Powerful pH

The effects of pH are not limited to the acidity or alkalinity of the soil; pH affects the availability of soil elements by making them more or less available for plant uptake.

By NANCY STAIRS/ Technical Editor

Plants with roots in a soil pH environment for which they're not adapted tend to be more susceptible to pests and diseases. This isn't because pH has a direct effect on plant growth but, rather, through more indirect effects.

The elements in the soil which, by photosynthesis, are converted to nutrients necessary for plant growth are more available or less available in response to soil pH. A very acidic soil can have limited microbial activity and, for many elements, increased solubility or mobility. Adding lime to the soil can help correct an acidic soil condition. In an alkaline soil, beneficial microorganisms may be more active, but for many soil elements their solubility or mobility is reduced. If a soil has excessive alkalinity, it can often be adjusted by adding sulfur.

However, you should not amend soil without first testing the soil. Excess lime can raise the pH above plant tolerances and affect the availability and growth of beneficial microorganisms in the soil. And, even a soil test will not tell you how much material is needed to amend a soil; different soil types require different amounts of amending materials to affect the soil pH. Test a topsoil or ask for an analysis before you buy it to be certain that excess salts and elements are not present.

Don't amend soil for pH extremes without first testing the soil.

The significance of pH and nutrient availability is important for ornamental plants and for turfgrasse,s although the symptoms of a deficiency or toxicity in turfgrasses may be different from the symptoms of ornamental plants.

Nitrogen is the most commonly deficient soil element. Other deficiencies are less common or occur under more specific circumstances. Nitrogen itself is soluble at any pH and is subject to leaching in acidic soils.

While **phosphorus** usually occurs in amounts adequate for most shrubs and trees, its availability is minimal in most soils due to low solubility. A pH range between 6.5 to 7.5 is best for phosphorus availability although it is also available above pH 8.5. Excess phosphorus can increase soil salinity and tie up micronutrients, especially copper and zinc.

Potassium is also present in sufficient amounts for most woody plants but deficiencies can occur; most often in the eastern half of the U.S. where it is humid with more soil leaching. Potassium deficiencies are less common in the more arid regions of the west except where irrigation has been practiced for many years. Large amounts of potassium reduce magnesium uptake, particularly in acid and sandy soils. Raising pH by adding lime can limit potassium availability.

Sulfur behaves like nitrogen, being soluble at any pH and subject to leaching. A deficiency in sulfur resembles a nitrogen deficiency, but occurs in the newer leaves rather than the older leaves.

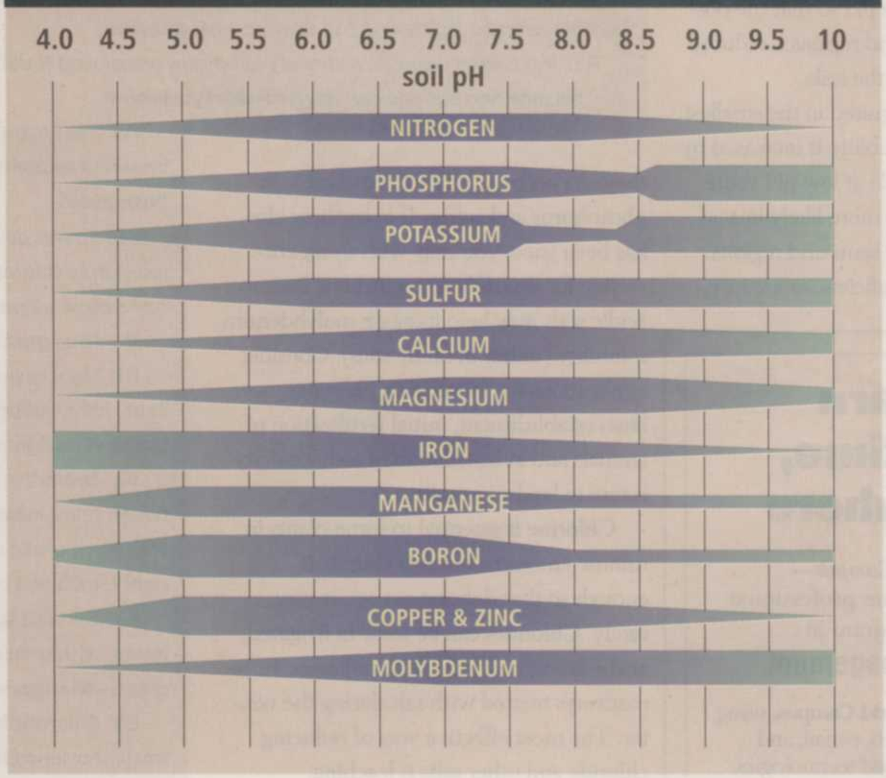
Calcium is usually present in large enough quantities to meet plant needs but levels will decline in acid soils where soils drain well and rainfall averages over 30 inches a year. As soils become more alkaline calcium becomes more available although very high pH can make it unavailable. An excess of calcium results in low solubility of phosphorus, iron, manganese, boron and zinc which result in deficiencies of those elements.

