

KiwiTech Bulletin No. 43

Kiwifruit Nutrient Testing

Revised May 2008

Introduction

Nutrient testing provides the information that is used in developing an orchard fertiliser programme. Soil testing and leaf analyses are the basic complimentary tools for evaluating soil fertility and the vine nutrient status. The goal is to ensure that vine growth is never limited by nutrient availability. Adequate nutrient supply is managed through timely additions of fertilizer inputs.

Soil testing

Soil tests using chemical extraction methods measure the plant available fraction of the soils nutrient pool. For the results to be effectively applied, the tests need to be carefully calibrated for the wide variety of soils (e.g. clay, loam, silt and sand) in which kiwifruit are grown, as soil characteristics influence nutrient availability (Refer to Organic Kiwifruit Fact Sheet: Soil Systems). In this way, orchardists are able to assess the nutrient status of the soil as a basis for deciding what quantities and kinds of fertilizer are appropriate to satisfy the crop's requirement.

Soil tests are taken

- to determine the nutritional status of the soil
- to indicate the existence of any deficiency, excess, or imbalance of the major nutrients
- to provide a basis for a recommendation on the amount of lime and fertiliser to apply

When and how often to sample

- Sample annually or biennially, preferably at a similar time, after fruit harvest in late autumn or early winter.
- Collect a representative soil sample defined by either orchard size (One soil sample for every four canopy hectares), soil type, crop variety ('Hayward' or 'Hort16A'), or non-typical areas e.g. contoured land, topography (slope), imperfect drainage, unhealthy vine areas.
- Do not collect a soil sample within two months of fertiliser or lime application.

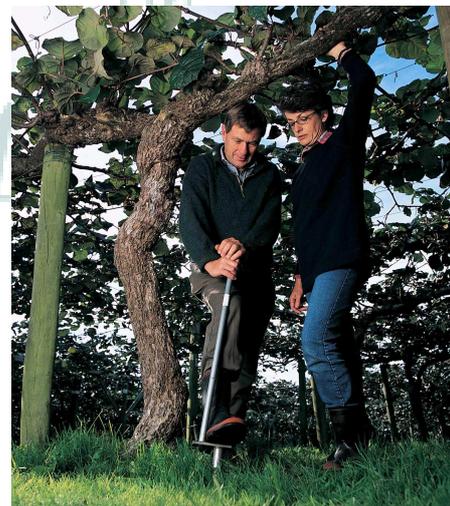


Figure 1. Use a soil corer to collect a minimum of 20 soil cores per sample from within the rooting zone of kiwifruit vines.

Soil sample collection procedure

1. Soil samples should be collected using a soil corer (or if one is not available, a spade), taking soil samples from the vines root zone avoiding collection of surface material such as leaf or organic matter (Figure 1).
2. Collect samples with clean equipment.
3. Soil cores should be taken from the top 15 cm of the rooting zone, with a deeper (15-30 cm) core collected every 3 years to check on acidity and salinity levels.
4. Soil samples should be collected on a fixed transect across the orchard area using monitored bays if possible. Consistently following the same soil sampling procedure allows for improved year-on-year comparisons to be made in tracking orchard fertility. Where fertiliser banding is employed (e.g. with young vines, or in heavy clay soils), confine sampling to the banded area. Separate samples should be taken from herbicide treated and grassed strip between rows when fertilizers are broadcast. In some cases growers have elected to sample at the herbicide/grassed strip interface.
5. Collect a minimum of 20 soil cores per sample and place into a bucket. Avoid sampling very wet or very dry soils. If testing a large orchard area, collect a greater number of soil cores to obtain a more representative soil sample.
6. Thoroughly mix the soil cores in the bucket and then place a sub-sample of approximately 500 grams into a clearly labeled, clean plastic sample bag. The sample bag must be clearly labeled with the identification of the orchard area being sampled.
7. Dispatch the soil sample to the laboratory as soon as possible. Do not allow samples to sit in moist or warm conditions as soil samples can incubate thereby altering the levels of some plant available nutrients.

Element	Unit	Desired Range
pH		6.2-6.7
Olsen P	(mg/L)	35-60
Potassium (K)	(me/100g)	0.6-1.2
Calcium (Ca)	(me/100g)	7-14
Magnesium (Mg)	(me/100g)	1.0-2.8
Sodium (Na)	(me/100g)	0.0-0.4
CEC	(me/100g)	12-25
Volume Weight	(g/mL)	0.6-1.0
Base Saturation	(%)	70-85

Table 1: Typical desired ranges in 'Hayward' kiwifruit orchard soil nutrient levels*

* TABLE NOTES

- CEC (cation exchange capacity): A measure of the soil's ability to absorb and retain cations (K, Ca, Mg, Na). Indicates the size of the soil 'tank' for holding K, Ca, Mg and Na.
- Volume Weight (VW): also known as Bulk Density (BD). The weight of a known volume of air-dried and ground soil. This measure gives an indication of the soils physical characteristics, for example, heavy soils (e.g. clay loams) have higher values and conversely sandy soils have lower VW measurements.
- Base Saturation: Calculated by summing together the levels of K, Ca, Mg, and Na found in the soil and expressing the sum as a percentage of the CEC value. Base Saturation is the percentage of the cation exchange capacity (CEC) of a soil that is occupied by basic cations, and indicates how full the soil 'tank' is with the basic cations (K, Ca, Mg and Na).

