The pH Factor: Beneficial or Bologna
Part 1: In Field Soils, pH Provides Beneficial Information
("Part 2: In Containers, pH is mostly Bologna" will appear in the next issue)

Carl E. Whitcomb PhD, Lacebark Research, Stillwater, OK

Much has been written and said about the importance of having proper pH in order to provide micronutrient availability. The general conclusion(s) put forward are typically that soilless container growth media and field soils respond in the same way. Certainly both soilless container growth media and field soils are root environments and are the suppliers of water and nutrients essential for plant growth. But differences between container growth media and field soils are huge.

Background

I received my MS and PhD from Iowa State University in Horticulture, Plant Ecology and Agronomy. A major portion of those fields of study focused on soils, soil fertility, soil physics and, those amazingly productive black soils of the Midwest. My first job following grad school was in 1967 as assistant professor of ornamental horticulture at the University of Florida in Gainesville. Soils over most of that state were nearly pure sand with no clay or silt and little organic matter. It was a different ball game! I was assigned to work primarily with the nursery industry struggling to grow plants in both field sand and containers. I attempted to apply what I had learned at Iowa State about soils and nutrition. Some success occurred in the fields. But, after three years of frustration and little progress it became clear that containers are different, very different. It was only when I set everything aside and started over from scratch studying the unique container environment was progress made.

Most text books on field soils note an optimum range of pH between 5.5 and 6.5 and some narrow the range to 6.0 to 6.5 as ideal. However, I have generally found most woody plants grow best at soil pH of 4.5 to 5.5. On the other hand, while conducting research relative to the unique environment of a container during the past 40 years I have repeatedly tried to relate pH of a soilless growth medium to plant growth and health. The correlation is poor to nonexistent.

pH of field soils provides valid and beneficial information.

In field soils, the relationship between pH and micronutrient availability is very real. In most soils, micronutrients are present in substantial quantities. By adjusting pH down chemical complexes gradually shift and increase availability of iron, manganese, copper and zinc. As soil pH goes up chemical complexes gradually shift and reduce micronutrient availability (Figure 1). Calcium is the primary player in causing pH to go up and sulfur and other acidifying agents are primarily responsible for pH to go down. Other bases such as magnesium, sodium and potassium are also involved but their role is minor compared to calcium. The practice of adding lime (calcium carbonate), dolomite (a combination of calcium and magnesium carbonate) or some other calcium source is widely used to keep soil pH from becoming too low. But it is really about maintaining optimum levels of iron and other micronutrients while supplying adequate calcium that is essential to plant growth and development. In many cases, it is excess calcium that causes problems. In cases where excess calcium has soil pH too high or pH has crept up to a higher than desired level because of alkaline irrigation water or excess liming, sulfur can be applied to stabilize or lower soil pH. Soil acidification from sulfur applications is quite slow, but addresses the true cause of iron chlorosis and slow plant growth.

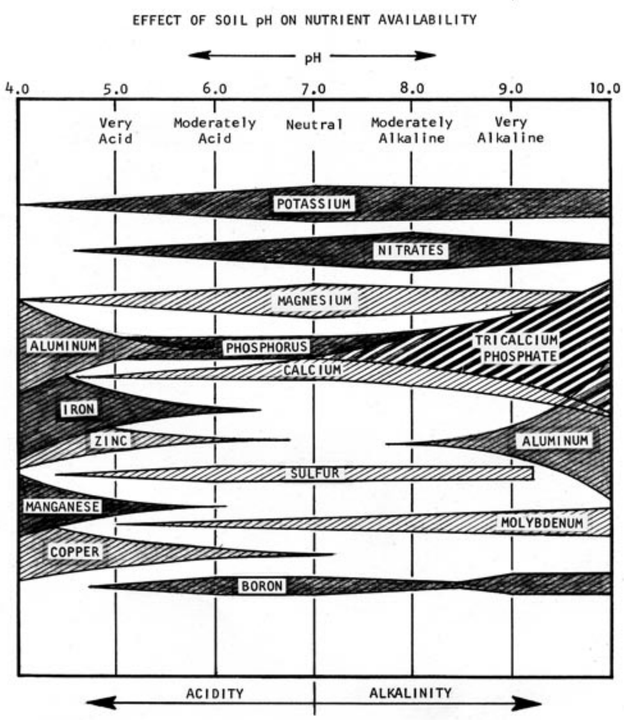

Figure 1. A generalization of how soil pH influences availability of various elements essential to plant growth. A variety of similar charts have been published; however, this one appears to more clearly relate to response of plants in field nurseries and landscapes. For example, note the decrease in estimated level of available iron, manganese, copper and zinc as pH changes from 5.0 to 6.0. Most woody plants have very sparse root systems compared to most annuals and perennials and especially when compared to grasses. This sparse root system and relatively inefficient capability of absorbing micronutrients is probably why most woody plants grow better at pH 5.0 compared to 6.0.

