



Field Consultants Guide to Soil & Plant Analysis

**field sampling,
laboratory processing
&
interpretation**

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Acknowledgements

Contributions from a number of people have made this revision of the Guide a better and more comprehensive document than it was ever envisaged to become.

We would like to thank Amanda Hawken for her artistic talent that created the many line drawings used to elucidate the sampling instructions.

Thanks to John Turner for diligently accumulating information over the years on many crops. Also for his suggestions regarding technical questions and content.

Some information in the Guide was obtained from, or checked by, several of our clients expert in their respective fields. Thank you for your contribution.

Some of the drawings in the Guide were taken off photographs taken at nearby orchards. Thanks to those growers who gave permission for their crops to be photographed.

We would also like to thank in advance those who will give us valuable feedback about the Guide. Consideration will be given to it to correct or update future versions.

Preface

In April 1985, Roger Hill of R. J. Hill Laboratories produced the first *Field Advisors Guide to Soil and Plant Analysis*. The guide was intended for the increasing number of field consultants submitting samples to this laboratory, as a means to standardise their sampling technique and to give them interpretive information about the laboratory's analysis reports. The guide was very well received and it is our belief that the advice given to farmers and growers by our consultant clients has improved because of it.

Thirteen years later, the second most common questions asked is still: 'How do I collect a sample?', and the most common being: 'What do these results mean?'. The demand for information, whether in the form of this guide or informal verbal advice, is still very high. For this reason it was decided re-issue the guide.

In this re-vamped form of the guide, additional information has been included to give you a broad-brush introduction to, and understanding of Hill Laboratories as a company specialising in the chemical analysis of your samples. The emphasis is on soil and plant analysis, but more general information is included where it is thought to be useful. As well as information on how to sample and interpret results, some of the other important topics are briefly discussed. These include the practical steps involved to get samples to the laboratory, the various reporting options, as well as some of the policy positions taken regarding confidentiality of results and the making fertiliser recommendations.

At the heart of this document are the **Crop Guides**. All the technical information relating to sampling procedures has been revised. Furthermore, an attempt has been made to re-establish and emphasise the important relationship between the sampling method used, and the interpretive information provided. Hopefully the credibility of the **Crop Guides** will be enhanced by stating wherever possible the references used; generally published scientific papers and other reference texts. Having said this, there are instances where information is limited or inappropriate. In these cases, modifications and best estimates based on the laboratory's accumulated knowledge and historical information is used. Again, this will be stated where appropriate.

It is our intention that this document be used as a ready reference from which the consultant can quickly find information required when meeting grower clients. For this reason the content is deliberately kept as brief as possible. Our approach is to produce **Technical Notes** on a regular basis to expand on any important technical matters. The **Technical Notes** currently available are included in this guide.

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Hill Laboratories

The Company

R. J. Hill Laboratories was founded in 1984 by Roger and Anne Hill, operating from a small 150m² building in Hamilton East, and employing three staff. Prior to this, Roger Hill had been the Chief Analyst at New Zealand's most successful privately owned soil and plant testing laboratory, Analytical Services Laboratory in Cambridge.

The company grew as a soil and plant testing laboratory servicing the agricultural and horticultural sectors, but soon expanded into water testing, and testing of other materials such as fertiliser and industrial chemicals. Due to a requirement for more space, the laboratory was re-sited to a 650m² building in Te Aroha St, Hamilton, in 1990.

With the introduction of the Resource Management Act in 1991, the company expanded rapidly into new areas of organic and inorganic environmental analysis. At this time there was a major commitment to capital investment in high tech instrumentation and specialist staff.

In 1994, the acquisition of Analytical Services Laboratory saw this laboratory continue trading as a division of R. J. Hill Laboratories. Once again, the increase in sample numbers justified further investment in equipment to process samples more efficiently. For two and a half years the company's Soil & Plant Division operated from the Cambridge site.

With the growth in the range and number of tests, the company grew to employ over 75 staff located in three buildings in Hamilton and Cambridge, and the need to consolidate became more pressing. During 1996, three floors, totalling about 1800m², of a four storey building in Hamilton East were renovated and all operations and staff were relocated there during the latter part of that year. This exercise allowed the design of many purpose built rooms and laboratory areas and offered considerable improvements in operational efficiency. In January 1998, about 90 staff were employed.

In conjunction with the shift, the trading name of the company was changed to Hill Laboratories. At the same time, the long standing name of Analytical Services Laboratory, or ASL, began to be phased out.

Hill Laboratories now enjoys a reputation for quality, integrity and innovation. It is a leading analytical laboratory in New Zealand, specialising in a broad range of chemical analyses.

