KNOW YOUR SOIL TEST

Soil tests are an important way to measure physical, chemical and biological properties of your soil as indicators of your soil health. Soil analysis can identify amount and availability of nutrients, existing or potential soil constraints to plant growth, and help guide practices such as fertiliser requirements or crop suitability. Regular testing can monitor how soil properties may change with different management activities. Understanding how to interpret a soil test is beneficial economically and environmentally. This will help make cost-effective management decisions to optimise plant growth, minimise movement of fertiliser away from the root zone, and maintain or improve overall soil health.

The key tests that will appear on your soil analysis results and what this means for your plant growth, are outlined below. Links to additional resources are also provided.

Soil texture

Soil texture is the percentage of clay, silt and sand in a soil, which determines the soil textural type. E. g. A soil with 55% sand, 15% silt and 30% clay is classed as a clay loam. Soil texture is determined either by hand (e.g. ribbon test in the field) or by using Mid Infrared Spectroscopy (MIR or MIRS). Texture is important in determining how much water and air a soil can hold which influences processes such as infiltration and can influence how we manage (work) the soil. We sometimes refer to soils as light (high in sand) or heavy (high in clay). Light soils tend to allow water to penetrate and drain more freely compared to heavier soils. The clay content in a heavier soil can improve soil nutrient retention and availability for plant growth.

Soil Properties: Soil Texture

Soil Texture

pH

Soil pH is a measure of the acidity or alkalinity of the soil solution, and influences availability of nutrients, and subsequent deficiencies or toxicities. The two standard tests are pH (water) and pH (calcium chloride). pH calcium chloride generally measures 0.7 – 1. 2 units lower than pH water, this test is considered more reliable with less variability throughout the season. Plants generally favour a pH in a range around neutral (pH 7). A soil pH can be influenced by management. Addition of mineral and organic fertilisers can lead to an acidification (lowering of the soil pH to values below 7) of the soil over time, as can the removal of pasture and crops, because both of these processes can lead to an increase in hydrogen ions. The pH can be brought back up by the addition of lime (or dolomite). In some instances, the soil pH may become more alkaline (higher than a pH of 7) over time. This is often seen in areas where irrigation is used and the local geography is rich in limestone, which naturally adds lime to the system. If a soil is deemed to be too alkali, then adding elemental sulphur will bring the pH down.

Soil Acidity

Effects of Soil Acidity

Territory Natural Resource Management

This project is supported by TNRM through funding from the Australian Government's National Landcare Program.

Australian Government National Landcare Program

une University of New England

Soil carbon

Soil carbon is measured either with combustion (LECO) or with wet chemistry (Walkley-Black) methods. Both methods present results as a percentage of carbon in the soil. Soil organic carbon (SOC) is important for many soil processes. Australian soils have relatively low (around 1%) SOC. We use SOC measures to estimate soil organic matter (SOM) which plays a vital role in adsorbing nutrients. SOM is composed of approximately 58% SOC, so the SOC value is normally multiplied by 1.72 to get an estimate of SOM. There is some debate about what conversion factor should be used, so if comparing results from different labs either just use the SOC or make sure the same conversion factors were used.

How to Measure and Interpret Results in Relation to Soil Organic Carbon

Soil Carbon Sequestration

Soil Carbon Snapshot

Nitrate and Ammonium (N)

Crops have various demands for nitrogen (N), so knowing the content in your soil can help with planning your fertiliser requirements. Nitrate and ammonium are indicators of the available N in your soil. N, as either nitrate or ammonium, is a very mobile element in the environment, so if there is more N in a field than a crop needs or can access, it is at risk of being lost to the environment. Therefore, getting your N budget and application rates right can not only be good for your wallet, but also the environment. As a rough guide, values of around 10 mg/kg or ppm are generally considered adequate for pasture with values nearer to 20 mg/kg or ppm for horticultural and broad acre production.

