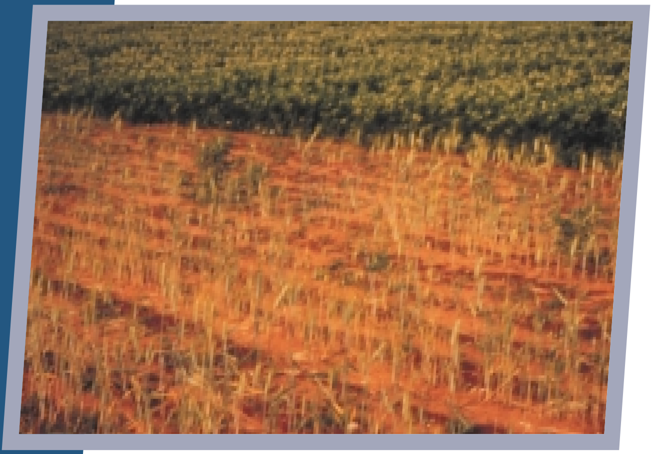
LEAFLET NO.2

Understanding Soil pH



Acid sensitive barley struggling in acid soil next to a healthy tolerant lupin crop.

To understand soil acidity you need to appreciate that soil is made up of various components which determine its properties. These include mineral particles (sand, silt and clay, which give soil its texture), organic matter (living and dead), air and water.

The water component is where pH is measured, where dissolved chemicals cause the soil to be acidic or alkaline.

Soil acidity and alkalinity are measured in units of pH. The pH scale is from 0 (most acid) to 14 (most alkaline) and a pH of 7 is neutral.

The pH of a soil will change over time influenced by factors including parent material, weathering and current agricultural practices. It will also fluctuate through the year. Soil pH will affect how plants grow.

MEASURING SOIL pH

Soil pH can be measured in the field using a test kit or by sending a sample to a laboratory for more accurate results. The standard depth of sampling is 10 cm.

- Soil pH in the field can be measured using a simple test kit based on a colour-card method available from agricultural supply stores called the Raupach soil pH kit. The kit gives the soil pH on the water scale (see later) and should be used only as a guide to soil pH.
- Analysis in a laboratory provides the most accurate measurement of soil pH. It is the best basis we can have when deciding whether or not to start an acid soil management strategy such as liming.

For further details on collecting a sample and where to have it analysed see Acid Soil Action Leaflet No. 3.

FIGURE 1.

Plant growth and pH ($CaCl_2$) scale.

