National Landcare Program: Smart Farms Small Grant – Fruit Growers Victoria

FACT SHEET 1 Soil pH

One of the first measures on the soil analysis report is pH. Soil test pH is the *potential of hydrogen*. The pH scale of 1 to 14 shows pH 7 as neutral, while below 7 is acidic, and above 7 it is alkaline. The pH scale is logarithmic, meaning a pH of 6 is ten times more acidic than pH 7, and pH 5 is one hundred times more acidic than pH 7.

As growers, we aim to manage pH to ≈6.5 where we see nutrients are mostly available to plants.

In higher rainfall regions and irrigated crops, we often see increased acidity, with the development of strongly acidic soils (pH <5.5) resulting in poor plant growth as a result of increased solubility of aluminium and manganese becoming toxic, calcium and magnesium deficiency, and low levels of essential plant nutrients such as phosphorus and molybdenum.

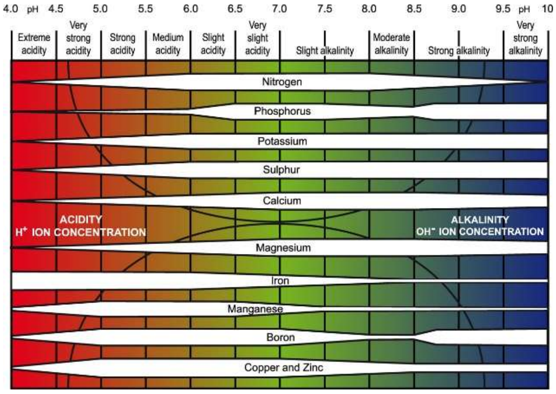
As a result of acidity, soil pH can also affect root health, the cycling of nutrients particularly nitrogen, and soil microorganisms, predisposing crops to disease infection.

pH in Australia is usually measured in both pH water (pH_w) and pH calcium chloride (pH_{Ca}). pH calcium chloride provides reduced change over the wet and dry seasons, and also reveals a lower pH. Be aware to calibrate applications of nutrients based on the same pH test.

Soil pH in Orchards:

Orchard soils are naturally acidic or alkaline depending on the region, with soil pH further influenced by management and nutrient sources added to soils for amelioration or crop production. pH is best measured with a soil test at your preferred soils lab.

It is important to note, as growers increase crop yields and support yield with a range of nutrient sources, account needs to be made for fertilisers that potentially increase in acidity.



Causes of soil acidity

Soil acidification occurs naturally and slowly as soil is weathered, with this process exacerbated by production agriculture. Soil acidification occurs as the concentration of hydrogen ions in the soil increases.

Plant roots take up nutrient cations, which are positively charged (ammonium, potassium, calcium or magnesium) or as anions, which are negatively charged (nitrate, phosphate or sulphate). When a cation is absorbed by a plant, a positively charged hydrogen ion is excreted into the soil to maintain electrical balance. When an anion is absorbed, a negatively charged hydroxide ion is excreted into the soil.
Ammonium fertilisers can be major contributors to soil acidification, specifically if the nitrogen is leached rather than taken up by plants.

Nutrient Use Changes to pH

The amount of lime required to correct an acidic pH will vary from soil to soil. Soils with higher clay content will be more resistant to changes in pH and will require larger application rates. Therefore soil pH, while indicating the need for lime, is not a reliable guide as to how much lime is required. This will depend on complete soil testing and balance of cations on the CEC.

pH Effects

The hydrogen concentration of the soil solution has a pronounced effect on a number of soil constituents and especially on the soil minerals, soil microorganisms and plant roots.

In addition to decreasing nutrient availability, low pH can degrade clay minerals in the soil that contain aluminium. This process releases aluminium (Al), which is toxic to many plants and can interfere with root growth and crop development.

pH Effect on Microorganisms

Soil pH influences the occurrence and the activity of soil microorganisms. Generally, in the low pH range (<5.5) fungi dominate in the soil and in the rhizosphere, whereas at higher pH levels the bacteria are more abundant.

The nitrification of ammonium (NH4-N) and nitrate (NO2-N) by Nitrosomonas and Nitrobacter, respectively, depends on soil pH because these bacteria prefer more neutral soil conditions. In strongly acid soils nitrate content is often low due to the inhibition of the N cycle.

The fixation of molecular N by free living soil microorganisms (Azotobacter, Clostridium), symbiotic microorganisms (Rhizobium, Actinomyces) and denitrifying bacteria are also favoured by more neutral pH conditions in the soil.

pH Effect on Plants

Plant species are able to cope, to a varying degree, with differences in hydrogen concentration in the soil solution and the accompanying effects that these pH changes induce in the soil. The optimum pH ranges for maximum growth of individual crops therefore differ. Managing the soil pH to best suit the crop grown is important.

