SOIL ACIDITY (pH)

Soil acidity, or its pH value, refers to the relative proportion of hydrogen (H^+) ions and hydroxyl (OH^-) ions in solution in the soil water. A low pH indicates a high concentration of H^+ ions, and greater acidity, and conversely, a high pH indicates a low concentration of H^+ ions, and lower acidity (higher alkalinity). A pH meter measures acidity on a logarithmic scale:

1.....7.....14
Acid Neutral Alkaline

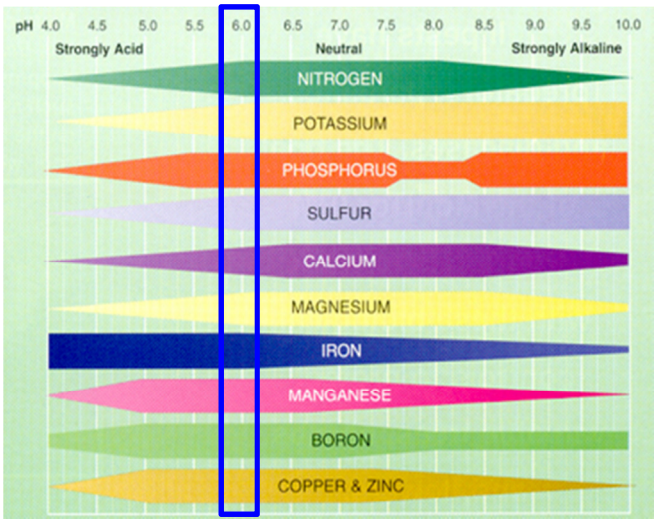
At the midpoint of the range (pH 7), the acidity is neutral because the H^+ ions and OH^- ions are present in equivalent numbers, and so cancel one another out. A soil with a pH of 5 (acid) has ten times the number of H^+ ions in solution as a soil with pH 6 (moderately acid) and 100 times as many as a soil with a pH 7 (neutral). Soil pH is measured using a pH electrode in a 1:2 (by volume) mixture of soil and distilled water.

Different species of plants have different pH ranges for best growth conditions (see figure below left).

PLANT	OPTIMAL pH RANGE
Cereals	
Wheat	5.5 – 6.5
Barley	5.8 - 6.5
Oats	5.0 – 6.5
Pasture	
Ryegrass	5.5 – 6.5
White clover	5.6 – 7.0
Red clover	6.0 – 7.0
Lucerne	> 6.0

When the pH drops below the optimal (desirable) range, a number of problems can develop e.g. nutrient availability, low biological activity (especially bacteria and earthworms) and often poor soil structure and low aeration. Conversely, if the pH is too high, similar problems can also result e.g. nutrients may also become less available, biological activity can decline (especially fungi), and the release of elements from weathering minerals may be reduced.

It is important to realise there are some limitations with soil pH testing. The topsoil generally has a higher pH than lower down the soil profile in the subsoil. An acid subsoil can be a problem, especially with some deep rooting species e.g. Lucerne - which is susceptible to high availability of aluminium. Soil pH is a bulk measurement but there will always be some variation in patches or different areas of paddocks. pH is generally lower around plant roots. The gut of some soil animals (including earthworms) can reach a pH of over 10. This aids the release of nutrient elements which would otherwise be relatively unavailable in an acid soil.



The figure to the left illustrates how the soil pH impacts the availability of some common soil nutrients. As a general rule, within a pH range of 5.8-6.2 (6.0 +/- 0.2) most of the agronomically important nutrients are at their greatest overall availability.

Below pH 5.6 there is increasing availability of elements which are less desirable in soil solution because they can be detrimental to plant growth i.e. aluminium, manganese & iron. Therefore, as a general rule, it is best to maintain soil pH above 5.6 if possible.

Lime (calcium carbonate) applications are commonly made to lift soil pH. The calcium carbonate in Aglime (granular lime) comprises calcium cations and carbonate anions. After Aglime has been applied and assimilated into the soil, it works to lift soil pH as the carbonate anions combine with, and neutralise, the hydrogen (H^+) ions present in the soil.

However, there is more to good soil fertility than just getting the pH right by applying lime. Calcium is a major soil cation nutrient, along with magnesium and potassium, and to a lesser extent sodium. Maintaining these cations in the soil in proper proportion will aid crop quality and yield, as well as pasture production and, perhaps most significantly, stock health.

Soils vary as to the amount of lime required to lift pH. Generally soils with a high cation exchange capacity, and thus with a large number of H^+ ions on the cation exchange system, will require more lime to lift pH than soils with a lower CEC.

The application of fine lime (limeflour) is generally an ineffective way to lift overall soil pH. On the other hand, applications of fine lime are an extremely effective way of providing highly available calcium to the soil, and thus boosting the rapid release of calcium (usually not obtained through bulk Aglime applications) into the soil solution. This promotes a temporarily high pH in the soil solution with resultant benefits to plants, nutrient availability and soil organisms. Most importantly, the lift in soil solution calcium boosts earthworm, fungi and other soil organism activity and numbers, resulting in immediate and long term beneficial effects in the soil.

Applications of Aglime and fine lime are both beneficial to a soil, but for different reasons. Aglime is required to lift the soil pH through the bulk soil in the long-term, whilst fine lime is applied to boost short term calcium availability to the soil solution, and the resultant benefits just outlined. Generally, a soil which has been "activated" by the application of fine lime will be better able to assimilate the particles of Aglime and thus obtain a better result when Aglime is applied, than a soil which has not had a fine lime application.

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