



## SOIL TESTS FOR pH

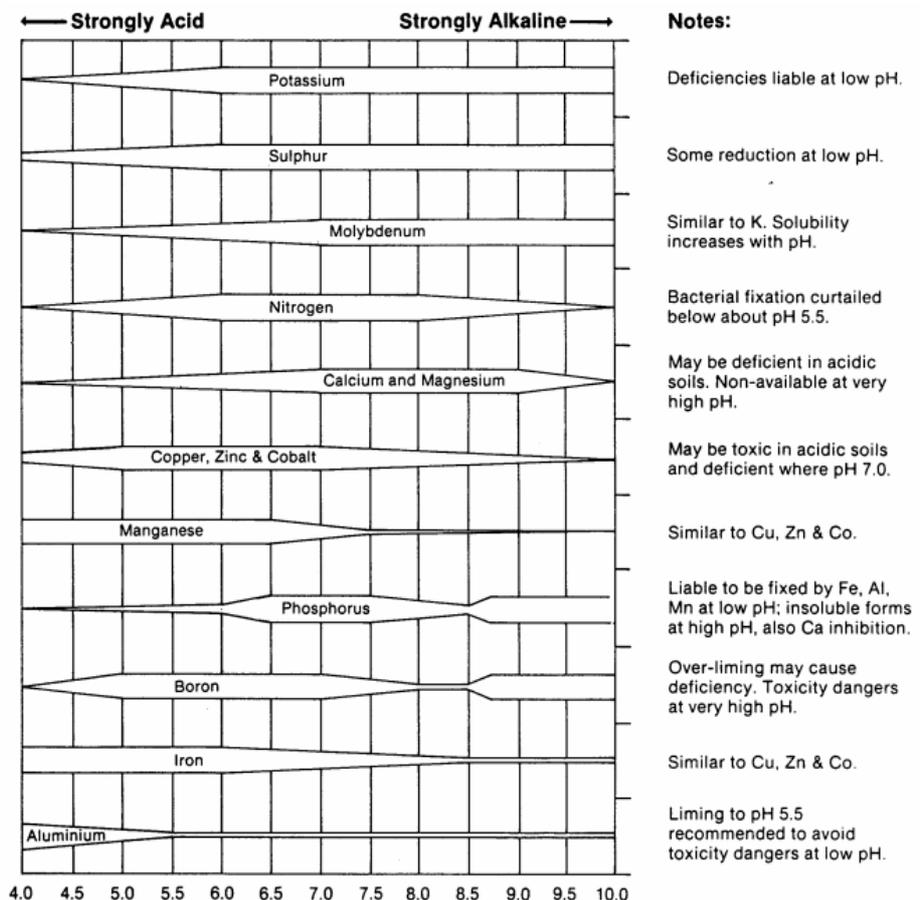
### Introduction

Soil pH is an indication of the acidity or alkalinity of soil and is measured in pH units. Soil pH is defined as the negative logarithm of the hydrogen ion concentration. The pH scale goes from 0 to 14 with pH 7 as the neutral point. As the amount of hydrogen ions in the soil increases the soil pH decreases thus becoming more acidic. From pH 7 to 0 the soil is increasingly more acidic and from pH 7 to 14 the soil is increasingly more alkaline or basic. Soil pH is important because of how it influences the chemical and physiological processes in the soil, and the availability of plant nutrients (see Fig 1).

Soils with low pH (< ~ 5.6) i.e. acid soils, may contain significant amounts of soluble aluminium which is toxic to the roots of many plant species. Please refer to the Technical Note: Aluminium Soil Test Interpretation for further explanation of this effect.

This technical note describes factors that cause development of soil acidity, the two soil pH tests available at Hill Laboratories and the limitations of these tests, and how soil acidity is corrected. The conventional soil test for pH in New Zealand uses water (H<sub>2</sub>O) as the suspension medium, but an alternate method using calcium chloride (CaCl<sub>2</sub>) is also offered.

Figure 1: pH effects on plant availability of nutrients<sup>2</sup> for mineral soils.



#### Hamilton

1 Clyde Street  
Hamilton 3216  
Private Bag 3205  
Hamilton 3240  
New Zealand  
T +64 7 858 2000  
F +64 7 858 2001

#### Christchurch

101c Waterloo Road  
Hornby Christchurch 8042  
PO Box 16607  
Christchurch 8441  
T +64 3 377 7176  
F +64 3 377 7276

## The Development of Soil Acidity

Soils become acid from natural processes occurring in the soil, such as weathering and leaching<sup>3</sup>. Leaching of the basic cations (e.g.  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{K}^{+}$ ) lowers the base saturation of the soil, resulting in a lower pH, as these exchangeable bases are replaced on the cation exchange sites by the acidic cations  $\text{H}^{+}$  and  $\text{Al}^{3+}$ . Also, the uptake of these basic cations by plants causes the plant to release  $\text{H}^{+}$  ions into the soil solution. Micro-organism and plant root respiration produce carbon dioxide, which when combined with water forms carbonic acid. When this soluble acid dissociates there is a release of  $\text{H}^{+}$  ions into the soil solution. Another contributory factor to development of soil acidity is caused by the weathering of aluminosilicate minerals - the hydrolysis of aluminium releasing  $\text{H}^{+}$  ions. Some fertilizer application can accelerate development of acidity, particularly N and elemental S fertilizers. Phosphatic fertilisers only cause a temporary pH change around the fertilizer granule – but otherwise do not cause soil acidity to develop apart from perhaps accelerating the natural soil biological processes by increasing the food supply for microbes.