Buffer pH

Variations in soil pH come about slowly since a well-formed soil possesses the ability to oppose transformations towards high acidity or high alkalinity. This property is known as *buffer capacity* and is related to the soil's content of organic matter and the amount of clay and silicates. For example, heavy clay and clay loam soils are highly buffered, because large quantities of calcium, magnesium and potassium can be adsorbed without changing the pH. The effect of acidity is more obvious in sandy soils than in heavier loams because sandy soils have a lower buffering capacity, making the use of lime more critical.

The buffer pH should not fluctuate throughout the growing season like the water pH can.

The test commonly used is the SMP/Sikora Buffer and is used to determine lime needs. Charts have been developed that show amounts of lime needed to acquire a certain pH_w. The buffer tests are not commonly conducted in Australian Labs, with other models utilised.

Observations

pH measured in our soil tests at both the surface and subsurface show a wide range of acidity. Management to reduce the acidity is important, and probably the most important constraint indicated in the program. Continued measurement using soil analysis and at multiple depths is strongly recommended.

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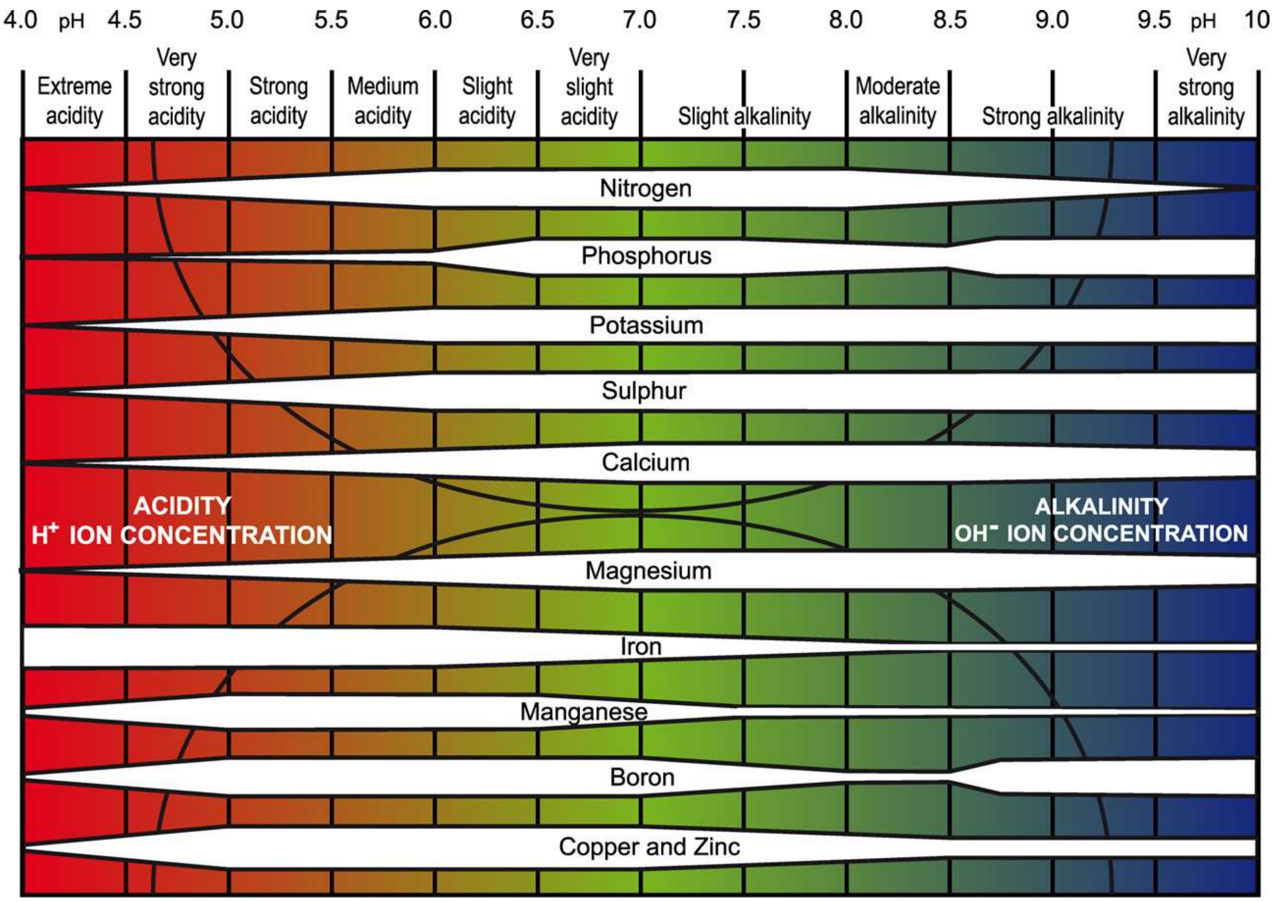

redrawn for PDA from Truog, E. (1946). Soil reaction influence on availability of plant nutrients. Soil Science Society of America Proceedings 11, 305-308.
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