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Soil testing for acidity

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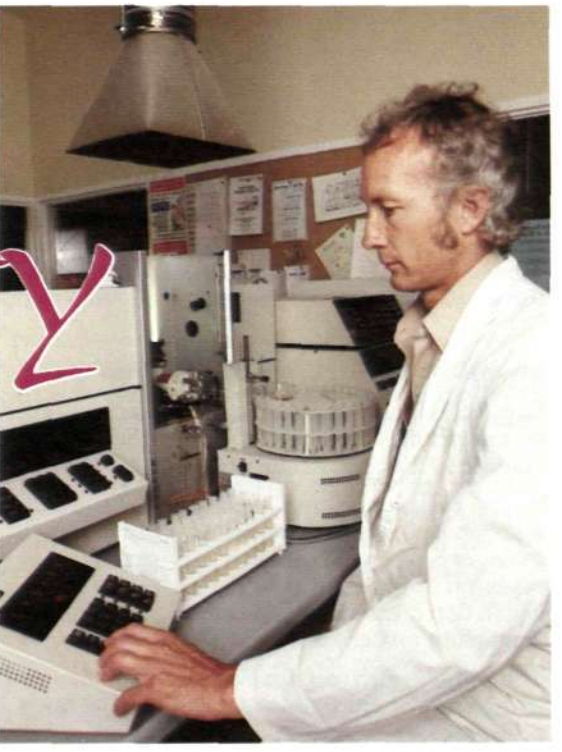

By I. R. Wilson, Chemist and Research Officer, Government Chemical Laboratories

One of the most important aspects of the soil acidity research programme is the accurate analysis of soil and plant materials.

A soil acidity problem cannot be simply diagnosed with one test. Although the soil pH test is used for the initial evaluation of soil acidity, it does not measure the other factors which affect plant growth as a result of this acidity.

For example, plant growth on a coastal soil with pH 4.3 (in water) may not be affected by applying lime, but growth may improve markedly on a central wheatbelt soil of pH 4.8 (in water).

Another two analyses may be useful. They are the level of soluble aluminium in the soil (too much soluble aluminium can be toxic to plants) and the soil's lime requirement. Both tests are being evaluated by the Agricultural Chemistry Laboratory of the Government Chemical Laboratories for their future usefulness to farmers.

Soil pH

The pH of a soil is a measure of its acidity or alkalinity. A neutral soil has a pH of seven and as the pH falls, it becomes more acid. (Figure 1.)

A colour indicator solution as used in the CSIRO pH test kit can give an approximate estimate of soil pH in the field. Field pH meters which operate without batteries and are pushed into the soil are generally unreliable. Only soil testing laboratories can give an accurate measure of soil pH.

Ideally scientists would like to measure the pH of the soil solution, that is the liquid which is in contact with the surfaces of the soil particles and plant roots. However, because of the very small amount of solution in a field soil, these measurements are impossible without resorting to elaborate and expensive procedures. The measurements obtained in the laboratory are very close to the soil solution pH or related to it in a predictable way.

Traditionally in Western Australia a mixture of one part soil to five parts water is used. To measure pH, an electrode of special glass is immersed in the soil-liquid mixture and the pH is read off a meter.

However, soluble salts in the soil can have a small, variable effect on the measured pH. To overcome this "salt effect", the pH is often measured in dilute salt solutions. The pH measured in a mixture of one part soil to five parts dilute calcium chloride solution is a better measurement of soil acidity than the pH of soil measured in water alone because dilute calcium chloride suppresses the salt effect.

The pH measured in a soil-calcium chloride mixture is almost always lower than the pH of the same soil measured in a soil-water mixture. When the soil is diluted with a large volume of water, the acidity tends to remain attracted to the soil particles and is not released into the soil solution. Adding a small amount of salt (such as calcium chloride) to the soil-water mixture raises the salt concentration of the solution to approximately that of a field soil solution. The added salt displaces some of the acidity from the soil particles, making its concentration in the bulk solution closer to that found in the field. Usually the difference between pH measured in water and calcium chloride is between 0.5 and 0.8 pH units, but it can range from nil to as much as 1.8 pH units. It is extremely important to know the method used to determine any pH measurement.

Measuring the pH of a soil in a mixture of soil and water can produce variable results depending on what time of the year the soil is sampled. As part of a study of acid soils in the Lower Great Southern, R. Glencross, Senior Research Officer at the Department of

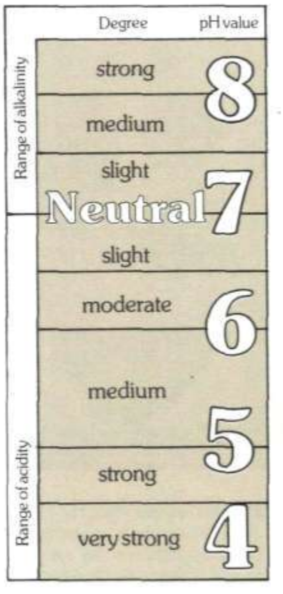

Figure 1. Part of the pH scale.