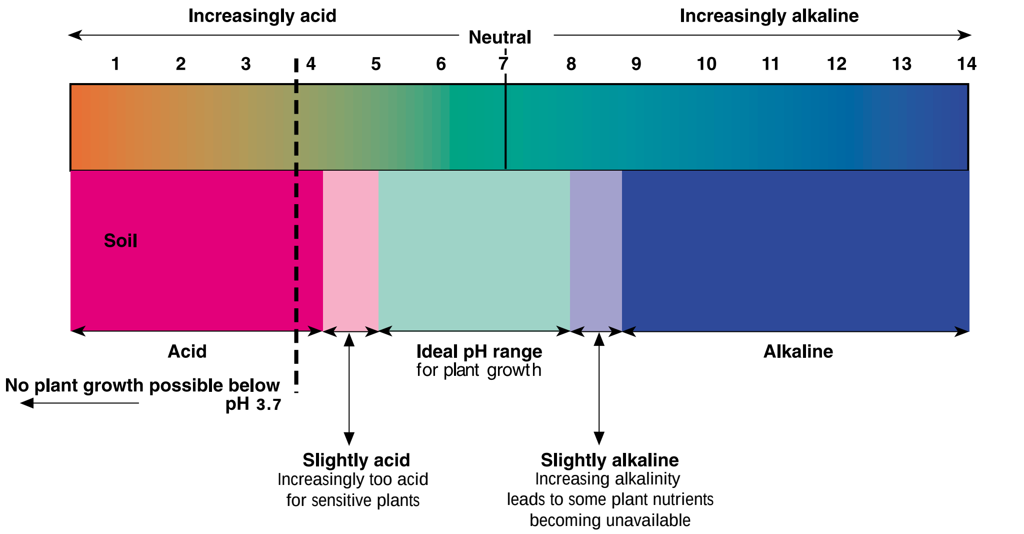


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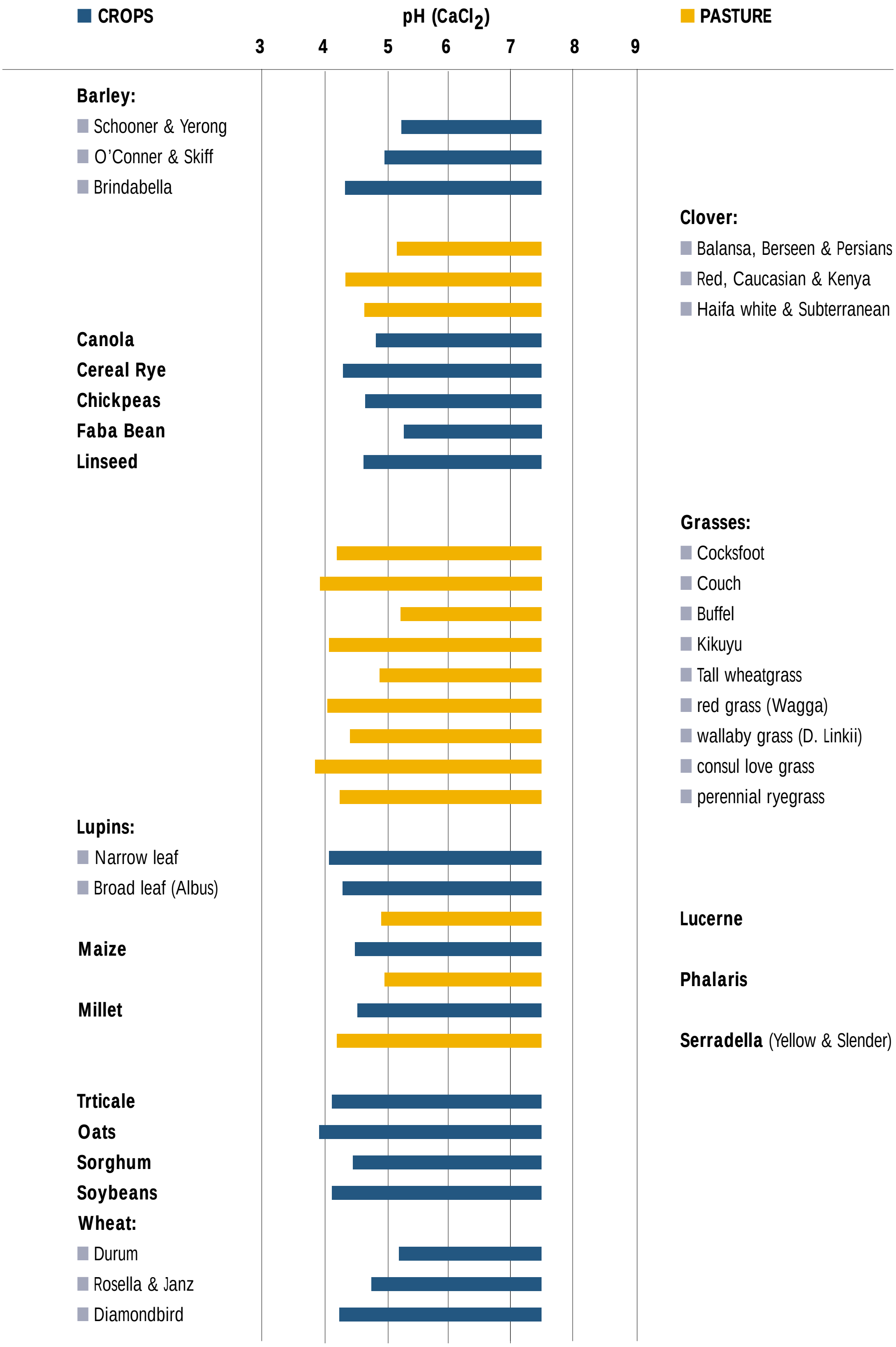
FIGURE 2.

Optimum pH ($CaCl_2$) range up to pH 7.5 for a number of crops and pastures. Above pH 7.5 the acidity/alkalinity is no longer the principal factor that controls growth. Other factors such as phosphorus, zinc, cobalt or boron deficiency or the sodicity of soil are most likely to affect production.



The two main laboratory methods used in Australia use calcium chloride or water.

Soil pH in calcium chloride
This is the standard method of measuring soil pH in all states other than Queensland. An air-dry soil sample is mixed with five times its weight of a dilute concentration (0.01M) of calcium chloride ($CaCl_2$), shaken for 1 hour and the pH is measured using an electrode. The results are usually expressed as pH($CaCl_2$).

Soil pH in water
Distilled water is used in place of 0.01M calcium chloride, and results are expressed as pH(w).

The pH($CaCl_2$) test is the more accurate of the two pH tests, as it reflects what the plant experiences in the soil. The values of pH($CaCl_2$) are normally lower than pH(w) by 0.5 to 0.9. A useful, but not consistently accurate, conversion is to subtract 0.8 from the pH(w) to obtain a pH($CaCl_2$) value. The difference between the methods can be significant when interpreting results and it is important to know which method has been used, especially if pH figures derived some years apart are being compared to assess any pH fluctuations.

