dissolve easily in water, in moister climates they wash out of soils, so their presence is indicative of arid conditions. Salinity can be damaging to susceptible plants. Soil salt concentration is measured as electrical conductivity (EC). Salt levels affecting plants are shown in Table 1 below. Most non-native horticultural plants are affected by salinity in the 2 to 8 dS/m range.

Most salts can be easily leached or washed out of soil simply by over-watering and allowing salts to drain out of the soil along with the excess water. All irrigation water contains salts, so salts will build up unless excess water is applied. All irrigated plants, whether in the landscape, or in containers or pots, must be over-watered periodically to flush salts out of the soil. The frequency and amount of flushing is dependent on quality of irrigation water and salt-tolerance of plants being grown.

Table 1. Levels of soil salinity affecting plant growth.

EC (dS/m)	Plant response
0 to 2	Mostly negligible
2 to 4	Growth of sensitive plants may be restricted
4 to 8	Growth of many plants is restricted
8 to 16	Only tolerant plans grow satisfactorily
Above 16	Only a few tolerant plants grow satisfactorily

One particular type of salt, sodium, can cause additional problems. Soil particles are usually aggregated, or clumped together, through the action of cementing agents in the soil. This is important, because spaces between aggregates are relatively large and provide spaces for water, air, and roots to penetrate the soil.

Sodium salts can prevent the formation of soil aggregates, and cause individual particles to separate from one another. Separated or dispersed particles fill soil pores and plug the soil, preventing water infiltration.

Calcium salts, on the other hand, are very good cementing agents. To treat dispersive sodium-affected soils, add gypsum $Ca(SO4).2H2O$ to provide calcium, then leach with clean water to remove excess salts.

NUTRIENTS

In addition to iron and zinc, phosphorus also has limited availability in alkaline desert soils. Calcium, prevalent in desert soils, reacts with phosphorus rendering it unavailable to many plants. Therefore, it is often helpful to fertilize with a fertilizer containing phosphorus (this is the middle of the numbers on a fertilizer bag which represent percentages of: Nitrogen-Phosphorus-Potassium).

Phosphorus fertilizers are generally quite insoluble. Exceptions are the polyphosphates contained in soluble household fertilizers intended to be dissolved in water, which are useful for application through an irrigation system. Because phosphorus fertilizers are insoluble, over-application is not a major danger. However, the low solubility of phosphorus means that it moves very little in the soil, and stays where it is placed. Therefore, it is desirable to distribute phosphorus when the opportunity presents itself, such as during preparation for planting perennial plants.

Nitrogen, represented by the first number on a fertilizer bag, is also often limiting in desert soils. This is because organic matter, a major source of soil nitrogen, is in very short supply in desert soils. Nitrogen fertilization will help promote growth of most plants growing in desert soils.

Nitrogen can be applied in inorganic fertilizers such as ammonium nitrate, ammonium sulfate, urea, etc. These are all very soluble and immediately available to growing plants. They can also damage plants if over-applied, so do not exceed recommended rates.

Organic fertilizers, such as animal manures and animal and plant processing by-products, can be a good nitrogen source, although they are very dilute (low analysis fertilizers), so large quantities may need to be applied. Nitrogen is subject to several mechanisms of loss from soil, and generally does not remain in the soil over long periods of time. Therefore, nitrogen must be added to soil regularly to maintain optimum plant growth.

SUMMARY

Desert soils are naturally quite fertile, and can be productive if inherent limitations are addressed. The most obvious of these is water supply. Assuming irrigation water is applied, other soil properties that need to be considered are: alkalinity, salinity, and fertilization.

Alkalinity affects zinc and iron nutrition and can be addressed by acidifying soil, or by fertilizing with these nutrients. Salt levels are high in many desert soils, and can become a problem in any irrigated soil. Salts should be flushed from the soil with excess irrigation water. In sodium-affected soil, gypsum should be applied before salts are leached.

Nitrogen and phosphorus supplies are inadequate to provide for optimum plant growth in desert soils, so proper fertilization with these nutrients is an important management tool. ▼

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