Agriculture's Albany Regional Office, monitored the pH of four soil types in water and calcium chloride every three months for more than two years. Figure 3 shows the results for two of these soil types.

Levels of extractable aluminium

Reduced plant growth in acid soils is not caused by low pH itself, but by the changes in soil chemistry that can occur when soil pH is low.

At low pH, aluminium dissolves in the soil water and can become toxic to plants. One of the main aims of the Department of Agriculture's research programme is to develop a soil test which can measure whether the levels of soluble aluminium present are toxic to plants.

The soil chemistry of aluminium is complex and many ways of extracting aluminium have been proposed.

One measurement being evaluated is the amount of aluminium extracted with the same dilute calcium chloride solution used to measure pH. When soil pH is greater than 4.7 (in calcium chloride), hardly any aluminium is extracted. When the soil pH is less than 4.7 (in calcium chloride), the amount of extracted aluminium varies according to soil type.

■ Testing soils for pH. The different colours in the soil samples indicate the range in pH within one paddock.

Figure 3 shows wheatbelt soils with pH 4.7 (in calcium chloride) have only one or two parts per million of extractable aluminium, but those with pH 4.0 can have as much as 40 ppm extractable aluminium. A peaty sand from the south coast may have a very low pH of 3.5 but, because it has very little clay, the extractable aluminium may be only 4 to 6 ppm.

Lime requirement

Lime is added to the soil to raise its pH and lessen problems associated with acidity. The amount of lime needed will vary between soil types, crops to be grown and sources of agricultural lime.

Soils vary in their ability to resist changes in pH when lime is applied. This ability is known as buffering capacity. Organic matter has a high buffering capacity and a lot of lime is needed to raise its pH by one unit. Peaty sands, therefore, need a lot of lime. In contrast, the wheatbelt soils contain little organic matter and their clays have a low lime requirement. Less lime is needed to raise the pH of a wheatbelt soil by one unit.

Plants have different tolerances of pH and soluble aluminium. The soils in which they grow may need liming at different pH levels. Sources of agricultural lime also vary in their ability to lessen soil acidity.

The Government Chemical Laboratories is evaluating methods of measuring the lime requirement of soils.

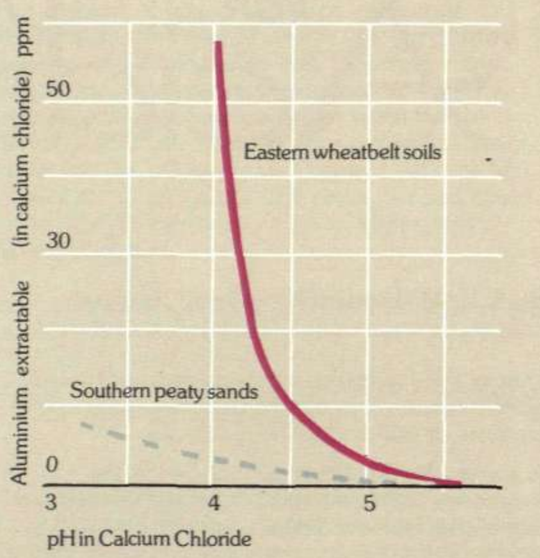

Figure 2. Relationship between pH and extractable aluminium for two soil types.

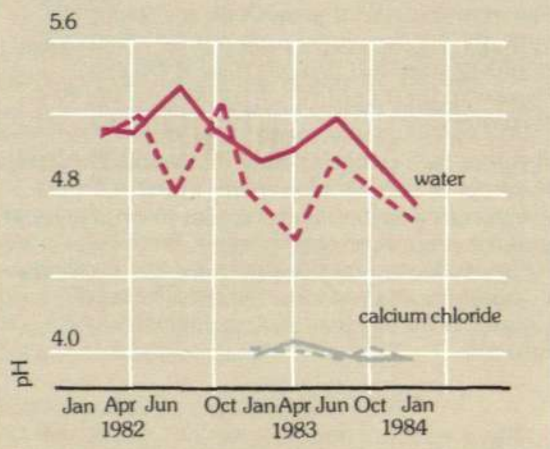

Figure 3. pH measurements in water and calcium chloride for two soil types in the Lower Great Southern.

Other analyses

The Government Chemical Laboratories conducts a wide range of analyses on soils and plants to help solve the problems of soil acidity. These include measurements of the soil and plant tissue levels of phosphorus, potassium, total nitrogen, calcium and magnesium, as well as the amounts of sulphur and trace elements. The plant tissue levels of all these elements are influenced by soil acidity and are modified by liming. Soil is also analysed for clay and organic matter content.