Soil Nitrogen Supply

Nitrogen Decision - Guidelines and Rules of Thumb

Phosphorus (P, Colwell and BSES)

Phosphorus (P) is another nutrient that is essential for plant development. We normally assess the available form in the soil using the Colwell test. P is generally immobile in the soil environment, so applications of P may not be instantly seen in the current crop. P also interacts with clay and organic matter, which influence the Phosphorus Binding Index that you may also see on your soil test. The higher the PBI then the more P you have to add to your systems to overcome this inherent buffering and provide more P to your plants. P availability is also influenced by pH with both high and low (alkaline and acidic pH) changing how P will bind to the soil, thus altering its availability. Some soil tests present a BSES soil P result. This is useful to undertake and monitor as the BSES pool (where the P is assessed from a weak acid recovery) tops up the available (Colwell P) soil pool of P. If you continue to crop without replenishing the removed P then you are effectively mining the BSES pool, which when it becomes depleted will present as a sudden loss in yield.

How Do I better Manage Phosphorous for Pasture Growth in Light Sandy Soils?

Why Phosphorous Is Important

Sulfur (S)

Sulfur (S) is another essential element required by plants to make amino acids form proteins. It is also important in plant defence systems. Much of the plant-required sulfur comes from the turnover of organic matter in the soil (mineralisation) so replenishing the S that is removed in crops and livestock should be considered. We are applying mineral S when we fertilise with ammonium sulphate (AS) or single superphosphate (SSP). Many of our soils show low S levels, due in part to their low soil organic matter content and our global efforts to reduce sulfur emissions from manufacturing, which was a major cause of acid rain. As such, S deficiency may be something you might encounter. When replenishing sulfur it is worth remembering that it is a mobile element in your soils, so aiming for soil levels around 7 to 12 mg/kg, depending on soil type, can help you retain what you replenish.

Potassium (K)

Potassium (K) is another essential element, the source of which in the soil is normally derived from the parent rock. In the soil it exists in available forms that are adsorbed to the soils cation exchange surfaces (CEC) and in a range of mineral forms, which are less available. Because K's availability is influenced by the soil's CEC, the soil type (texture) can influence this. The amounts desired in soils for different crops is not a constant, so speak to your local agronomist for guidance on target values. As with P, applied K is fairly immobile in the soil so timing and placement of applications are important.

Potassium

Trace elements

Boron (B), Copper (Cu), Molybdenum (Mo), Iron (Fe), Zinc (Zn), Manganese (Mn), Chlorine (Cl) and Sodium (Na)

Trace elements are essential nutrients for plants, however these elements are only needed in small amounts. Trace element deficiency in Australia is believed to be the major cause of yields not reaching their expected potential. So if your soil (or tissue) test suggests a trace element deficiency, consider either adding some to your soil fertiliser regime or applying a foliar if the crop is already out of the ground.

Trace Elements and Remineralisation of Your Soil

Salinity (EC)

Salinity (Electrical Conductivity) is the measure of the salts in the soil solution. High levels of salts can affect the ability of plants to recover water from the soil. Soil salinity is measured in a soil suspension and reported as either deci- or micro-Siemens (dS/m or mS/m, respectively, with 1 dS/m = 100 mS/m). Salts exist as a cation and an anion in a single molecule, with the most common salt being sodium chloride (NaCl). Sodicity (see CEC) and salinity are not the same and are not always found together. Salinity can occur for different reasons, but rain brings salts into our landscape every year and rising groundwater can also bring salts back into our crops rooting zones. Knowing what your environment is more prone to can help with management, as can crop selection if a soil is known to be sodic.

Salinity

Measuring Soil Salinity

Cation Exchange Capacity

Cation Exchange Capacity (CEC) is the ability of the soil to hold exchangeable cations (positive charged particles), and has a significant influence on nutrient availability and soil pH. It is the soil's 'nutrient magnet'. Soil analysis reports may present an Effective CEC result (ECEC). CEC is associated with the presence of clay and organic matter components of the soil that adsorb and hold the positively charged nutrients, which are then used by plants. Sandy soils have low CEC with corresponding low nutrient and water holding capacities. The most common cations are aluminium, calcium, magnesium, potassium and sodium. The ratio of these cations, discussed below, is also an indicator of soil nutrient availability.

