Hill Laboratories
BETTER TESTING **BETTER RESULTS**

TECHNICAL NOTES

LABORATORY TESTS FOR SOIL POTASSIUM

Introduction

Potassium (K) is one of the most abundant elements in the earth's crust and is found in many of the primary minerals e.g. micas, feldspars and in the 2:1 type soil clays. It is an essential plant nutrient with roles in electrical balance, cell-water regulation and enzyme activity e.g. activation of protein and starch synthesis within the plant. Potassium is also necessary for the development of cellulose and lignin – giving strength to the plant so it can stand upright. Root and tuber development in crops such as potatoes also requires adequate potassium. As well, potassium is an essential element for animals, maintaining osmotic pressure in cells and enabling ion transfer across cell membranes.

Plants require relatively large amounts of potassium, with most of the demand in the vegetative growth stage. Potassium is highly mobile in the plant, translocating from the older leaves to the younger growing tips as required i.e. deficiency symptoms would appear in the older leaves first. Symptoms are generally chlorosis and necrosis beginning on the leaf margins and tips, although in clovers K deficiency may present as white spots on the leaves.

Potassium occurs as either common salts or as salts of organic acids and is highly soluble. Unlike nitrogen, sulphur and phosphorus it does not form organic compounds with C, H and O – so 'organic K' does not exist even though K within plant and microbial material does get returned to the soil.

Potassium in the soil occurs as four distinct fractions:

1. Soil solution K (0.1-0.2% total K) – readily plant available
2. Exchangeable K (1-2% total K)– readily plant available
3. Tightly-held or "Fixed" K (1-10% total K) – slowly plant available
4. Structural mineral K (90-98% total K) – almost completely unavailable to plants

The soil solution and exchangeable pools of K are usually very small relative to the total pool and are either taken up by plants or leached in the drainage water. Leaching of K will be partly dependent on the Cation Exchange Capacity (CEC) of the soil, with high CEC soils having lower K losses in general. Leaching losses are accelerated where high inputs of calcium (Ca^{2+}) displace K^{+} from the exchange sites.

The soil minerals provide the majority of the soil K as they are broken down by weathering; the rate of release dictated by the amount and type of mineral present (see Fig 1). "This interlayer K is often referred to as being fixed. However, as these soil minerals are exposed to the actions of weathering and dissolution, the layers are 'peeled' away, allowing some substitution of K by other, often larger, hydrated cations. This also allows greater access to the K ions that still reside within the 'wedge' zones" (Carey, 2003)

Hamilton
1 Clyde Street
Hamilton 3216
Private Bag 3205
Hamilton 3240
New Zealand
T +64 7 858 2000
F +64 7 858 2001

Christchurch
101c Waterloo Road
Hornby Christchurch 8042
PO Box 16607
Christchurch 8441
T +64 3 377 7176
F +64 3 377 7276

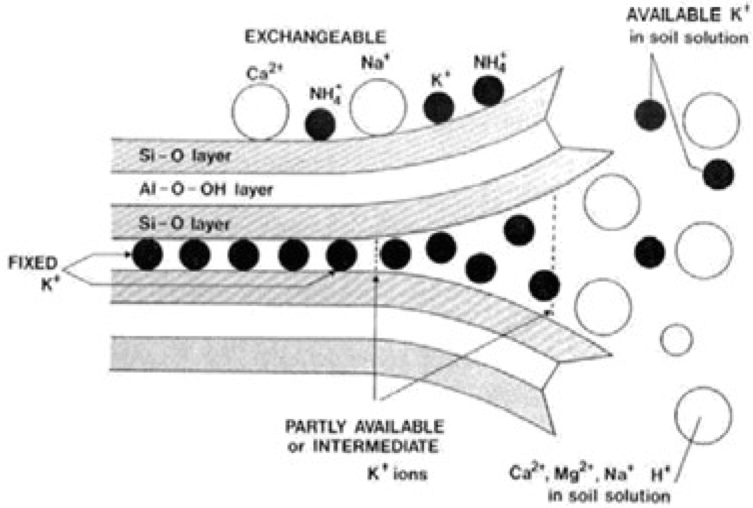

Fig 1. Representation of mica showing interlayer K positions (McLaren & Cameron 1990).

Laboratory Tests for Soil K

For agronomic purposes, useful soil tests for managing crop requirements of K are the tests that measure the Exchangeable and the Reserve K fractions.

Exchangeable K [K] is measured by extraction in neutral 1M Ammonium Acetate, whereby the $NH4^{t}$ ions displace K^{t} ions from the exchange sites on the soil. This test will also measure the solution K but as this is usually very low the fraction measured is almost entirely the exchangeable pool.

Reserve K [TBK] is a measure of the potassium supplying power of a soil and is recommended particularly on sedimentary soils. At Hill Laboratories it is now measured by extraction with sodium tetraphenylboron (NaTPB) – precipitating K as KTPB allowing soil minerals to dissolve at a faster rate than normal. Prior to August 2010, an alternative test measuring reserve K by sequential extraction with boiling nitric acid was used but the TBK test has been adopted as it is an input into the Overseer model and is more widely referred to in NZ scientific papers. The TBK test now being used is a modification of the Jackson Test (JT) as this test gave problems in the laboratory. The current test has however been correlated with the JT test so that similar interpretive criteria can be used.

Effluent paddocks

While plants require quite high levels of K (~3-5%), animals do not (~1-2% in forage ingested) and the extra K is excreted largely in the urine. This can create hot-spots of K in a paddock from individual urination events, but is also important for paddocks receiving effluent.

Effluent paddocks should be soil-tested separately from other monitoring paddocks and managed to minimise the risk to animal health e.g. by making silage or growing crops on these paddocks and feeding the resultant feed elsewhere on the farm. Additional K fertiliser would rarely be required on these areas.

References

1. *Carey, P.L (2003); NZ Soil News; Newsletter Vol. 51, No6 "To test or not to test? – that is the (reserve K) question".*
2. *McClaren, R.G & Cameron, K.C. (1990); Soil Science – an introduction to the properties and management of New Zealand soil. Auckland, Oxford University Press. pp228-232*
3. *Course Notes (2005) : Sustainable Nutrient Management in NZ Agriculture, FLRC (Massey University) and FMRA*

Contact Details

For further information about any of the above tests please contact our client service managers.

Fiona Calvert	Agriculture Division Client Services Manager	fiona.calvert@hill-labs.co.nz
Janice Christiansen	Agriculture Division Client Services Manager	janice.christiansen@hill-labs.co.nz
Nevan Ofsoski	Agriculture Division Client Services Manager	nevan.ofsoski@hill-labs.co.nz
Jane Smillie	Agriculture Division Client Services Manager	jane.smillie@hill-labs.co.nz