The People - The Partners

Hill Laboratories is currently owned and operated by its senior staff. The senior analysts all have postgraduate degrees in chemistry and together have an intimate knowledge of the laboratory's operations.

- **Dr Roger Hill** is the Managing Director who has extensive experience in soil and plant analysis for agriculture and horticulture. Although currently involved more with administrative matters, Roger keeps up to date with technical developments.
- **Tony Kay** gained many years of experience in soil and plant analysis at Ruakura Agricultural Research Centre before making the move to Hill Laboratories in 1992. Tony obtained his MSc(Hons) in 1996, with a thesis on soil anion analysis. Tony is Manager of the Soil & Plant Division.
- **Dr Terry Cooney** joined in 1990 and is Operations Manager, in charge of the day-to-day running of the laboratory as well as the development of new methods. Terry came from a background in soil and plant analysis, with previous work in biochemical research.
- **Dr Peter Robinson** came to Hill Laboratories in 1992 and is Manager of the Environmental Division. Peter is especially well known for his work in chromatography.

An extensive collective knowledge of chemistry, particularly analytical chemistry, enables the laboratory to offer a service to clients which is

difficult to match. As owners of the company, the senior analysts are able to respond quickly to changing and developing client requirements.

The philosophy of the partners is to provide a fast, high quality and expert service in a low key, helpful manner.

The People - The Staff

The majority of our staff are tertiary qualified and include people with PhD, MSc, BSc(Tech), BSc and NZCS qualifications. Almost all the middle management staff started their career as technicians at the bench, and are therefore trained and experienced in the practical aspects of their sections. It is a major strength of the company to have a depth of expertise in all section of the laboratory. The staff are young and enthusiastic, and as a developing management group, their style and approach is to a large extent a reflection of senior management's philosophy on quality and integrity.

Quality Assurance

At Hill Laboratories we always strive to improve the quality of our work. We employ a full time Quality Manager and have an extensive system of checks and documentation covering all aspects of our operations.

We are International Accreditation New Zealand (IANZ) Accredited (formerly TELARC) for a wide range of tests on many different sample types, including:

- 2.36 Agricultural Products and Agricultural Materials
- 2.41 Waters
- 2.58 Environmental monitoring
- 2.70 Instrumental Techniques (including ICP-MS, ICP-OES, GC-MS, GC, AA, Auto-analysers)

Copies of our IANZ Accreditation Certificate are available on request.

IANZ accreditation is based on ISO 9002 and ISO Guide 25: *General requirements for the technical competence of testing laboratories*. From this the *New Zealand Code of Laboratory Management*

Practice has been derived for use by IANZ, and focuses not just on the laboratory's Quality Systems, but also its competence to perform the tests that it claims it can.

The Soil & Plant laboratory participate in three Inter-Laboratory Comparison Programmes (ILCPs); one for soil, one for plant and one for potting media analysis (see Table 1). These help us monitor our performance, on a regular basis, against other national and international laboratories.

In November 1997, several New Zealand laboratories founded the New Zealand Soil and Plant Analysis Council (NZSPAC). It is hoped that in the near future this body will become a branch of the Australian Soil and Plant Analysis Council (ASPAC). When this happens, we will also participate in the Australian soil and plant ILCPs, together with about forty Australian laboratories.

The Environmental and Non-Routine sections also participate in various ILCPs appropriate to their work.

Client Base

We undertake work for clients from all over New Zealand, as well as Australia and some of the Pacific Islands.

Soil & Plant clients include agricultural and horticultural consultants and merchants, fertiliser company representatives and private individuals. Regional, District and City Councils, industrial companies and environmental consultants dominate the Environmental Division's client list.

We have an Import Permit which allows importation of samples from many different countries. All imported samples are disposed of according to MAF Biosecurity approved procedures. Copies of necessary permits are available from the laboratory.

Analyses Offered

Hill Laboratories specialises in the routine inorganic and organic chemical analysis of soil, plant and water. In addition, we also analyse many other sample types such as fertilisers, industrial chemicals,

feed supplements, rock, drenches, biota and foods. Many of these samples are of a one off, non-routine nature and may require analyses to a high specification.

	Number of participating laboratories	Frequency	Scope	Participants
Soil	6	Monthly	New Zealand	Commercial, government and university laboratories
Plant	200	Two monthly	International	Commercial, government and university laboratories
Potting Media	2 to 6	Two monthly	New Zealand and Australia	Commercial, government and manufacturer's laboratories

Table 1: Soil & Plant Laboratory ILCPs

Laboratory Visits

We encourage clients to visit our laboratory, and would be pleased to host inspection or audit visits. We have often found such visits very useful, as it gives us valuable feedback from our clients, and they in turn come away with a better appreciation of what is involved in the analysis of their samples.

