Back to soil pH basics

Nutrient Availability

Trees require varying quantities of different nutrients at certain stages of development. If any essential nutrient is not available when required, growth and physiological functions can be impacted, reducing the viability and longer-term production capability of the tree. Soil pH influences the availability of plant nutrients in the soil and biological activity. Often nutrient availability is constrained by the pH of soils being too acidic or alkaline.

What is pH?

The soil pH is a measure of the alkalinity or acidity of the soil. In technical terms, pH is a measure of the hydrogen ions (H^+) in the soil solution. It is expressed as a logarithmic scale where a soil with a pH of 4 is 10 times more acidic than a soil with pH 5 and 100 times more acid than soil with pH of 6 (Figure 1). In a soil that is acidic (<6.5pH) there is a high concentration of hydrogen ions, whereas an alkaline soil (> 7.5 pH) has a low concentration of hydrogen ions. Most soils have a natural pH range of between 3.5 and 10, but this will vary between regions, based on rainfall and soil types.

The parent material of the soil, and the different weathering processes that act on it, affect the pH overtime, generally by increasing the acidity. This includes climate, vegetation, topography, and age. There are also agricultural practices that increase soil acidity.

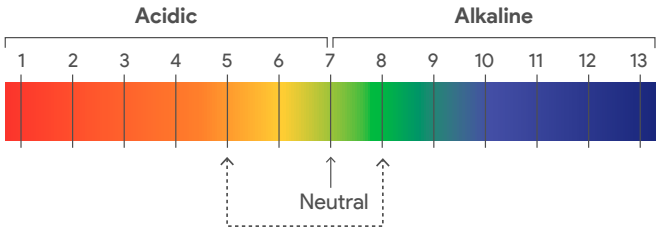

Figure 1. The pH scale ranges from 0-14 and 7 is neutral (Source: NSW Local Land Services, 2020)

Key points

- Nutrients are necessary for plant growth.
- pH effects the availability (undersupply or oversupply) of nutrients from the soil to the plant.
- There are two categories of plant nutrients: macronutrients and micronutrients.
- The major nutrients, or macronutrients, supplied by the soil are nitrogen (N), phosphorus (P), potassium (K), sulphur (S), magnesium (Mg) and calcium (Ca).
- The minor nutrients, or micronutrients/ trace elements, supplied by the soil are molybdenum (Mo), copper (Cu), zinc (Z), manganese (Mn), iron (Fe), boron (B), nickel (Ni) and chlorine (Cl).
- Fertilisers are used to overcome nutrient deficiencies and to replace the nutrients that are lost or removed from soil and pasture.
- Nutrient cycling (soil-plant-atmosphere) involves nutrients:
  - Being brought onto the farm in various forms.
  - Undergoing ongoing reactions in the soil.
  - Being used by the trees.
  - Being lost to the farm system by various means.
- A deficiency in any one of the 14 essential nutrients will reduce optimal tree growth and production.

How does pH affect plant growth?

The soil pH can impact the amount of each nutrient that is soluble in soil water and therefore the amount of nutrient that is available to the tree. Depending on individual nutrients, some are more available under acidic conditions, whereas other nutrients will be more available in alkaline conditions. The majority of major nutrients essential for tree development are readily available at a neutral pH (5-8 pH). Figure 1 shows the availability of different nutrients at different pH levels within the soil.

Figure 2 shows that when the bars are thicker, the greater the availability of that nutrient, across pH ranges.

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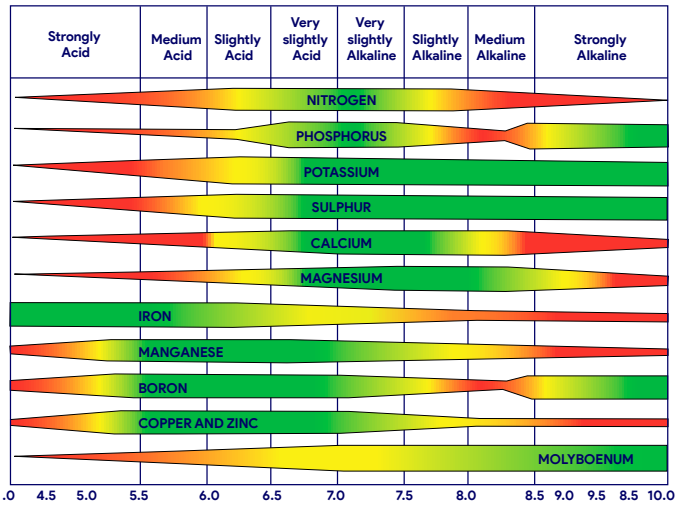

