Technical Note

CALIBRATION DATA FOR SOIL TRACE ELEMENT TESTS IN NZ

If used appropriately, soil trace element tests can make a useful contribution to the assessment of a farm's mineral status.

Soil testing for trace elements has had a somewhat chequered history in New Zealand. For the results of soil tests conducted in a laboratory to have practical value, they need to be calibrated against plant responses, in glasshouse and/or field trials, with consideration of all factors that influence trace element availability to plants.

For many years, the consensus view of many New Zealand researchers has been that soil trace element tests have been insufficiently calibrated for New Zealand conditions to be of significant benefit to farmers. For this reason, Hill Laboratories did not actively promote trace element soil testing.

Two papers presented to a conference at Massey University in 1995, however, reported on successful calibrations of trace element soil tests under New Zealand conditions. These findings suggest that trace element soil tests can play a useful role in New Zealand farm management, provided they are used in the context of other information, including the farm's mineral status.

Cobalt in New Zealand Pastoral Soils

Mike O'Connor of AgResearch reported on an extensive survey of cobalt levels both in soil (EDTA extraction) and in plant tissue (total levels), undertaken by Ag Research between 1991 and 1994 in the Central North Island and Southland regions.

This paper[i] suggested that the following levels of extractable soil cobalt were required for an 80% probability of pasture cobalt levels being above 0.08 ppm (the critical level needed by sheep).

The authors of this paper also studied the relationship between soil cobalt and manganese levels in Southland soils. Their survey confirmed that pastures were much more likely to be cobalt-deficient when soil manganese levels were high.

Region	Critical Co Level in Soil (EDTA)
	ppm
Southland	1.0
Rotorua - Taupo	1.7
King Country	2.2

Copper and Zinc in Canterbury Cropping Soils

Dr. Dick Haynes of NZ Institute for Crop and Food Research, Lincoln, reported[ii] on a study of Cu, Zn, and Mn levels in 44 fields used for growing winter wheat in the Central Canterbury region.

He was particularly interested in Cu and Zn levels, and studied winter wheat grown for 6 weeks in greenhouse trials, and its response to the application of additional Cu and Zn. His study found that these trial plants grew significantly better when levels of soil Cu exceeded 0.8 µg /g (EDTA method) and soil Zn exceeded 1.1 µg /g (EDTA method). These are very similar to critical levels published by overseas researchers.

Of added interest was that Cu and Zn deficiencies were not observed in plant matter sampled from winter wheat crops growing on these same Cu and Zn deficient soils. Dr. Haynes suggested that "the long growing period (i.e. 8 months) probably enables the crop to extract sufficient micronutrients.... In comparison, under greenhouse conditions the crop grows extremely rapidly (over only 2 or 3 months) and as a result the nutrient-supplying capacity of the soil is placed under stress and Cu and Zn deficiencies are induced."

For more information, freephone 0508 HILL LAB 44 555 22 mail@hill-labs.co.nz hill-labs.co.nz

A Plea For Caution

This laboratory now accepts that trace element soil testing does have a valid place in New Zealand agriculture, and we now offer the tests shown over-leaf on a routine basis. We continue to recommend caution in their interpretation, however. As with all soil tests, soil trace element results should only be considered as indicators – with considerable uncertainty still associated with them.

- **Other Factors MUST Be Considered**

Factors such as soil types, plant species, the levels of other soil elements, the soil's physical structure, pH and moisture status, and even seasonal weather patterns can all have a significant influence on soil trace element availability. For example, manganese and iron become less available as pH is raised, and can exist in more than one chemical form, depending on the drainage of the soil.

- **Very Low Levels Involved**

Some of the elements (e.g. Mo, Co, Se) are required in the plant at levels less than 1 part per million For a soil test alone to predict whether an element will be in adequate supply to a plant or animal is a tall order!