Sampling Principles and Techniques

The Role of the Field Consultant

It is our belief that the interpretation of analysis results and any subsequent fertiliser programming should be undertaken by field consultants. The alternative approach, where results are interpreted by the testing laboratory, is less satisfactory, as other relevant factors may not be taken into consideration.

We realise, however, that this approach places greater demands on field personnel, as assessing the laboratory results is not always straightforward. To assist our clients, we have prepared a series of sampling and interpretation guides for a variety of crops. All currently available **Crop Guides** are included in Section 2 of this manual, as well as being available separately on request from the laboratory's office. In addition, field staff are invited to contact the laboratory to obtain advice or assistance with problems they may encounter. We believe that the recommendations should be made by the field consultant, but we will endeavour to provide technical support where ever possible.

In some instances, very little will be known about a particular crop's requirements, and in these cases, the interpretation criteria may be very tentative. No doubt there is also data that we are unaware of, and new research that is yet to be published. As we obtain further relevant information, the **Crop Guides** will be revised.

Why Test? - Defining the Problem

Before collecting samples for analysis, realise what you hope to obtain from the results, and then sample accordingly.

Some common, primary objectives of testing are¹:

Soil Testing

- to determine the nutritional status of a soil.

- to indicate clearly the existence of any deficiency, excess or imbalance of major nutrients.
- to form a basis for assessing fertiliser and lime requirements of crops, pastures and turfs.

Plant Analysis

- 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, adequacy of growing media, nutrient solutions and many other management practices.
- To assess the supply of essential nutrients for animal health^{2&3} in the case of forage crops.
- To monitor the success of fertigation programmes.

Plant tissue analysis permits a much more reliable assessment of the crop nutrient status than is possible from soil tests alone. One of the main problems associated with soil testing is the lack of calibration of the tests for the wide variety of crops and soil types likely to be encountered. Plant tissue analysis bypasses this and other problems, as the adequacy of nutrient supply is assessed directly from the plant.

There are two main limitations of plant testing however. Samples may not always be available. For example, a suspected trace element deficiency in an area cannot be confirmed by plant analysis prior to crop establishment. Furthermore, plant analysis will not always identify the cause of nutrient problems. Low plant nutrients may not be due to low soil nutrient levels, but due to drought stress, disease or water logged soils. The involvement of a field

¹ Refer to TN003: Sampling Options for Pastoral Farms.

² Refer to TN002: Mineral Ratios and Grass Staggers.

³ Refer to TN013: The Animal Dietary Mineral Balance Report.

consultant is vital in assessing these possible influences.

Sampling Strategies

The objective of sampling largely determines the sampling approach to adopt. Some examples of different sampling approaches are discussed in this section.

Crop or Nutrient Logging

The first approach is nutrient logging, also known as crop logging. Both soil and plant samples are analysed on a regular basis in the same manner and from the same area. If sampling is undertaken over a number of years, the consultant can assess the results along with other data such as previous test results, production yields and fertiliser applications, and assess how effective a fertiliser programme has been in meeting the crop's requirements. If a particular nutrient level has regularly declined over the period, it may be prudent to increase the fertiliser input for this element for the coming season. Similarly, steadily increasing levels may mean the inputs can be reduced. This approach may also circumvent potential problems associated with soil testing being inherently less accurate than plant analysis. Trends, when interpreted in conjunction with the current nutritional status of the crop, can result in more effective fertiliser recommendations being made, and thus the likelihood of nutritional disorders developing unnoticed becomes minimal.

Diagnostic Approach

A second approach is to use testing as a means of diagnosing disorders when they first become apparent.

If the consultant suspects a nutritional problem exists, then soil samples should be taken from the worst affected areas. If possible, plant tissue samples should be taken from areas that show symptoms, but are still relatively healthy. Plant tissue that is severely affected by the nutrient disorder may show secondary nutrient imbalances that are not necessarily indicative of the underlying problem. The leaf tissue results are more likely to identify the problem, but the soil test may be crucial in defining the cause.

For high value crops or crops for which little data is available, it is recommended that a second sample be taken from areas where the crop is healthy and vigorous. By comparing the two sets of results, a more reliable interpretation may result.

Because the sampling time with this approach is usually dictated by when symptoms show, and not by regular events such as fertiliser applications or the pre-planting period, there are some extra considerations to get a good sample. Generally, soil samples are taken from the root zone of affected plants. For very young plants, the usual sampling depth may need to be reduced to stay within the root zone. Also realise that a much higher fertility can occur in areas where fertiliser applications have been restricted to banded areas around the plants, or in the wetted zones where trickle irrigation is used.