Magnesium, the only metallic element contained in chlorophyll, is normally abundant in most soils, although subject to leaching in acidic soils and unavailable at high pH levels. The type of amendment most appropriate for raising or lowering the pH depends on the soil type, so check with your extension agent or testing laboratory.

Iron is the most commonly deficient micronutrient in the landscape. Less soluble at high pH, an iron deficiency can result from over-liming an acid soil and is seen most frequently in alkaline soils and soil high in lime. Iron deficiency can also result from an excess of zinc or manganese in acidic soils, or from high phosphorus levels in neutral or alkaline soils which can reduce iron availability. Iron deficiency in turfgrass causes chlorosis while sufficient iron increases color, enhances root growth and complements late fall nitrogen fertilization. Iron availability increases with lower pH when soils have too much iron to be depleted by leaching.

Manganese and iron have closely related roles and should not be applied in the absence or exclusion of the other.

AVAILABILITY OF NUTRIENTS WITH VARYING SOIL PH



Manganese is generally deficient under the same conditions as iron, although deficiencies are more likely to occur in poorly drained soils high in organic matter or soils with high levels of copper, iron or zinc. Treating a manganese deficient plant with iron may increase chlorosis. Symptoms of iron toxicity are similar to manganese deficiency and symptoms of manganese toxicity are similar to iron deficiency. Liming, to raise pH, can overcome toxicity in poorly aerated soils; however, excessively overliming soils high in manganese will increase toxicity. Increased iron and zinc can also avert manganese toxicity as they reduce plant uptake of the element. Toxicity can occur in poorly drained soils even at high pH and in well-drained soils if pH is less than 5.6.

Zinc is adequate in most soils but deficiencies are often seen in cultivated trees and large shrubs. In turf, symptoms of zinc deficiency can include stunted growth with thin dessicated leaves. Like copper and manganese, zinc can become less soluble at high pH and can be leached out at lower pH. Deficiencies in acid soils indicate low total zinc content and are most likely to occur in sandy soils with leaching, and in sites along the Gulf Coast. High concentrations of phosphorus or magnesium tend to reduce the availability of zinc. Low soil temperatures reduce zinc uptake by plants and can accentuate a zinc deficiency. Overliming can also cause zinc deficiencies, but applying phosphate fertilizer can reduce zinc toxicity.

Copper deficiency is not as common as boron or zinc but will occur in organic soils, particularly soils derived from sphagnum moss. Deficiencies can occur at both high and low pH as copper is less soluble at high pH and can be leached out at lower pH as well as where phosphorus, zinc or nitrogen levels are high. A copper deficiency can cause iron to accumulate in plants and a copper toxicity can cause a chlorosis similar to iron deficiency. If toxicity is a result of copper fertilization or spraying, liming acid soils and spraying plants with iron chelate can help reduce toxicity. Toxicities tend to be rare but copper is toxic even at low levels so confirm with a soil test. Do not re-treat without a soil test and follow copper product application directions.