For example, near Stillwater, OK, soils typically contain excess calcium and pH ranges from 6.7 to 8.2. This results in low available iron and manganese and slow growth and chlorosis in some species. One study was conducted on heavy clay soils with pH 8.2 and 3,200 pounds of calcium per acre. Initial iron availability was 11 ppm and 9 ppm manganese. Seven months after applying 100 pounds of granular elemental sulfur (Figure 2) per 1000 square feet, iron availability was 46 ppm and manganese 30 ppm, even though pH had only dropped from 8.2 to 7.8. Ten years later, calcium was still high at 1,920 ppm, but soil chemistry was far more favorable to plant growth as pH had dropped to 5.9, with iron availability 123 ppm and manganese 47 ppm. And, it is important to note that no iron or manganese was applied to this soil, only granular sulfur. As a reference point, about 600 lbs/acre (1000 ppm) calcium is generally considered sufficient for crops. Any additional calcium either provides no benefits or may create complications.

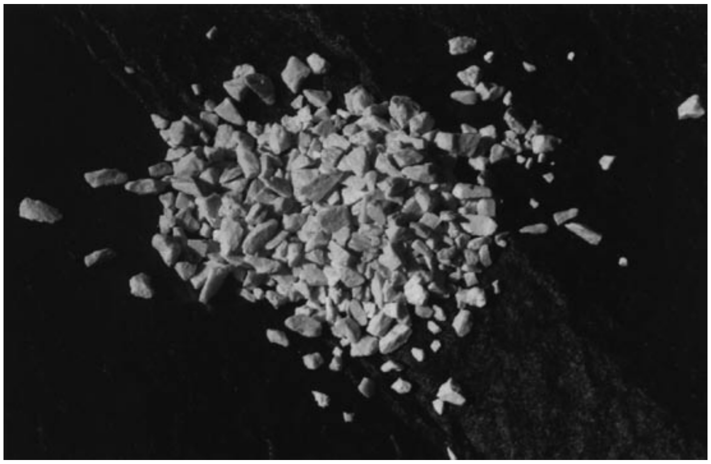

Figure 2. Granular elemental sulfur is clean and easy to spread with conventional rotary spreaders. Do not use powdered sulfur as it is difficult to spread and can cause major eye irritation. Incorporating sulfur into the soil speeds the reaction. However, if incorporation is not practical, surface applications still work, but the reaction time is slower.

Rates of granular sulfur, based on my research, may be from 15 to 60 pounds per 1000 square feet (500 to 2,000 pounds per acre) depending on pH and drainage characteristics of the soil and amount of excess calcium present. For example, if a soil contains several thousand pounds of excess calcium, a high rate of sulfur can safely be applied with little risk of damaging existing plants. The reason is because as soon as the sulfur begins to degrade there is an abundance of calcium to react with. On the other hand, if only a modest amount of excess calcium is present, a lower rate of sulfur must be used. This relationship between amount of calcium present in the soil and amount of sulfur granules applied is important.

Sulfur works by reacting with moisture to create a very dilute sulfuric acid. The sulfate portion of this acid reacts with calcium to form calcium sulfate (gypsum). Calcium sulfate is water soluble and with successive rains or irrigation is slowly leached downward and eventually out of the root zone of most plants.

In cases of soils that have a suitable pH and micronutrient availability but have insufficient calcium, calcium sulfate (gypsum) becomes the fertilizer of choice. When gypsum is applied to soils low in calcium, the calcium and sulfate separate and attach to particles. But because for every unit of calcium added there is an offsetting unit of sulfate, pH of the soil does not change. And, unless rate of gypsum is excessive, micronutrient availability is not affected.

Never use aluminum sulfate to acidify soils as aluminum is toxic to most plants.

For more information, read *Plant Production in Containers II* by the author. To order visit www.lacebarkinc.com.