When submitting samples for diagnostic purposes, include on the request form all relevant information. We may be able to assist if we know the background of the sample.

Routine Monitoring

For some crops, regular analyses through the growing season can ensure that optimum nutrient levels are being maintained, and imbalances can be detected before they seriously affect crop yields. High value annual crops can be monitored in this way.

Formulating Fertiliser Programmes

The use of soil testing and plant analysis provides data to ensure that the fertiliser programme is well planned. Fertiliser is a major farm expense and its proper control means production is not restricted by under fertilisation, or profit lost by over application. If funds are limited, testing can help decide just where those funds can be put to best use. A regular testing programme can then be used to monitor soil fertility trends over a period of time and will enable fine-tuning of the programme to ensure that optimum soil pH and adequate nutrient levels are maintained.

Fertiliser Recommendation Policy

We do not make recommendations for specific products and rates of fertiliser.

- *Such advice should not be given without all the relevant farm/orchard information, which we do not have.*
- *We cannot claim to have an expert knowledge of all the fertiliser products available on the market.*
- *Fertiliser advice is the business of many of our clients, and we do not wish to be at cross purposes with those clients.*

Animal Health

The productivity and health of livestock depend upon an adequate and balanced supply of a number of essential nutrients. Farm animals need at least fourteen essential elements to maintain good health and production. Economically significant production losses are well known to arise from inadequate supplies, imbalances among, and availability of cobalt, selenium, iodine, copper, calcium, magnesium, phosphorus, sulphur, sodium and molybdenum. Herbage and forage crop testing identifies where these elements can limit stock productivity and direct corrective action.

Changing Land Use

Soil tests are also useful when developing new land, changing the use of the land already under cultivation or altering the physical aspects of the soil, for example, contouring and playing greens preparation. In these situations, information about the soil nutrients can help estimate capital fertiliser requirements.

Conclusion

It is apparent from the above notes that the consultant has various sampling options, and has to define objectives before commencing sampling. These decisions should be made by the consultant, who effectively "controls" the exercise from sample collection, through assessment of results and final fertiliser recommendation. If the emphasis is placed on the laboratory, and the field consultant merely acts as a supplier of samples, there is a very real danger that important factors may be overlooked, resulting in an inferior service to the farmer or grower.

Sampling Guidelines

For laboratory work and subsequent interpretation to be effective, it is essential to ensure that recommended sampling procedures are adhered to so that the samples collected truly reflect the area under consideration. *Sampling is the greatest contributor to the variability of test results.*

In general, soils samples are taken from the rooting zone of crops. Tissue samples are taken by taking a specific leaf at a specific time of year or physiological growth stage. Typically, a recently matured leaf is collected, either when the plant is in flower or when the fruit are beginning to swell.

The following guidelines are provided to assist in selecting sampling areas, taking samples and submitting samples to the laboratory. For detailed sampling instructions, refer to the appropriate **Crop Guide**.

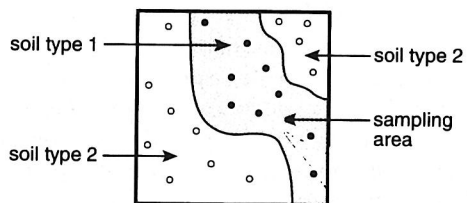
1. Do not sample within two months of applying fertiliser or lime.
2. For cost considerations, it is desirable to collect the minimum number of samples that will define the fertility status of the property. Ideally, however, divide up the area under consideration according to any of the following delineations:
 - Soil type
 - Topography
 - Land use
 - Fertiliser history
 - Crop variety
 - Healthy/unhealthy areas

In the case of sports turfs, cricket wickets and outfielders, these areas should be sampled separately, as should greens and fairways of golf courses.

3. Take representative samples from each of these sites as described below^{4&5}, avoiding sampling areas that are atypical.
 - In the case of pasture, or crops at pre-planting, take 20 cores by walking in a random or zig-zag pattern across the selected site.

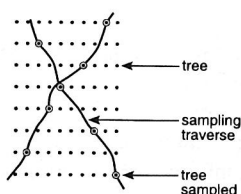
⁴ Standard sampling method used in New Zealand.

⁵ Reuter, D.J. and Robinson, J.B. (Eds) 1997. *Plant analysis: an interpretation manual*. Second Edition. Australia, CSIRO Publishing. p59.



Avoid sampling near dung and urine patches, fences, hedges, tracks, gates and stock camps.

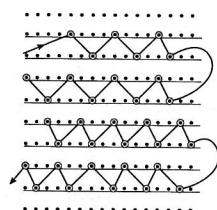
- The same principles apply to sampling from recreational turfs, lawns and home gardens, but on a much reduced scale.
- In the case of tree crops, take two cores from the rooting zone of 10 trees selected on two diagonal lines through the area of interest.



