Soil Acidity and Liming

Introduction

Soil acidity is a major concern in Massachusetts. Correcting soil acidity (pH) is a fundamental step in productive plant growth. The pH of a soil should always be tested before making management decisions that depend on the soil pH.

Why do soils become acidic?

The major causes of acidity are:

Acidic parent materials: Soils that developed from certain material such as granite are likely to be more acidic than those developed from limestone.

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Wet climate: In heavy rainfall areas, such as in Massachusetts, as water passes through the soil, the basic soil cations including Ca, Mg, and K are gradually leached and replaced with acid cations like Al and H^+.

Organic matter decay: Decaying of organic matter releases CO_2 which reacts with water to form acids.

Crop management: Harvesting high-yielding forages, such as corn silage or alfalfa which both contain significant amounts of basic elements i.e. Ca, Mg, and K, has a significant effect on soil acidity. Much more complex cations are removed by grains as compared to leaf and stem. Application of ammoniacal nitrogen fertilizer also may influence soil acidity.

What is the significant of soil pH?

Soil pH influences many soil characteristics that are important to its quality. Characteristics included:

Availability of nutrients to plants: In acidic soils some important nutrients such as phosphorous, magnesium, and calcium become less available to plants. Moreover, soil pH affects microorganism activities that are responsible for breaking down organic matter as well as many chemical reactions that are taking place in the soil. Thus, the availability of nitrogen, sulfur, and phosphorus to plants will be reduced.

Aglime reacts slowly and may not promote plant growth immediately after application. The finer the lime material, the faster the aglime corrects the soil pH.

Aluminum and manganese toxicity: Under acidic conditions, Al^{+++} that normally is firmly attached to the soil particles begins to dissolve and enters into the soil solution. Small amounts of Al^{+++} in the soil solution can prohibit root growth of many plants. Similarly, high Mn^{++} concentration interferes with the growth of aerial parts of plants and therefore, significantly reduces final yield.

Pesticide effectiveness: Many pesticides are effective only if soil pH is appropriate. In acid soils the pesticides may change to an undesirable form, becoming ineffective. Their degradation in the soil may not happen as expected, and could pose a problem for the next crop.

Plant diseases: Sometimes, many plant diseases are caused or exacerbated by extremes of pH, because this makes essential nutrients unavailable to crops or because the soil itself is unhealthy. For example, chlorosis of leaf vegetables and

potato scab occurs in overly alkaline conditions, and acidic soils can cause clubroot in brassicas.

How is soil pH modified?

For many crops, the ideal pH range is between 6.0 and 7.0. When pH is below the optimum range adding liming material such as calcium carbonate will correct the soil pH. As lime dissolves in the soil, Ca^{+2} attaches to soil particles, replacing the acid cations (H^{+}). Carbonate reacts with H^{+}, forming CO_2 and water, thus soil becomes less acidic.

How much lime is needed?

Lime recommendation is based on soil testing and the amount of liming material required to correct the soil pH is often specified by the soil testing labs. Although soil pH is a good indicator of the need for liming, a buffer pH measurement is necessary to determine the quantity of soil acidity to be neutralized in order to change the soil pH. The most important source of buffering in an acidic soil is the exchange of lime through cation elements, like Ca^{++}, which attach to the surface of soil particles. As the crop removes such elements from the soil solution, attached elements move into the solution. In time, reserve elements are depleted enough to cause acidity.

Some Important Tips for Liming:

- Clay soils and soils with high organic matter have a larger reservoir than sandy soils; therefore more lime is required to correct the soil pH.
- Unlike fertilizer, aglime reacts slowly and may not promote plant growth immediately after application. The finer the lime material, the faster the aglime corrects the soil pH.
- The limestone recommendation is based on the use of a liming material that is equivalent in neutralizing power to pure calcium carbonate. If the purity of liming material is 80%, then recommendation rate must be adjusted by multiplying by 100 ÷ 80.
- When a high rate of lime is recommended, (4 tons or more per acre) two applications, with 6 months time between them, is highly recommended.
- Under minimum or no-till systems the top 1-2" inch of soil becomes rapidly acidic. If surface layer has a low pH, establishment of legumes must be delayed for a minimum of 6 months until lime reacts with the soil.

Resources

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For more information visit www.umass.edu/cdl

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This publication has been funded in part by the Massachusetts Department of Agricultural Resources and the Massachusetts Farm Bureau Federation, Inc.