Cation Exchange Capacity

Calculating Cation Exchange Capacity, Base Saturation, and Calcium Saturation

Exchangeable cations/ Ca:Mg ratio/ K:Mg ratio

Exchangeable cations are generally assessed using Ammonium acetate method (AmmAc) and different labs will present the results in different ways and often provide both an amount and a percentage of the total. The soil and the situation may determine what we want to gain from knowledge of our cations. If you are worried your soils are sodic, then you want to know if your sodium (Na) as a percentage of cations is above 6% at the surface or 15% at depth. There is an interaction with salts, so this is a guide value only. Generally, we expect Ca to be the dominant cation. The calcium:magnesium (Ca:Mg) ratio, which if less than 2:1 might indicate a reduction in soil structure, but this is no longer thought to be as widely applicable as initially proposed. However, a Ca:Mg ratio of around 10:1 would suggest possible magnesium deficiencies (see Trace elements). In pastures, a magnesium:potassium (Mg:K) ratio of less than 1.5:1 could also indicate magnesium deficiency.

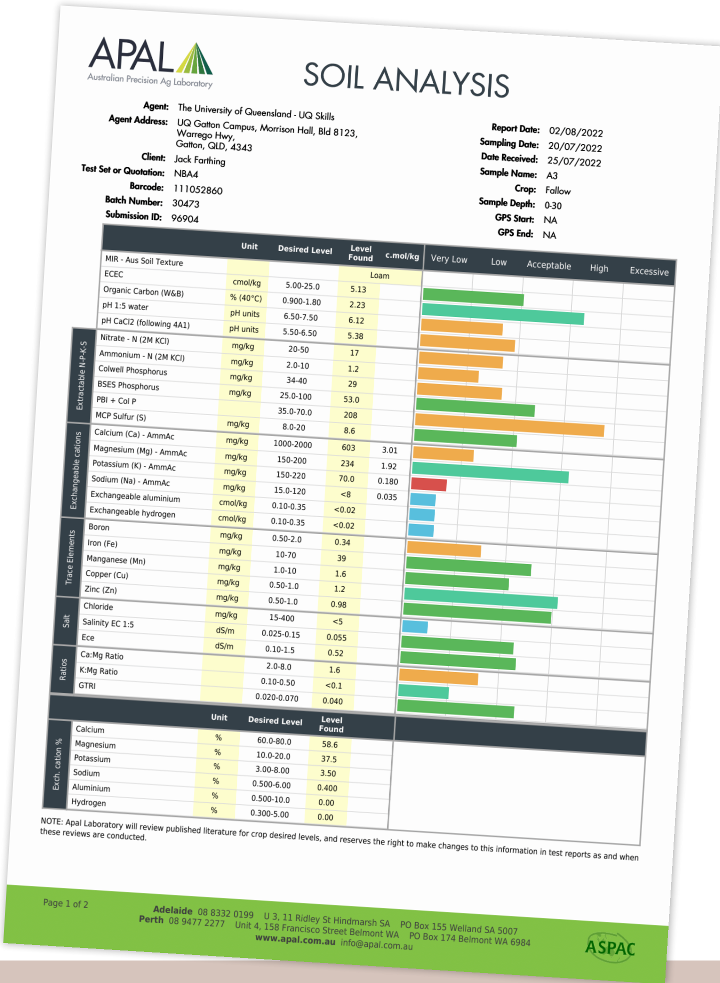
Interpretation of analysis

Different labs may use slightly different tests and may present results in different units, so being able to understand these differences can be important. If you are unsure then it is worth talking to the lab, because most will help you understand the results and some will present results in the format you desire. It is important that you use an accredited lab, so look for the National Association of Testing Authorities (NATA) and Australian Soil and Plant Analysis Council (ASPAC) accreditations.

In most cases the reported values are conserved between labs making interpretation easier, but in some cases units can be interchanged. This means we have to ensure we are comparing like with like. Some of the different units reported in a soil test could include %, pH, dS/m and mS/m, mg/kg, mg/l, cmol/kg, meq/100g. Knowing a little about what these units are and how they are related can be useful if you change laboratories or want to compare your information with other data reported in different units. Several of the key nutrients are generally reported as mg/kg and we have guidance values based on these. pH is a log measure of the Hydrogen ions, but the only thing we compare pH to is other pH values. DeciSiemens and microSiemens are the measure of salt, so just be sure you have the same unit or remember there are 100 mS/m in 1 dS/m. Percentages are just a fraction of one measure over another. In the case of soil carbon this is the amount of C per kg of soil. For CEC it is the percentage of the cation of interest over the total amount of aluminium, calcium, magnesium, potassium and sodium.