Avoid sampling near boundary rows, track or outside the drip zone of trees.

If the orchard has herbicide treated strips, these should be sampled separately from grassed areas between rows.

- For grapes, kiwifruit or other crops that are planted in hedgerows, take 12-20 cores from the rooting zone of the vines according to the diagram below:



Again, avoid sampling near boundary rows, tracks or outside the drip zone of trees, and take separate samples from herbicide treated and grassed strips.

- The most effective sampling tool is a soil auger. In its absence, a spade or trowel may be used to simulate the use of an auger. Because soil nutrients are not distributed evenly throughout the soil profile, it is important to avoid taking

wedge shaped samples, as this will bias the results.

Collect tissue samples using clean shears, scissors, or plucking by hand.

- The depths to which soil samples should be taken for various applications are:

Application	Sampling Depth (cm)
Pasture	7.5
Arable and Horticulture (excl. pipfruit)	15
Pipfruit	20
Fine Turf - Cotula	5
Fine Turf - Grass	7.5

- Take care to avoid contaminating samples, especially with fertilisers. Use clean sampling equipment and new plastic sample bags.

Also avoid contaminating tissue samples with soil, dust and trace element sprays and drenches, as the presence of these will affect the result.

- Combine the soil cores (approximately 500g) into one plastic sample bag. For plant tissue samples, paper bags are best, or plastic with breather holes. Label the bag with an appropriate name or number that can be understood later when the report comes back from the laboratory.
- Send all samples to the laboratory as quickly as possible. Do not allow samples to sit in moist or warm conditions prior to submission. Fresh plant tissue deteriorates rapidly when stored in these conditions, and soil samples can incubate, altering the levels of some plant available nutrients. Bare in mind the transport time of the samples by post or courier, so that samples aren't delayed in transit over weekends and holidays.

Soil or Plant Sampling?

There are several considerations in deciding the most appropriate sample to take; soil or plant.

- The first is that a soil test will give an indication of levels of nutrients present in the soil, but it wont necessarily show accurately just how much is plant available. Other factors may combine to influence the utilisation of these nutrients. For example, soil pH, drought stress and disease all influence the way that nutrients get from the soil to the crop. In light of this, the plant itself is perhaps the ideal soil nutrient extractant. If such influences are present, the crop will reflect them.
- There is also the issue of timing. It is of no use to use plant analysis to determine the presence of adequate levels of nutrients in the soil to sustain

the growth of a new or annual crop. If there is a deficiency, it is often too late to rectify this before the crop yield is affected. It is therefore best to use soil testing prior to planting.

- Soil trace element analysis is of limited value due to a large affect of pH and other factors on their plant availability, as well as a lack of suitable crop specific calibration data. For essential trace elements, plant analysis will provide more accurate data than soil analysis.
- As stated before, when diagnosing a nutrient problem it is often advisable to submit a plant sample together with the soil sample in order to obtain the maximum amount of information in the shortest possible time. *Leaf tissue results are more likely to identify the problem, but the soil test may be crucial in defining the cause.*

When to Sample

Crop production continuously removes and recycles nutrients, with fertiliser often an additional annual input. Therefore the means to assess requirements and plan effective expenditure should be applied annually. This enables the trends in nutrient status to be monitored so that any deficiencies, excess or imbalance of nutrients can be anticipated and corrected by adjustment to the fertiliser programme.

Sampling annually is best done at the same time each year during a period of active growth. Soil samples can be taken at most times of year, except during drought conditions or soon after fertiliser application. Plant tissue sampling should be done at particular times of the year or physiological growth stages, usually avoiding stress periods. Refer to the appropriate **Crop Guide** for details.

Chapter three

Soil Tests and Interpretation

Hill Laboratories has organised its soil tests into two groups. The first, the Basic Soil test, includes components of significance across all applications:

- pH
- Phosphorus
- The Cations: Calcium, potassium, magnesium and sodium
- Cation Exchange Capacity and Base Saturation
- Volume Weight

The Basic Test can be supplemented by additional tests where extra information is required. Hill Laboratories routinely offers the following:

- sulphate - sulphur
- extractable organic sulphur
- organic matter
- soluble salts
- phosphate retention
- available nitrogen
- total nitrogen
- total phosphorus
- boron
- reserve potassium
- reserve magnesium
- aluminium
- trace metals

Selection of these additional tests depends upon the crop under consideration, the cultivation technique and other factors (see Table 2). If in doubt about your exact requirement, or if you require analyses not listed, please do not hesitate to inquire, or talk to your consultant or merchant.