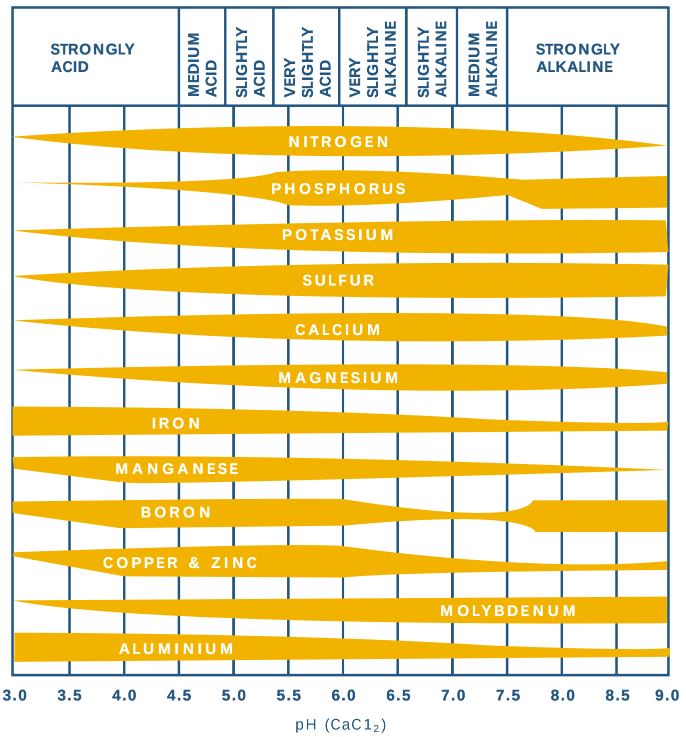
UNDERSTANDING SOIL pH RESULTS

Soil pH effect on plant response
A soil pH($CaCl_2$) of 5.2 to 8.0 provides optimum conditions for most agricultural plants (Figure 1). All plants are affected by the extremes of pH but there is wide variation in their tolerance of acidity and alkalinity. Some plants grow well over a wide pH range, whilst others are very sensitive to small variations in acidity or alkalinity. Figure 2 provides a guide to the preferred pH($CaCl_2$) for some common crops and pastures.

Microbial activity in the soil is also affected by soil pH with most activity occurring in soils of pH 5.0 to 7.0. Where the extremities of acidity or alkalinity occur, various species of earthworms and nitrifying bacteria disappear. Legume root colonising bacteria (*Rhizobia*) vary in their sensitivity to soil pH and have preferred ranges in which they are effective. In some crops and pastures (e.g. faba beans and lucerne) the *Rhizobia* specific to these plants are more sensitive than the plant itself.

Soil pH effect on availability of soil nutrients
Soil pH affects the availability of nutrients and how the nutrients react with each other (Figure 3). At a low pH, beneficial elements such as molybdenum (Mo), phosphorus (P), magnesium

FIGURE 3.
Effect of pH ($CaCl_2$) on the availability of soil nutrients



The effect of aluminium toxicity on the roots of Condor wheat. From left to right, the plants were grown in solutions containing 0, 10 and 20 ppm aluminium.

(Mg) and calcium (Ca) become less available to plants. Other elements such as aluminium (Al), iron (Fe) and manganese (Mn) may become more available and Al and Mn may reach levels that are toxic to plants. The changes in the availability of nutrients cause the majority of effects on plant growth attributed to acid soils. Sensitive crops such as barley and lucerne can be affected by small amounts of exchangeable aluminium. Consequently, knowledge of the soil pH and associated aluminium toxicity is vital before planning to sow crops or pastures.

In contrast, when the pH($CaCl_2$) is greater than 7.5, calcium can tie up phosphorus, making it less available to plants. Additionally, alkaline soils cause zinc and cobalt deficiencies that lead to stunted plants, poor growth and reduced yields in some crops and pastures.

Soil pH trends over time

Monitoring pH changes over time is an important management tool. By comparing past and present soil tests, it is possible to see if the soil acidity is increasing over time and, if it is, to alter management methods to prevent this trend from continuing.

FURTHER INFORMATION

For further information on understanding soil pH, see the NSW Agriculture publication Agfact AC.19 *Soil acidity and liming*, and Acid Soil Action Leaflets 3 to 6, and the chapter on soil chemistry in *Soils: Their Properties and Management*, P.E.V. Charman and B.W Murphy (eds), second edition, (Oxford University Press, Melbourne).

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This leaflet is one of a series on Acid Soil Management, prepared for the New South Wales Acid Soil Action Program by Belinda Lake, Acid Soils Project Officer, Yanco, June 2000

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