Most labs will provide results indicating a desired level compared to the level found from your soil test. This provides an indication of whether your soil has very low, low, acceptable, high, or excessive amounts of the trait being compared (e.g. Nitrogen, Zinc, Organic Carbon or Exchangeable cations). This can then help inform you how to manage your soil to ameliorate the problem, such as a specific fertiliser, and tailor rates to your production system. Using soil tests can be a valuable tool in making cost-effective management decisions to improve your soil health and farm productivity.

Example of soil test results (Credit from Australian Precision Ag Laboratory)



APAL Australian Precision Ag Laboratory

SOIL ANALYSIS

Agent: The University of Queensland - UQ Skills
Agent Address: UQ Gatton Campus, Morrison Hall, Bld 8123, Warrego Hwy, Gatton, QLD, 4343
Client: Jack Farthing
Test Set or Quotation: NBA4
Barcode: 111052860
Batch Number: 30473
Submission ID: 96904

Report Date: 02/08/2022
Sampling Date: 20/07/2022
Date Received: 25/07/2022
Sample Name: A3
Crop: Fallow
Sample Depth: 0-30
GPS Start: NA
GPS End: NA

		Unit	Desired Level	Level Found	c.mol/kg
	MIR - Aus Soil Texture			Loam	
	ECEC	cmol/kg	5.00-25.0	5.13	
	Organic Carbon (W&B)	% (40°C)	0.900-1.80	2.23	
	pH 1:5 water	pH units	6.50-7.50	6.12	
	pH CaCl2 (following 4A1)	pH units	5.50-6.50	5.38	
Extractable N-P-K-S	Nitrate - N (2M KCl)	mg/kg	20-50	17	
	Ammonium - N (2M KCl)	mg/kg	2.0-10	1.2	
	Colwell Phosphorus	mg/kg	34-40	29	
	BSES Phosphorus	mg/kg	25.0-100	53.0	
	PBI + Col P		35.0-70.0	208	
	MCP Sulfur (S)	mg/kg	8.0-20	8.6	
Exchangeable cations	Calcium (Ca) - AmmAc	mg/kg	1000-2000	603	3.01
	Magnesium (Mg) - AmmAc	mg/kg	150-200	234	1.92
	Potassium (K) - AmmAc	mg/kg	150-220	70.0	0.180
	Sodium (Na) - AmmAc	mg/kg	15.0-120	<8	0.035
	Exchangeable aluminium	cmol/kg	0.10-0.35	<0.02	
	Exchangeable hydrogen	cmol/kg	0.10-0.35	<0.02	
Trace Elements	Boron	mg/kg	0.50-2.0	0.34	
	Iron (Fe)	mg/kg	10-70	39	
	Manganese (Mn)	mg/kg	1.0-10	1.6	
	Copper (Cu)	mg/kg	0.50-1.0	1.2	
	Zinc (Zn)	mg/kg	0.50-1.0	0.98	
Salt	Chloride	mg/kg	15-400	<5	
	Salinity EC 1:5	dS/m	0.025-0.15	0.055	
	Ece	dS/m	0.10-1.5	0.52	
Ratios	Ca:Mg Ratio		2.0-8.0	1.6	
	K:Mg Ratio		0.10-0.50	<0.1	
	GTRI		0.020-0.070	0.040	

		Unit	Desired Level	Level Found
Exch. cation %	Calcium	%	60.0-80.0	58.6
	Magnesium	%	10.0-20.0	37.5
	Potassium	%	3.00-8.00	3.50
	Sodium	%	0.500-6.00	0.400
	Aluminium	%	0.500-10.0	0.00
	Hydrogen	%	0.300-5.00	0.00

NOTE: Apal Laboratory will review published literature for crop desired levels, and reserves the right to make changes to this information in test reports as and when these reviews are conducted.

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ASPAC

[Soil Test Interpretation Guide]

[Understanding Soil Tests for Pastures]

[Result Interpretation]

Territory Natural Resource Management

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