The following information is prepared as a general summary of the range of soil test levels likely to be encountered in New Zealand soils. It is intended as a guide only. It is crucial to take both the specific crop requirements and local conditions into account when using this summary in conjunction with any analysis results. Also refer to the appropriate **Crop Guide** for more specific information and to the

histogram presentation issued with individual reports.

Refer to Appendix two for more details of the methods used.

Sample Preparation

All soils are dried in a forced air convection drier at 35°C. All results are reported on this basis and no correction is made to an oven dried basis (103°C). In-house experiments have determined residual moistures to be typically 5%.

After drying, soils are crushed to pass through a 2mm sieve.

Basic Soil Test

Following is a brief description of the most common tests available. The section also has interpretation data from published⁶ references or derived from our own database. Where applicable, cross references to our Technical Notes are also made.

pH

The soil pH is a measure of the acidity or alkalinity of the sample. It is important because of how it influences the chemical and physiological processes in the soil, and the availability of plant nutrient.

Level	Peat	Loam	Sandy
Very Low (acid)	4.0	5.0	5.0
Low	4.5 - 5.0	5.1 - 5.5	5.1 - 5.8
Medium	5.1 - 5.5	5.6 - 6.5	5.9 - 6.8
High	5.6 - 6.0	6.6 - 7.0	6.9 - 7.5
Very High (alkaline)	> 6.0	> 7.0	> 7.5

Figure 1 shows how pH can affect the availability of nutrients.

⁶ Blakemore, L.C.; Searle, P.L.; Daly, B.K. 1987. *Methods for chemical analysis of soils*. New Zealand, NZ DSIR. (NZ Soil Bureau Scientific Report 80.

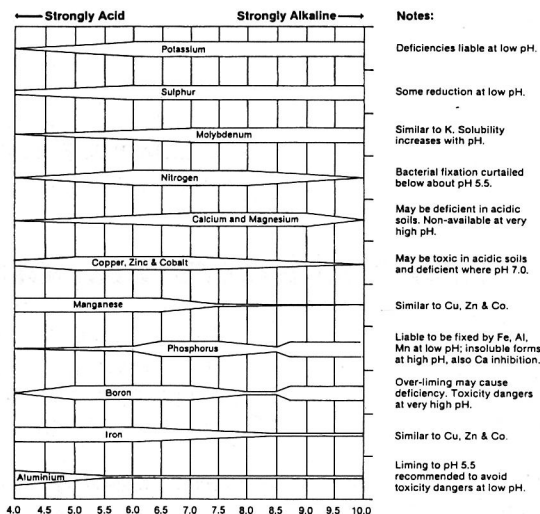


Figure 1: pH affects on plant availability of nutrients⁷

Phosphorus

The Olsen P is the standard method in New Zealand to assess phosphorus availability to plants. The Resin P test is an alternative test, described later, and is recommended for soils where RPR or other slow release P fertilisers have been used.

The following interpretations apply to autumn sampling of soils in areas with rainfall more than 1000 mm per year.

Level	Ag. Soil (µg/mL)	Hort. Soil (µg/mL)	G/H Soil (µg/mL)
Low	< 20	< 30	< 70
Medium	20 - 30	30 - 80	70 - 150
High	> 30	> 80	> 150

It is recommended that the phosphate retention of the soil is be considered when interpreting P levels.

Cations and Cation Exchange Capacity

The cations potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na) are an important group of nutrients essential for plant growth.

There are two ways to consider cations in the soil:

1. In terms of the actual amounts extracted, which gives an indication of the absolute amount available to plants. Their concentrations are expressed in me/100g. At Hill Laboratories, this is the preferred and recommended way to assess cations.

2. As a proportion of the soil's CEC (see below). This is the cation's Base Saturation level, and is expressed as a percentage.

There are complex interactions that may take place among the cations, affecting the soil's characteristics and their availability to plants. Considering the cations in terms of their Base Saturation as well as absolute concentrations may provide more information than either can do alone.

Crop	K (me/100g)	Ca (me/100g)	Mg (me/100g)	Na (me/100g)
	Agricultural	0.5 - 0.8	6 - 12	1 - 3
Horticultural	0.5 - 1	6 - 12	1 - 3	0 - 0.5
Glasshouse	1 - 3	8 - 15	2 - 4	0.2 - 0.6

For many crops the magnesium level should ideally be twice as much as the potassium. When magnesium is lower than potassium, suppression of magnesium uptake can occur.

Sodium is only of secondary importance in the soil test as its uptake by plants is largely dependent on the plant species involved and the potassium status of the soil, rather than the actual level of sodium extractable from the soil. This element is mainly of interest for animal health and can generally be ignored for cropping and horticultural situations.