Figure 2. How soil affects availability of plant nutrients (Source: www.agrobest.com.au)

Most soil in the Northern Rivers of NSW is acidic, with a pH of around 4.5-5.5. This can result in poor plant growth as a result of one or more of the following:

Aluminum toxicity

When pH drops below 5.5, the clay minerals will dissolve and release aluminum into the soil. This can cause aluminum toxicity and restrict root growth, which is the main source for uptake of water and nutrients and can lead to poor plant growth.

Soil test indicators → aluminum of > 15mg/kg

Manganese toxicity

At pH below 5.5, manganese will become very soluble within the soil solution. This can lead to manganese toxicity within the plant. Toxicity will occur on very acid, poorly drained and water- logged soils.

Soil test indicators → extractable manganese > 45mg/kg

Calcium deficiency

Calcium deficiency can affect both plant growth, and soil physical characteristics. Calcium within the soil will displace sodium and magnesium from the exchange, improving soil structure, flocculation and aeration of the soil.

Soil test indicators → Exchangeable calcium <5cmol/kg → Calcium Magnesium ratio ideally 2:1 → Calcium saturation <80%

Magnesium deficiency

Acidic soils have a low capacity to absorb magnesium due to excess leaching, especially where cation exchange capacity is low.

Soil test indicators → Exchangeable magnesium < 1.0cmol/kg

What can I do about a low pH?

Lime is a soil amendment that can be used to increase your pH from an acidic soil to a more neutral soil. To work out how much lime to apply to your soil, identify the base pH of your soil through a soil test, then use Table 1 to calculate the amount of lime to apply.

Table 1

Limestone required to lift the pH of the top 20cm of soil to 5.2 (Source: NSW DPI, 2005)

Soil test ECEC (meq/100 g)	Lime required (t/ha) to lift the pH of the top 10cm:			
	from 4.0 to 5.2	from 4.3 to 5.2	from 4.7 to 5.2	from 5.2 to 5.2
1	1.6	0.8 *	0.3 *	0.2 *
2	2.4	1.2	0.5 *	0.4 *
3	3.5	1.7	0.7	0.5 *
4	3.9	2.1	0.9	0.6 *
5	4.7	2.5	1.1	0.7
6	5.5	3.0	1.2	0.8
7	6.3	3.3	1.4	1.0
8	7.1	3.8	1.6	1.1
9	7.9	4.2	1.8	1.2
10	8.7	4.6	1.9	1.3
15	12.5	6.7	2.8	1.9

* It is recognised that low rates of lime are impractical to apply, but over liming can cause nutrient imbalances, particularly in these light soils.

Key: Limestone rates per hectare

0.5 t/ha	1.0 t/ha	1.5 t/ha	2.0 t/ha	2.5 t/ha	3 to 4 t/ha	Split applications advised

References

GRDC, Focus on calcium: *Its role in crop production* (2013), Accessed on the 15/10/2021: Focus on calcium: Its role in crop production - GRDC

Incitec Pivot Fertilisers (2017) *Soil Acidity Agritopic*, Accessed on the 15/10/2021: 35 Soil Acidity Agritopic (incitecpivotfertilisers.com.au)

Incitec Pivot Fertilisers (2017) *Manganese Agritopic*, Accessed on the 15/10/2021: 24 Manganese Fact Sheet (incitecpivotfertilisers.com.au)

NSW Department of primary industries (2005) *Agfacts: Soil Acidity and liming*, Soil acidity and liming (nsw.gov.au)

NSW Local Land Services (2020) *Soil Chemistry - Fact Sheet 3*

Queensland Government, *Soil PH*. Accessed on the 15/10/2021: Soil pH | Environment, land and water | Queensland Government (www.qld.gov.au)

Victorian State Government *Trace elements for Pastures and Animals in Victoria- Aluminium*, Accessed on the 15/10/2021O: Microsoft Word - trace elements vic pastures.doc (agriculture.vic.gov.au)

Yang M, Tan L, Xu Y, Zhao Y, Cheng F, et al. (2015) *Effect of Low pH and Aluminum Toxicity on the Photosynthetic Characteristics of Different Fast-Growing Eucalyptus Vegetatively Propagated Clones*. PLOS ONE 10(6): e0130963

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