AGRONOMY

Soil pH

A soil pH between 6.5 and 7.0 is ideal for agronomic crops; a soil pH that is greater or less than this affects nutrient availability and toxicity. Understanding what causes soil acidity and how to correct it is essential to nutrient management.

Soil pH measures the relative amount of acidity or alkalinity in the soil by measuring the concentration of hydrogen ions (H+) and hydroxyl ions (OH-). The pH scale ranges from 0 to 14. As you'll see in Figure 1, a pH of 0 is extremely acidic and a pH of 14 is extremely alkaline. A pH of 7 indicates that the amount of acid and alkalinity is equal; therefore, soil with a pH of 7 is neutral.

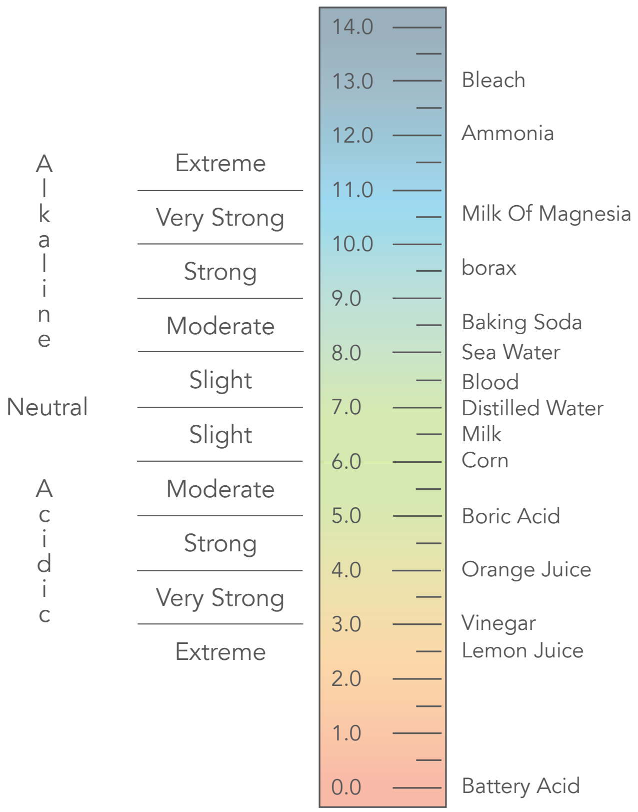
It is interesting to note that each number on a pH scale represents ten times the value of the previous number. For example, a pH of 6 is 10 times more acidic than a pH of 7. Thus, using the substances listed in Figure 1, battery acid is 10,000,000 times more acidic than distilled water. It is easy to understand why soil pH is so important.

In extreme situations, soil pH can be as low as 3.0 and as high as 9.5. Soil pH normally ranges between 5.0 and 8.5, and values below 5.0 or greater than 8.5 represent severe yield-limiting situations for most crops.

Soil pH Effects on Nutrient Availability and Toxicity

Managing the soil pH maximizes the effectiveness of the nutrients in the soil. For example, availability of nutrients such as nitrogen, potassium, and phosphorus is optimum at 6.5 to 7.5. Conversely, phosphorus availability decreases at pH levels lower than 6.0 because of aluminum and iron tie-up and at pH levels higher than 7.5 because of calcium tie-up. Here are two more examples: at soil pH values lower than 5.0, aluminum and manganese become toxic to plants. At soil pH values higher than 7.5, manganese, iron, zinc, and copper become insoluble and unavailable, which results in micronutrient deficiencies. These examples are further detailed in Figure 2 (on reverse). known. Potassium is generally associated with winter hardiness and disease resistance in plant tissue.

Figure 1.



Soybean growth impacted by low soil pH (4.5).

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Sources of Acidity

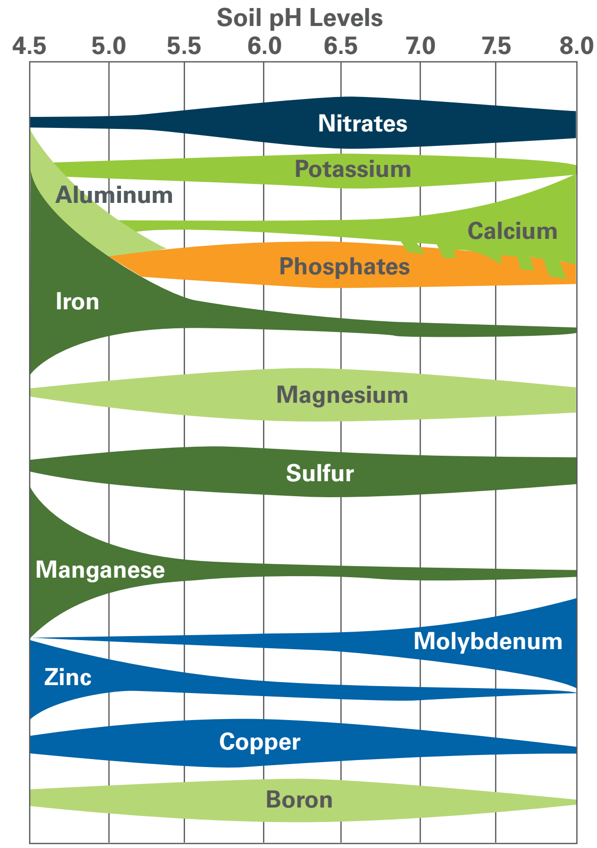
Soil acidity originates from rain, microbial activity, and nitrogen fertilizers. Therefore, soils naturally become acidic with time. Of these three factors, only nitrogen fertilizer can be controlled by growers.

Three characteristics of rain can cause soil pH values to be less than seven. First, rain is intrinsically acidic. Rainfall carries with it a certain amount of nitric, sulfuric, and carbonic acid absorbed from the atmosphere. (Nitric and sulfuric acid are a result of burning fossil fuels. Carbonic acid, on the other hand, is the natural product of carbon dioxide and moisture, i.e., rain.) Second, geographic location makes a difference. Rainfall downwind of a metropolitan area can have a pH as low as 4.2 because there is more nitric and sulfuric acid in the atmosphere near a city. (Rain free of nitric and sulfuric acid has a pH of 5.6 because of carbonic acid.) Third, when an area receives more than 25 inches of rain per year, primary (or base) nutrients are leached from the topsoil, creating acidic conditions.

Microbial activity also results in soil pH values of less than seven. As the nutrients necessary for plant growth are removed from the soil, plant residue, organic matter, and manure remain. Soil microbes exhale carbon dioxide as a result of this decomposition. The carbon dioxide makes up three to five percent of the soil atmosphere (compared to 0.033% of the atmosphere we breathe). Because this carbon dioxide does not easily escape the soil atmosphere, it remains there to react with soil moisture, thus creating more carbonic acid.

Nitrogen fertilizers containing ammonium also lower the soil pH. Ammonium creates acidity during nitrification. On the average, 1.8 pounds of limestone is needed to neutralize the acidity from one pound of ammonium nitrogen. On a positive note, this is one source of acidity that the grower can control by using nitrification inhibitors or using more nitrogen fertilizers that do not contain ammonium.

Figure 2. Soil pH levels affect micronutrient availability.



Conclusion

Soil pH is the cornerstone of a good soil fertility program. A soil pH between 6.5 and 7.0 is ideal for agronomic crops; a soil pH that is greater or less than this affects nutrient availability and toxicity. Fortunately, it is possible to manipulate soil pH with lime. How to manage soil acidity that originates from ammonium-containing nitrogen fertilizers and how to make effective lime recommendations to counteract soil acidity will be examined in additional bulletins.