SOIL TESTS FOR SALINITY

Introduction

Soils can become saline when they accumulate salts, with an adverse effect on plant growth and soil structure. High salt soils occur naturally in some places (arid inland soils, coastal soils) but may also be a result of human activity such as application of excessive fertiliser or wastewater containing high levels of salts. In general, soil salinity occurs only in semi-arid conditions where high evapo-transpiration rates means the salts become concentrated in the surface soil. Saline irrigation water may also be a cause of soil salinity and crop damage.

Some plant species are more tolerant of salts than others but many crop and pasture plants will suffer a reduction in growth and productivity and may develop toxicity symptoms. Crops such as barley and fodderbeet are tolerant to sodium and chloride, whereas most clover species and maize are considered sensitive.

It is important to identify saline areas so these soils can be managed appropriately, such as with application of gypsum.

Soluble Salts

The standard test for soil salinity is made by measuring the electrical conductivity (EC) of a 1:5 soil:water extract. For soils with high levels of salts, a high electrical conductivity will be observed in these extracts.

The EC is measured as mS/cm (=dS/m) in the extract and converted to Soluble Salts % by equation.

SS% = EC (mS/cm) x 0.35 (assumes an approximate relationship between EC and salts as 700mg/L)

For glasshouse soils, there is a special, modified test available i.e. a 2:5 soil:saturated calcium sulphate extraction. This is to avoid solubilising solid calcium sulphate residues present as a result of intensive fertiliser applications.

Level	Glasshouse Soils (%)	Field Soils (%)
Low	<0.10	<0.05
Normal	0.10 - 0.20	0.05 - 0.30
High	0.20 - 0.40	0.30 - 0.70
Very High	>0.40	>0.7

Saturated Paste Extract

As the soluble salts test is measured on a diluted extract, a more realistic measure of the actual salt levels encountered by plant roots in the soil solution is achieved by doing a ‘saturated paste extract” (SPE). The SPE method is a procedure where the soil is brought just to the point of saturation, and the resultant extract obtained by vacuum-filtration. This extract is therefore much less diluted than alternate routine methods and is thought to more closely resemble the soil solution occurring naturally in the field.

The Saturated Paste Profile reports nutrients (phosphorus, potassium, calcium, magnesium, sodium, nitrate-nitrogen and ammonium-nitrogen) and also Total Soluble Salts, Sodium Absorption Ratio (SAR) and Potassium Absorption Ratio (PAR). It should be noted that these solution nutrients are generally only a small fraction of the plant-available pool and are not good predictors of plant yield i.e. this test does not replace the Basic Soil profile tests for nutrient management decisions.

NOTE: The saturated paste profile requires a very large sample to be submitted as it requires ~ 300g dried & ground sample for this group of tests (about 500g fresh soil). It is a very labour-intensive test in the laboratory and as such is considered a non-routine test designed for special investigation purposes only.

Soils with total soluble salts in the saturated paste extract of less than ~1000 mg/L (EC_{spe} <1.5 mS/cm) are unlikely to cause salinity issues unless for very sensitive crops (ref 5 & 6).

Sodium Absorption Ratio

The sodium absorption ratio (SAR) is a measure to assess the potential of excess sodium to cause structural damage to soil. Excessive levels of sodium in the soil can destroy its structure (soil sodicity). Sodium deflocculates the soil, resulting in a soil which dries into large hard clods separated by a few wide, deep cracks. A deflocculated soil has very undesirable physical properties, for example, decreased water permeability.

The structure of many irrigated soils will become unstable when exchangeable sodium exceeds 15 percent of the soil's total cation exchange capacity. The exchangeable sodium test is included in the Basic Soil profile, reported as sodium base saturation (Na BS%).

The sodium hazard involved depends on both the exchangeable sodium level and the sodium absorption ratio; problems increasing when the SAR exceeds 6. If irrigation water contains a high level of sodium, soil testing will reveal any build-up of sodium in the soil.

The SAR expression is calculated by the equation shown (concentrations of Na, Ca and Mg as mg/L in the saturated paste extract):

$$SAR = \frac{Na/22.99}{\sqrt{\left(\frac{Ca}{40.078} + \frac{Mg}{24.305}\right)}}$$

On request by customers managing land receiving potassium-rich wastewater, a calculated Potassium Absorption Ratio (PAR) has also been made available.

The PAR expression is calculated by the equation shown (concentrations of K, Ca and Mg as mg/L in the saturated paste extract):

$$PAR = \frac{K/39.098}{\sqrt{\left(\frac{Ca}{40.078} + \frac{Mg}{24.305}\right)}}$$

Recommended Tests

For initial assessment of suspected soil salinity or where routine monitoring of soils is required e.g. soils receiving wastewater on a regular basis, then the recommended approach would be to request the Basic Soil Profile + Soluble Salts tests. For special investigations the Basic Soil Profile and Saturated Paste Profile, or SAR and PAR only tests can be requested. Note, as stated above, a minimum of 500g fresh soil is needed for tests carried out on a saturated paste extract.

References

1. Handbook of Reference methods for soil analysis. Council on Soil Testing & Plant Analysis, Georgia University.1992
2. Soil Testing and Plant Analysis 3rd ed. Soil Science Society of America Book Series. Wisconsin, USA 1990. p306-308
3. Page, A.L. et al (1982). Methods of Soil Analysis. Part 2 - Chemical and Microbiological Properties. Second Ed. Am. Soc. Agron. p167.
4. Blakemore, L.C., Searle, P.L., Daly, B.K. 1972. Methods for chemical analysis of soils. New Zealand, NZ DSIR. (NZ Soil Bureau Scientific Report 10A. p A9.1.
5. Waitling, K. Measuring salinity. Factsheet L137. Natural Resources and Water, Queensland Govt. June 2007.
6. Russell, E.W. (1973). Soil Conditions and Plant Growth 10th ed. Longman Group, London.p749-753
7. Laurenson, S., Bolan, N.S, Smith, E., McCarthy, M. Soil structural changes following irrigation with a potassium rich winery wastewater.