High sodium levels may occur in low lying coastal areas, or in glasshouse soils irrigated with water high in sodium. If this situation is suspected, a soluble salts test may be useful.

The Cation Exchange Capacity (CEC) of a soil is a measure of it's capacity to hold cations⁸; in particular, potassium, calcium, magnesium and sodium. The larger the value of the CEC, the higher the soil's capacity for cation nutrients. Fine textured soils and those with high organic matter and clay content have higher CECs.

Soils may contain cations in the form of soluble salts that are not part of the exchangeable pool. Concentrations of exchangeable cations can be overestimated if soluble salts are high. Our CEC measurement assumes negligible free soluble salts.

Typical CEC values for different soils are given below.

⁷ From Truog, 1948.

⁸ Refer to TN004: Cation Exchange Capacity and Base Saturation.

Level	CEC (me/100g)	Soil Description
Low	5 - 12	Sandy or low in organic matter
Medium	12 - 25	Average, silty or clay soils with medium to low organic matter level
High	25 - 40	High fertility silt or clay soils with high or medium organic matter level
Very High	> 40	Clay soils with high organic matter levels or peat soils

Sometimes requests are made to convert our cation results from me/100g units to µg/mL or MAF units. This can be done according to the formula in the table below, provided the testing procedures are known to be similar, which is normally the case with results from New Zealand laboratories.

me/100g to µg/mL:	Potassium	me/100g x 391 x VW = µg/mL
	Calcium	me/100g x 200 x VW = µg/mL
	Magnesium	me/100g x 122 x VW = µg/mL
	Sodium	me/100g x 230 x VW = µg/mL
me/100g to MAF units	Potassium	me/100g x 20.8 x VW = MAF K
	Calcium	me/100g x 1.29 x VW = MAF Ca
	Magnesium	me/100g x 23.3 x VW = MAF Mg
	Sodium	me/100g x 53 x VW = MAF Na
Note:	for results on a weight basis:	µg/g = mg/kg = ppm
	for results on a volume basis:	µg/mL = mg/L = ppm
	For results on a per hectare basis (7.5 cm sample)	µg/mL x 0.75 = kg/ha

Base Saturation

As discussed above, the individual cations can be considered as proportions of the CEC. This approach may give interesting information about the balance among the nutrients. Desirable Base Saturation levels are given in the table below.

Crop	K (%)	Ca (%)	Mg (%)	Na (%)
Agricultural	2 - 5	50 - 75	5 - 15	1 - 2
Horticultural	3 - 6	50 - 75	7 - 15	1 - 2
Glasshouse	6 - 12	50 - 75	7 - 15	1 - 2

The proportion of the soil's total capacity for cations that is actually occupied by these nutrients, the Total Base Saturation, is calculated by summing together the levels of calcium, magnesium, potassium and sodium found in the soil and expressing this sum as a percentage of the CEC value.

There is a correlation between Total Base Saturation and soil pH, with increasing Total Base Saturation being associated with increasing soil pH. This can

give another perspective on the soils requirement for lime.

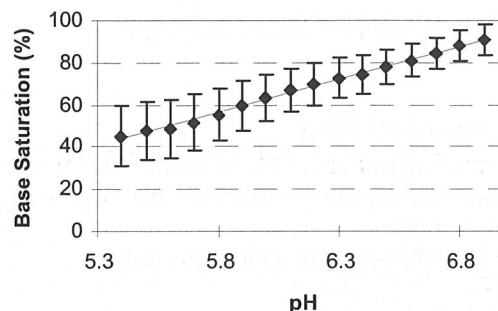


Figure 2: Relationship between pH and Base Saturation⁹.

Volume Weight (Bulk Density)

The Volume Weight is the weight of a known volume of air-dried and ground soil. This figure gives an indication of the soil's physical characteristics, as well as allowing the conversion of test results to other units if necessary.

Soil Type	VW (g/mL)
Sandy	1.0
Clay	0.8
Peat	0.5

In the past, this test was called Bulk Density, but the name was changed in 1997 to avoid confusion with the Field Bulk Density property.

Lime Requirement

Lime requirement is a calculation that estimates the amount of lime (CaCO₃, 90% pure) necessary to achieve a target total base saturation for a particular crop¹⁰. The default target is 70%. Other targets range from 35% for peat soils to 80% for some horticulture crops.

The formula for 15 cm core samples is:

$$\text{Lime Re } q.(t / ha) = (T \text{ arg et } \% BS - \text{Soil } \% BS) \times CEC \times VW \times 0.0083$$

The formula for 7.5 cm core samples is:

⁹ Soils with 0.60 ≤ VW ≤ 0.90 and 17 ≤ CEC ≤ 35 selected from Hill Laboratories database.