Boron deficiency can be hard to identify as it can appear like other deficiencies. It causes the death of terminal buds resulting in later shoot development and witches brooming. In turfgrasses, leaf chlorophyll, plant size and vigor can be affected. Boron deficiencies are usually related to parent materials low in boron, in acid, leached soils and organic soils. Deficiencies may also result from using irrigation water low in boron and high in calcium or by adding lime to soil low in boron which will inhibit boron uptake. The range between excess or deficiency of boron is very narrow, so it is easy to turn a deficiency into a toxicity. Toxicity can be reduced by leaching the soil. Boron is not very soluble at high pH so that the possibility for toxicity in arid regions is reduced due to the alkalinity of the soils.

Molybdenum is required in the smallest amount by plants. Solubility is increased by liming but is less soluble at low pH value so that deficiencies are more likely in acid soils and rare in arid or semi-arid regions. While molybdenum deficiencies are rare, they can occur in soils extremely low in phosphorus and sulfur. If everything else has been tried, you may wish to try correcting for this deficiency. Adding lime to acidic soils may help increase molybdenum solubility (unless in sandy soils). Consider applications for foundation plantings, new lawn establishment, initial fertilization of annuals and at installation of sod. Toxicity is rare in landscape soils.

Chlorine is essential to some plants in minute amounts, but it is abundant enough so that deficiencies occur very rarely. Chlorides can be toxic in irrigated, arid regions, near seacoasts and adjacent to roadways treated with salt during the winter. The most effective way of reducing chloride and other salts is leaching.

Aluminum is not necessary for plant growth but is abundant and absorbed by plants. It is soluble under acid conditions and can become toxic to plant growth. Keep soil pH above 5.0 as high levels of aluminum can also reduce plant uptake of phosphorus, calcium, magnesium and iron. When soils are strongly acidic due to the presence of aluminum, turfgrass roots tend to become short and brown with a decreased tolerance to environmental stresses (such as drought and heat) and reduced recuperative potential. **LM**

A Key to Nutrient Deficiencies of Ornamental Plants

This key is divided into 3 sections: (A) older leaves first affected; (B) youngest leaves first affected; and (C) terminal bud affected. Compare the symptoms listed with the symptoms observed.

A. Older leaves affected first

A1. General chlorosis progressing from light green to yellow; stunting of growth; excessive bud dormancy; necrosis of leaves, followed by abscission in advanced stages—**Nitrogen**

A2. Marginal chlorosis or mottled leaf spots which occurs later; tips and margins may become necrotic, brittle and curl upward—**Magnesium**

A3. Interveinal chlorosis with early symptoms resembling N deficiency; leaf margins may become necrotic and curl upward—**Molybdenum**

A4. Leaf margins may become brown or mottled and curl downward—**Potassium**

A5. Leaves develop blue-green or red-purple coloration; lower leaves may turn yellow—**Phosphorus**

B. Youngest leaves affected first

B1. Light green color of young foliage, followed by yellowing; tissue between veins lighter colored—**Sulfur**

B2. Distinct yellow or white area between veins; initially veins are green, becoming chlorotic under severe deficiency, followed by abscission—**Iron**

B3. Necrotic spots in young chlorotic leaves, with smallest veins remaining green—**Manganese**

B4. Chlorotic leaves abnormally small; shortened internodesin severe cases, becoming rosetted—**Zinc**

B5. Young leaves permanently wilted, becoming chlorotic, then necrotic—**Copper**

C. Terminal bud dies

C1. Brittle tissue, young or expanded leaves becoming chlorotic or necrotic and cupped under or distorted; terminal and lateral buds and root tips die—**Boron**

C2. Growing points damages or dead; tips and margins of young tissue distorted; leaves may become hard and stiff—**Calcium**

SOURCE: SMITH, E.M. FERTILIZING LANDSCAPE AND FIELD GROWN NURSERY CROPS. 1989. OHIO COOPERATIVE EXTENSION SERVICE, OHIO STATE UNIVERSITY.