For these reasons we strongly encourage our clients to conduct herbage tests before considering trace element nutrient applications. Herbage testing is many times more reliable because it measures the levels of trace elements that the plant itself is actually extracting from the soil. In the case of pastoral farms, testing the animals directly (with either blood samples, or liver biopsies) provides even greater accuracy in the assessment of trace element deficiencies.

- **When To Use Soil Trace Element Tests**

All laboratory analyses (whether of soil, herbage, or animals), together with visual observations and local knowledge, can be regarded as pieces of information to be considered when assessing the mineral status of a property. Each piece will have greater or lesser reliability, but each may further the overall assessment.

There are situations when soil trace element tests are particularly useful, such as:

- before planting a cereal crop, a farmer might suspect that the soil is zinc deficient and use a soil test to confirm his suspicion.

- on a pastoral farm, animals might exhibit visual symptoms of cobalt deficiency, and this might be confirmed by blood tests. If herbage tests show that cobalt levels in the pasture are moderate, and soil tests indicate that cobalt levels are adequate, then these three different laboratory analyses suggest that the cobalt deficiency in the animals is not due to lack of cobalt in the soil, but other factors such as insufficient feed availability, or interactions with other elements.

EDTA Extraction versus DTPA Extraction

A variety of extraction procedures have been developed by the many researchers working in this field. The most popular approach involves the use of organic acids to 'chelate' or form complexes, which can then be measured. In the USA, the organic acid DTPA (di-ethylene penta-acetic acid) is most commonly used, whereas in the UK and New Zealand, EDTA (ethylene-diamine tetra-acetic acid) is the preferred chelating acid. We recommend the EDTA extraction because this is the method for which we have the most useful calibration data. This procedure has been recommended[iii] as the most appropriate for NZ conditions.

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Element	Recommended Extraction Procedure	General Comments	Reliability	Suggested Critical Level
Boron	Hot Water Soluble	A well established test. Good for identifying toxicity, but not well calibrated at critical level.	Good	>0.4 mg/kg sandy soil >0.5 mg/kg clay soil >5 mg/kg toxic
Copper	EDTA	Calibrated for cereal cropping in Canterbury soils	Moderate	>0.8 mg/kg
Zinc	EDTA	Calibrated for cereal cropping in Canterbury soils	Moderate	>1.1 mg/kg
Cobalt	EDTA	Extensive surveys by AgResearch provide NZ calibration data	Moderate to Good	>1.0 mg/kg Southland > 1.7 mg/kg Rotorua-Taupo >2.2 mg/kg King Country
Selenium	Nitric/hydrochloric acid ("Total")	Used for soil survey work, and correlated to Se responsive sites. If level high then deficiency unlikely; However, low level may be either deficient or sufficient.	Low	>0.5 mg/kg
Manganese	EDTA	Not as good as Cu or Zn. Other factors (e.g. soil pH, water logging) dramatically influence Mn uptake by plant.	Low	>50 mg/kg (tentative)
Iron	Not recommended	Other factors (e.g. soil pH, water logging) markedly influence Fe uptake by plant.	Poor to Nil	–
Molybdenum	Not recommended	Some soil test methods have been investigated, but results are disappointing. Mo uptake is strongly influenced by soil pH.	Nil	–

i. MB O'Connor, JD Morton, JE Waller, MF Hawke, B Addison,1995. **Soil and Plant Cobalt Status in Farm Surveys in the Central North Island and Southland**,

ii. RJ Haynes,1995. **Micronutrient Status Of A Group Of Canterbury Cropping Soils And Its Relationship With Plant Response To Applied Cu And Zn.** Both in *Fertilizer Requirements of Grazed Pasture and Field Crops: Macro- and Micro-Nutrients*. (Editors: L D Currie and P Loganathan).Occasional report No. 8. Fertilizer and Lime Research Centre, Massey University, Palmerston North, pp.286-291,292-299.

iii. **An Evaluation of the Use of DTPA and EDTA as Extractants for Micro Nutrients in Moderately Acid Soils** RJ Haynes and RS Swift, Plant and Soil, 74, 112, (1983).