## Factors Affecting soil pH measurement

As the laboratory soil pH test is measuring the activity of hydrogen ions in the bulk solution surrounding a glass electrode (rather than the hydrogen-ion activity surrounding the soil particle itself), it is important that the conditions of measurement are rigidly controlled. Several factors can affect the measured value of soil pH.

**Moistness of soil to be tested:** Air-drying of soil can cause changes in pH values, but these changes are small in comparison to changes in stored moist soil (due to microbial activity) and the difficulty in obtaining a representative moist soil for testing. The laboratory method uses the same fraction as prepared for chemical analysis, with soil air-dried at not more than 38degC and sieved < 2mm.

**Suspension Medium:** Due to difficulties with directly measuring soil pH, the soil is usually suspended in a liquid and a glass electrode inserted into the suspension medium.

New Zealand has adopted water as the standard method for agricultural purposes, using a ratio of approximately 1: 2.5 soil:water and mechanical stirring. Researchers<sup>4</sup> have shown for NZ soils that this method gave the best approximation of the field soil solution ionic strength. Small differences in the soil:water ratio have been shown to not significantly affect the pH value, but large differences in this ratio can greatly affect the measured pH, depending on soil type.

An alternate method offered by Hill Laboratories (recommended only for specific investigation purposes), uses 0.01M  $\text{CaCl}_2$  as the suspension medium. The main advantage of the measurement of soil pH in 0.01M  $\text{CaCl}_2$  is the tendency to eliminate interferences from variable salt contents by standardising the salt effect of all soil types regardless of past management, mineralogical composition, presence of fertiliser residues etc.

Temperate region soil pH values in 0.01M  $\text{CaCl}_2$  are lower in magnitude (higher  $\text{H}^{+}$  ion concentration) and less variable than those made in water, due to release of  $\text{H}^{+}$  ions from the exchange sites by calcium ions. For New Zealand soils, results for pH using  $\text{CaCl}_2$  are 0.5 to 1 pH unit lower than measurements using water<sup>1</sup>.

## Interpretation

Typical values for soil pH in are shown in Figure 2. Seasonal variability can have quite a marked effect on test results however, with lower pH values often observed when soils are under hot, dry conditions. This is largely due to the build-up of salts in the soil under these conditions and also the concentration of organic acids released by microbes and plant roots.

Spatial variability will also be a consideration, due to the uneven return of dung & urine and variability in lime and fertiliser application. A well-defined soil-sampling regime will minimise this effect however.

Figure 2 : Typical  $\text{pH}_{\text{H}_2\text{O}}$  ranges

Level	Peat	Loam	Sandy
<b>Very Low (acid)</b>	4.0	5.0	5.0
<b>Low</b>	4.5 - 5.0	5.1 - 5.5	5.1 - 5.8
<b>Medium</b>	5.1 - 5.5	5.6 - 6.5	5.9 - 6.8
<b>High</b>	5.6 - 6.0	6.6 - 7.0	6.9 - 7.5
<b>Very High (alkaline)</b>	> 6.0	> 7.0	> 7.5



## The Correction of Soil Acidity

Soil pH needs to be maintained in the optimum range for the crop grown. Excess acidity is neutralized by liming, commonly with ground limestone (calcium carbonate). The speed and duration of the 'lime effect' will depend on many factors e.g. quality (%CaCO<sub>3</sub>), particle size of the lime (lime with a finer particle size will dissolve quicker) as well as mode of incorporation into the soil (surface applied lime moves very slowly into the soil profile). Recommendations for rate and type of lime to be applied should be sought from a suitably qualified advisor, as this is outside the scope of the laboratory.

## References

- <sup>1</sup> Blakemore, L.C.; Searle, P.L.; Daly, B.K. 1987. Methods for chemical analysis of soils. New Zealand, NZ DSIR. (NZ Soil Bureau Scientific Report 80).
- <sup>2</sup> From Truog, 1948
- <sup>3</sup> McLaren, R.G. & Cameron, K.C. 1990. Soil Science – an introduction to the properties and management of New Zealand soils. Auckland, Oxford University Press. p174-175; p259-260
- <sup>4</sup> Edmeades, D.C. & Wheeler, D.M. 1990. Measurement of pH in New Zealand soils: an examination of the effect of electrolyte, electrolyte strength and soil:solution ratio. NZ Journal of Agricultural Science, Vol 33. p105-109.

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F +64 3 377 7276