Additional optional soil tests include

Phosphate retention (%): Refers to the phosphorus immobilization property of the soil and gives an indication of the proportion of applied phosphate that will actually be plant available. Bay of Plenty soils have high phosphate retention values due to the presence of allophone, an amorphous clay particle. South Auckland and Northland brown granular loams derived from volcanic ash have medium values due to their 1:1 clay mineral (kaolinite, gibbsite, and halloysite) content. Levels (%) are given as very low <10; low 10-30; medium 30-60, high 60-80; and very high >80.

Organic matter (%): The organic matter content of soil is important as it contributes to the CEC, influences soil structure and moisture holding properties and is a reservoir of many plant nutrients, especially nitrogen. Organic matter is useful to monitor where applications of compost are recommended. Levels (%) are given as very low <3; low 3-7; medium 7-14; high 17-35; and very high >35.

Available nitrogen (kg/ha): The available nitrogen test measures the quantity of the soils organic matter that may be readily mineralized by microbial decomposition under ideal conditions of temperature and moisture. Interpret with caution as only a percentage of the test value will be plant available. Recent research conducted in a BOP kiwifruit orchard indicates an annual nitrogen contribution from this source of ± 40 kgN/ha. Levels (kg/ha) are given as very low <50; low 50-150; medium 150-250; high 250-350; and very high 350.

Nutrient units

The concentration of nutrients can be reported in a range of units. The formulas below enable conversion of values between the different units:

Conversion formula from me/100g to MAF units:

Potassium	$K \text{ (me/100g)} \times 21 \times VW$
Calcium	$Ca \text{ (me/100g)} \times 1.29 \times VW$
Magnesium	$Mg \text{ (me/100g)} \times 23 \times VW$
Sodium	$Na \text{ (me/100g)} \times 53 \times VW$

Where VW = volume weight

Conversion formula from me/100g to kg/ha:

Potassium	$K \text{ (me/100g)} \times 875$
Calcium	$Ca \text{ (me/100g)} \times 449$
Magnesium	$Mg \text{ (me/100g)} \times 269$
Sodium	$Na \text{ (me/100g)} \times 516$

Leaf analysis

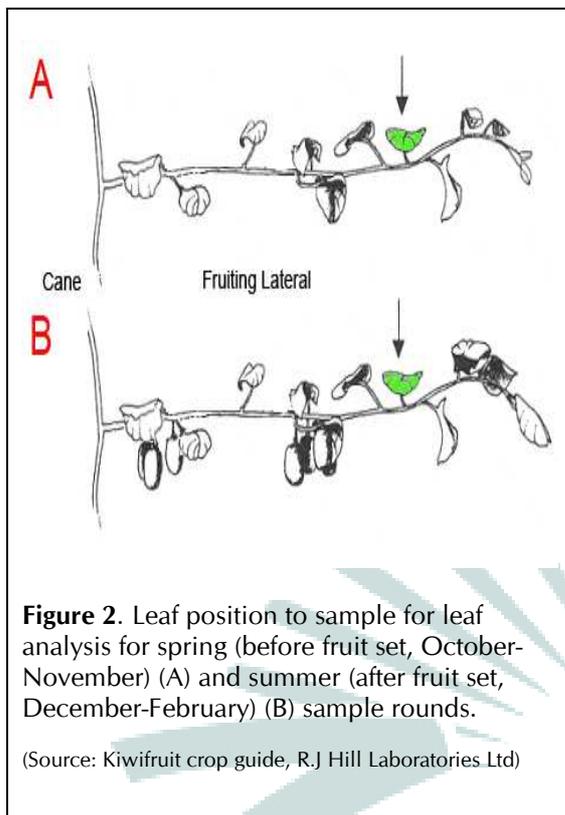
The nutrient status of the vine at a given time in the crop cycle is determined by leaf tissue sampling. Leaf samples are considered to give a better measure of which elements the plant has taken up because most but not all soil nutrients (identified in the soil test) are in a plant-available form.

