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Farmnote

The importance of soil pH

Farmnote 78/2000

Soil Acidity Series

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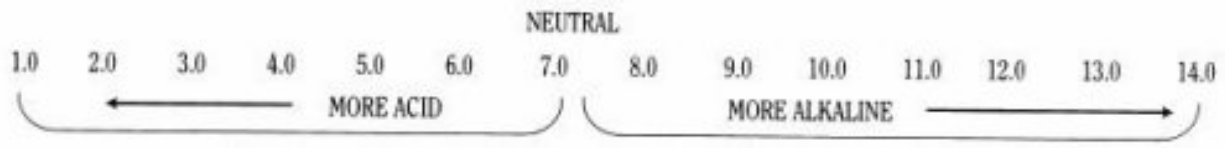
Summary

The level of soil acidity in cropping systems has a fundamental effect on plant growth and nutrient availability. pH is the measure of the level of soil acidity. The higher the pH value the more alkaline the soil, the lower the pH the more acid the soil.

What is pH?

pH is the measure of acidity. More correctly it is the measure of the **p**otential of **H**ydrogen ions. The higher the concentration of hydrogen ions in the soil, the lower the pH.

The level of acidity (low pH) or alkalinity (high pH) is measured on a scale of 1 to 14 with 7 being neutral (see Figure 1).



The pH scale is logarithmic, so a soil pH of 4.5 has 10 times the concentration of H^+ ions than a soil of pH 5.5.

Table 1. The pH of some everyday items.

Item	pH
Caustic Soda	13.8
Carwash	9.8
Sea Water	8.0
Human Blood	7.2

Coffee, white with one sugar (room temperature)	7.2
Fresh Milk	6.8
Beer	4.0
Vinegar	3.0
Soft Drink	2.8
Battery Acid	1.0
Hydrochloric Acid	0.0

Measuring soil pH

Soil pH can be measured in water (pH_w) or calcium chloride (pH_{Ca}). The world wide accepted standard is to complete soil pH measurements in calcium chloride, as this is the most reliable method.

It is difficult to compare pH readings in water to pH readings in calcium chloride. A rough guide to convert from pH_w to pH_{Ca} is to subtract 0.8 from the pH in water measurement (although the real difference in pH at extreme may be from 0.6 to 1.2).

A 1:5 mix of soil:$CaCl_2$ solution (0.01M strength calcium chloride) strength is used to estimate the concentration of hydrogen ions in the soil solution.

Demonstration of the effect of acid soil on chickpea growth. From left to right: Pot 1 pH 4.46 (0t/ha lime), Pot 2 pH 5.82 (1t/ha lime), Pot 3 pH 6.62 (2t/ha lime), Pot 4 pH 7.15 (4t/ha lime).

Symptoms of Topsoil Acidity

- Nodulation failure of legumes - reddening of stems and petioles on pasture legumes, or yellowing and death of oldest leaves on grain legumes indicate nitrogen deficiency.
- Deficiency symptoms of sulphur, phosphorus, molybdenum, calcium or magnesium.
- Root growth poor, with stubby roots and few fine roots.
- Crop yields / pasture growth are poor even in good seasons.

Faba bean response to topsoil pH. Plants on the left were grown in a topsoil with a pH of 4.1. The plants on the right were grown in a topsoil with a pH of 5.1

Symptoms of Subsoil Acidity

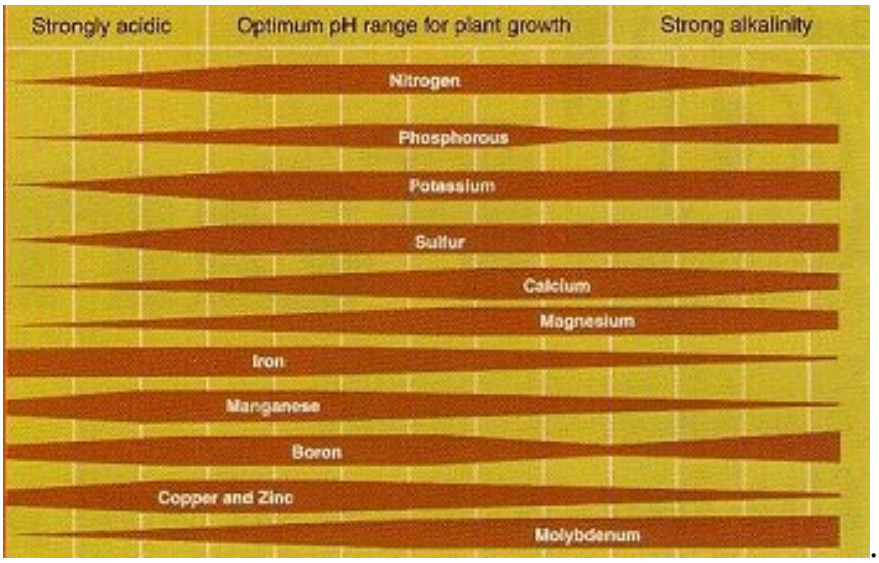
- Poor root growth (stubby and few fine roots) below 10 cm. Roots are often restricted to the topsoil area for no physical reason (e.g. no hardpan layers or tight clays that may normally stop root growth) since roots will not grow into a soil layer of high acidity.
- Crops drought easily since they have no deep roots.
- Crop yields are poor if spring is dry.

Influence of pH on Nutrient Availability

Plant nutrient availability varies quite dramatically with soil pH.

In very acid soils all the major plant nutrients (nitrogen (N), phosphorous (P), potassium (K), sulfur (S), calcium (Ca) and manganese (Mg)) and also trace element molybdenum (Mo), may be unavailable to plants, or only available in limited quantities. The other trace elements may be available in such soils in quantities sufficient to have a toxic effect. Some non-essential elements, notably aluminium may also be available in toxic amounts in very acid soils.

The picture is reversed in alkaline soils where the trace elements iron, manganese, copper, zinc and boron, so readily available in acid soils, may be unavailable to plants, even through they are present in the soil in adequate amounts, and molybdenum is readily available.



Affect of pH on nutrient availability. The width of the line indicates increasing or decreasing availability across a pH range from strongly acidic to strongly alkaline. Note how nitrogen, phosphorus, potassium and sulphur become much less available at low soil pH.

Acknowledgements

The WA soil acidity project is an integrated project of work being completed by Agriculture Western Australia, the University of Western Australia, and CSIRO. We would like to thank Chris Gazey of AGWEST and Mark Whitten of UWA for their contribution towards this farmnote.

Further Reading

- Farmnote No. 68/2000 'Looking at Liming - test strips'
- Farmnote No. 70/2000 'Looking at Liming - consider the rate'
- Farmnote No. 67/2000 'Looking at Liming - quality'
- Farmnote No. 69/2000 'Looking at Liming - comparing lime sources'
- Farmnote No. 80/2000 'Managing Soil Acidity in Agricultural Land'
- Farmnote No. 79/2000 'Soil Acidity and Barley Production'
- Farmnote No. 2/96 'Tolerance of Wheat Varieties to Soil Acidity'
- Bulletin No. 4343 'Soil Guide - A Handbook for Understanding and Managing Agricultural Soils'.

This file: F07800.HTM **Date converted:** 22 January 2001