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SOIL REACTION (pH)

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Soils have many physical, chemical, and biological properties that determine their suitability for the growth of plants. Soil reaction, or pH, is one very important property that has great influence on the growth of soil microorganisms and higher plants and on the soil management required for satisfactory crop production.

What Is pH?

Soil reaction, or pH, is a measure of the acidity or alkalinity of the soil solution or of the amount of active hydrogen-ions present in the soil. To simplify the expression of pH, a scale numbered from 0 to 14 has been adopted. Neutrality (such as in pure water) corresponds to pH 7, or the middle of the scale. Acidity increases as pH values decrease from 7 to 0, and alkalinity increases as pH values increase from 7 to 14. Soil pH values in Hawaii are generally between pH 4 and pH 8, and values between 5 and 7.5 are most common.

Many soils in Hawaii are acid, especially those that have been used for pineapple and sugarcane production, where large amounts of acid-forming fertilizers have been added to the soil for many years. Most soils found in the high-rainfall areas are acid also. Many soils found in the low-rainfall areas are neutral (pH 7) or alkaline. The white sands of Hawaii are alkaline because they are composed of coral, which is high in calcium carbonate—the principal ingredient of limestone. Many of the young volcanic ash soils are alkaline due to the presence of potassium, magnesium, calcium, and sodium, which are part of the minerals that make up lava, volcanic ash, and cinders. However, as these materials weather, the potassium, sodium, calcium and magnesium are removed due to leaching, and the soil becomes more acid.

Why Soils Become More Acid

Soils become more acid with time, unless they are controlled by proper soil management practices. There are many reasons why these soils become more acid. When soils are formed, they contain varying amounts of bases such as calcium, magnesium, potassium, and sodium. These bases are removed from the soil by the process of leaching and plant uptake. As they are removed, they are replaced by hydrogen or aluminum ions, causing the soil to become more acid. These bases are elements essential for the growth of plants. As plants take up these elements, the roots release hydrogen to the soil solution. Hydrogen is also released by the decomposition of organic matter in the soil. Aluminum comes from the weathering of soil minerals.

To meet the demand for increased crop yields, large amounts of fertilizer are required. These fertilizers generally contain large amounts of nitrogen needed by crops. Most of the nitrogen contained in fertilizer is in the ammoniacal form. Ammoniacal nitrogen is adsorbed by the soil and in a few weeks is converted into the nitrate form, releasing hydrogen ions to the soil. Hydrogen ions from all these sources result in the soil becoming more acid.

Soils differ in the extent to which each of the abovementioned processes affects acidity. Also, organic matter, the amount and type of clay minerals, and the amount and type of adsorbed ions all influence pH of the soil. Organic matter is important because its decomposition releases hydrogen that increases acidity (lowers pH) and because it forms part of the colloidal complex in the soil. Clay makes up the remainder of the colloidal complex. This colloidal complex provides soil with exchange capacity that adsorbs and holds various ions such as those of hydrogen and the bases. The exchange capacity constitutes most of the buffering capacity of the soil and slows the rate at which pH changes. The colloidal complex adsorbs both basic and acid ions. The pH of the soil reflects the proportion of each of these present in the colloidal complex.

Influence Of pH Upon Plant Growth

Plants differ in the optimum pH range over which

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they grow best. Above or below this range their growth may be affected.

The pH also affects the availability of each plant nutrient in the soil. In strongly acid soils (pH below 5), aluminum, iron, zinc, copper, boron, and manganese availability increases and these ions may reach levels toxic to plants. Strongly acid soils are usually depleted of bases—calcium, magnesium, potassium, and sodium—so that plants may be unable to obtain the quantities of these nutrients necessary for their growth. Strongly acid conditions also reduce the availability of phosphorus and molybdenum to the plant. Alkaline conditions reduce the availability of iron, zinc, copper, boron, manganese, and phosphorus to the plant.

How to Determine pH

Soil pH may be determined either colorimetrically or electrometrically. The colorimetric method is simple, inexpensive, and accurate to within 0.2–0.5 pH unit, depending on the dye or mixture of dyes used. The soil is saturated with the dye, the soil and dye are allowed to remain in contact for a few minutes, and then the color developed is compared with colors on a color chart. The electrometric method uses a pH meter that measures the hydrogen ion concentration by the use of electrodes. It is the most accurate method when properly done by a skilled operator. The equipment for the electrometric method is relatively expensive, and requires one hour or more of contact of soil and water before the measurements are made. When correctly done, it is accurate to within 0.1–0.2 pH unit, depending on the sensitivity of the meter.

Adjusting Soil pH

Adjusting soil pH is one of the more important soil management practices used to produce more favorable conditions for plant growth. Adjusting soil pH will not make any nutrient that may be lacking in the soil more available for plant use. Acidity is reduced by the use of agricultural lime, and alkalinity is reduced by the use of sulfur, iron sulfate, or similar acid-forming materials. The subject of adjusting soil pH will be covered in another Instant Information sheet.

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