Leaf tests are taken

- to routinely monitor nutrients to help sustain optimum levels and thus avoid nutritional disorders
- to diagnose visual symptoms resulting from nutrient deficiencies, toxicities or imbalances
- to identify conditions with no specific symptoms other than a general lack of vigour and reduced yield
- to indicate the effectiveness of current fertiliser programmes, nutrient solutions and many other management practices

Leaf sample collection procedure

1. In taking leaf samples it is important they are taken at similar physiological times each season, that is, at days after budburst rather than the calendar date. As leaf nutrient composition varies in a predictable way over the season (Tables 2 and 3), taking leaf samples at similar physiological stages each season allows year-to-year comparisons to be made.
2. Leaf nutrient concentrations vary considerably across orchard areas. This variability can be minimized by sampling across a wide range of vines and by taking leaf samples of a standard age and position within the vine. Take 40-80 leaves (blade plus petiole) from each of 20 vines (2-4 leaves per vine) across the assessed orchard area for analysis.
3. For both 'Hayward' and 'Hort16A', a pre-flowering (spring) sample is taken from the most recent, fully expanded leaf (Figure 2A), and from the second leaf past the final fruit cluster on a fruiting lateral for post-fruit set leaf analysis (Figure 2B). Avoid shoots that have been zero leaf pruned.



Mid-season leaf tissue sampling is usually carried out in February, when nutrient levels have stabilized but the timing means that the opportunity for corrective intervention is limited. This test is indicative of nutrient availability during spring and results can be used to support fertiliser adjustments for the following season's programme. Remedial fertiliser inputs resulting from a spring leaf test can be effectively assessed with a follow up analysis later in the season.

Interpreting leaf tests

Leaf nutrient composition varies over a growing season, as shown in Table 2 for 'Hayward' and Table 3 for 'Hort16A' respectively. Use the appropriate Table for assessment purposes. Hort16A vines are more vigorous and capable of higher crop yields than 'Hayward'.

"The seasonal trends for 'Hort16A' and 'Hayward' leaf nutrient accumulation are sufficiently different that they must be regarded as separate species".

(Source: Clark and Edwards, 2001)

- To avoid compromising test results, do not take leaves from non-fruiting shoots after fruit set as leaf nutrient levels are known to vary between fruiting and non-fruiting shoots (Refer to KiwiTech Bulletin 51: Hayward Kiwifruit – Phenology and Nutrient Uptake).
- Dispatch the fresh sample to the laboratory as soon as practicable after collection in a perforated plastic or paper bag for analysis.

When to leaf test

Leaf nutrient concentrations in 'Hayward' are subject to rapid change over the first 8 weeks after leaf emergence and the results require careful interpretation, especially in respect of the potassium content (Table 2). Pre-flowering sampling allows for early corrective action when nutrient deficiencies are detected. It is important to record the date of leaf emergence when early-season sampling is contemplated. Where available, combine with historical data to support any decision for additional fertiliser inputs.

Historical data, derived from several seasons of tissue analysis, is useful to identify trends with 'optimum' values, and where necessary fertilizer inputs may be adjusted. To diagnose visual deficiencies or disorders, collect a sample of the affected leaves together with a second, comparative sample in the same position from healthy, non-affected vines.

A holistic approach needs to be taken in interpreting test results as orchard and environmental conditions such as root anoxia (oxygen starvation) or physiological stress (moisture deficit, cool temperatures), may be the underlying cause rather than nutrient availability

Weeks After Leaf Emergence	Macronutrients (%)						Micronutrients (ppm)				
	N	P	K	S	Ca	Mg	Fe	Mn	Zn	Cu	B
0 – 2	5.8	1.0	2.8	0.6	1.8	0.5	145	214	156	38	28
3 – 4	4.8	0.9	2.3	0.6	1.5	0.3	168	120	112	39	25
5 – 6	3.7	0.7	2.0	0.5	1.4	0.3	132	90	63	24	20
7 – 8	2.9	0.4	2.7	0.5	1.8	0.3	103	97	34	14	21
9 -10	2.6	0.3	2.7	0.5	2.1	0.3	94	110	27	12	32
11 – 12	2.6	0.3	2.5	0.4	2.5	0.3	79	115	23	11	43
13 – 14	2.2	0.2	2.3	0.4	2.9	0.3	85	133	22	9	31
15 -16	2.5	0.2	2.2	0.4	3.3	0.4	78	142	22	9	46
17 – 19	2.4	0.3	2.1	0.5	3.7	0.4	84	153	20	8	54
20 – 22	2.4	0.3	1.9	0.5	4.2	0.4	92	168	21	9	50

Table 2. Typical 'Hayward' kiwifruit leaf nutrient levels and how these change across the growth period.

(Source: Smith, G.S. 1984. Spring Sampling Interpretation data. Ruakura Research Centre)

Hort16A					
Element	Unit	Sept/Oct	Nov	Dec/Jan	Feb/Mar
Nitrogen	%	2.3 - 4.0	2.0 - 2.8	1.6 - 2.3	1.5 - 2.0
Phosphorus	%	0.2 - 0.65	0.17 - 0.35	0.12 - 0.24	0.13 - 0.22
Potassium	%	2.2 - 3.5	2.1 - 2.9	1.6 - 2.6	1.4 - 2.3
Sulphur	%	0.3 - 0.5	0.26 - 0.46	0.22 - 0.40	0.22 - 0.40
Calcium	%	1.0 - 2.4	1.4 - 2.3	1.85 - 3.50	2.20 - 4.0
Magnesium	%	0.25 - 0.45	0.25 - 0.40	0.30 - 0.45	0.35 - 0.50
Sodium	%	0.0 - 0.1	0.0 - 0.05	0.0 - 0.05	0.0 - 0.05
Iron	(mg/kg)	50 - 150	45 - 100	45 - 100	50 - 120
Manganese	(mg/kg)	50 - 150	50 - 150	50 - 200	50 - 200
Zinc	(mg/kg)	20 - 60	15 - 50	15 - 30	15 - 30
Copper	(mg/kg)	7 - 20	7 - 20	7 - 20	7 - 15
Boron	(mg/kg)	20 - 35	24 - 38	25 - 40	20 - 40
Chloride	%	0.4 - 1.0	0.45 - 1.0	0.5 - 1.0	0.6 - 1.3

Table 3. Typical medium ranges in 'Hort16A' kiwifruit leaf nutrient levels and how these change across the growth period.

(Source: R.J Hill Laboratories Ltd).

Orchard water quality

Water supplies from bores and wells for supplementary irrigation and frost protection should be assessed on chemical, physical and biological factors. Vine nutritional status may be affected by the continued application of water with a high mineral content (Table 4).

The general salinity or level of total dissolved salts should not exceed an electrical conductivity (EC) of 2.5 micro mhos/cm or 1600 mg/l total dissolved salts (TDS). Kiwifruit vines are sensitive to sodium, boron and chloride toxicities. The deleterious effects of high sodium levels may be partially mitigated by the calcium and magnesium content of the soil.

Trace Element	Maximum Concentration (mg/litre)
Aluminium	5.0
Boron	0.75
Iron	5.0
Manganese	0.20
Molybdenum	0.01
Zinc	2.0

Table 4. Recommended maximum concentrations of some trace elements in irrigation water

Physical factors refer to the total amount of suspended solids present in the water while the main biological problem is iron and manganese bacteria. Both ground and surface water can contain small amounts of dissolved or fine colloidal iron. Bacteria flourishing in such water extract the iron and convert it into a rusty gelatinous sludge adhering to pipe walls, filters and drippers. It is advisable to forward a water sample for analysis and suitability for irrigation report. Consult a laboratory for instructions to collect and send water samples.

laboratories

The following IANZ registered laboratories provide analytical services for kiwifruit:

- **Analytical Research Laboratories (ARL)**
890 Waitangi Road
Awatoto
Napier
Phone: +64 6 835 9222
Fax: +64 6 835 9223
Email: arl@arllab.co.nz
Web: www.ravensdown.co.nz
- **Hill Laboratories**
1 Clyde Street
Private Bag 3205
Hamilton 3240
Phone: +64 7 828 2000
Fax: +64 7 858 2001
Email: mail@hill-labs.co.nz
Web: www.hill-labs.co.nz
- **NZLabs**
Ruakura Research Centre
East Street, PO Box 281
Hamilton
Phone: +64 7 838 5920
Fax: +64 7 838 5160
Email: Hamilton@nzlabs.co.nz
Web: www.nzlabs.co.nz

Further reading

- KiwiTech Bulletin 51: Hayward Kiwifruit - Phenology and Nutrient Uptake.
www.zespricanopy.com
- Organic Kiwifruit Fact Sheet: Soil Systems
www.zespricanopy.com
- Organic Kiwifruit Fact Sheet: Monitoring Soil Health
www.zespricanopy.com

References

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- Martin-Prevel, P., Gagnard, J., and Gautier, P. (eds). 1987. Plant Analysis as a Guide to the Nutrient Requirements of Temperate and Tropical Crops. Tech. et Doc. Lavoisier, Paris.
- McLennan, A., and Warburton, D.J. 1983. Trickle and Micro-sprinkler Irrigation. Dept. of Agric. Engineering. Massey University. 47pp.
- Smith, G.S., Ascher, C.J., and Clark, C.J. 1987. Kiwifruit Nutrition: Diagnosis of Nutritional disorders. Agpress Communications Ltd, Wellington. 61pp. (available online at www.hortnet.co.nz/publications/guides/kn/kiwi.htm)

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