¹⁰ Theoretically derived from first principles.

An alternative formula to calculate Lime Requirement for pastoral soils, based on New Zealand field trials¹¹ using pH and CEC, is:

$$\text{Lime Req. (t/ha)} = 26.2 - (4.4 \times \text{pH}) + (0.07 \times \text{CEC})$$

Additional Soil Tests

There is a range of additional tests available. Which to choose can depend primarily on the crop being grown. Refer to Table 2 to help select the appropriate tests.

Sulphate-Sulphur

This test measures readily available sulphur in the form of dissolved plus adsorbed sulphate. Sulphur testing is important where low sulphur or sulphur-free fertilisers are used, such as high analysis NPK fertilisers. Retention of sulphate-sulphur by the soil is related to its phosphate retention, with high leaching losses of sulphate being associated with low phosphate retention soils. This should also be taken into account when considering sulphur fertiliser options.

Level	Sulphate-Sulphur (µg/g)
Very Low	< 4
Low	4 - 10
Medium	10 - 20
High	20 - 50
Very High	> 50

Extractable Organic Sulphur

Most of the soil's sulphur (95%) is in organic forms. This pool of S is in a slow equilibrium with the plant available, inorganic form of S. Being a natural source of S, it is useful to have a means of assessing this component, especially where the sulphate-S test indicates low levels of the readily plant available form. This test measures the readily soluble fraction of the organic S pool.

Level	Extractable Organic Sulphur (µg/g)
Very Low	< 5
Low	5 - 11
Medium	12 - 20
High	> 20

Resin P

As with the Olsen P test, the Resin P test¹² also gives an indication of plant available phosphorus in the soil. The Olsen P test is considered to have a poorer

correlation with pasture growth than the Resin P test where there is a history of slow release phosphorus fertiliser use (i.e. RPR, PAPR or Longlife Super). There is also evidence that the Resin P test may have some advantages, particularly when interpreting results from a variety of soil types and pHs. However as interpretation data for the Resin P test is limited, this test is offered as an additional test rather than a replacement for the Olsen P test.

Level	Dairy Soil (µg/g)	Dry Stock Soil (µg/g)
Low	< 50	< 40
Medium	50 - 100	40 - 75
High	> 100	> 75

Soluble Salts

This test monitors the level of soluble salts in the soil. The 1:5 water extraction is used for field soils and the 1:2.5 calcium sulphate extraction for glasshouse soils.

Some common reasons for this determination are:

- Heavy application of fertilisers under conditions of intensive cropping (particularly in glasshouses) where plant growth may be affected by salt stress.
- For specific investigations of irrigation and ground waters.
- Soils recently affected by seawater are perhaps too salty to support some crops or pasture species.

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

Plants vary considerably in their tolerance to soluble salts. In outdoor situations, soluble salts should ideally be at a low level.

Phosphate Retention

Phosphate retention refers to the phosphorus immobilisation property of the soil. Although high phosphate retention soils may require between two to three times the amount of phosphorus as capital or maintenance fertiliser than low phosphate retention soils, it is important to realise that a phosphate retention of 90% does not mean that 90% of the applied P is rendered unavailable to plants.

¹¹ Edmeades, D.C.; Wheeler, D.M.; Waller, J.E. (1984). Comparison of methods for determining lime requirements of New Zealand soils. *New Zealand Journal of Agricultural Research* 28: 93-100.

¹² Refer to TN012: The Resin P Soil Test.

Level	Phosphate Retention (%)
Very Low	< 10
Low	10 - 30
Medium	30 - 60
High	60 - 80
Very High	> 80

Phosphate retention should be included with any initial soil test to establish the value for that soil type. This value is an inherent property of the soil and does not change.

Organic Matter

Organic matter in the soil is the main contributor to the soil's C.E.C, and is also a source of many nutrients, especially nitrogen. Soils with medium to high levels would generally be expected to have good structure, moisture retention and water percolation properties. The effectiveness of some agrochemicals is also dependent on soil organic matter.

Organic matter is calculated from the organic carbon level. It is also used together with the total nitrogen result to calculate the carbon/nitrogen ratio.

$$\text{Organic Matter (\%)} = \text{Organic Carbon (\%)} \times 1.72$$

No correction is made for incomplete oxidation of the organic carbon. Recoveries of 95% have been established¹³.

Level	Organic Matter (%)
Very Low	< 3
Low	3 - 7
Medium	7 - 17
High	17 - 35
Very High	> 35

Available Nitrogen

This test is designed to give an indication of the quantities of nitrogen that could be readily mineralised from soil organic matter under ideal soil conditions. The actual amounts of nitrogen that will mineralise in the field will depend on factors such as soil temperature and moisture, which are impossible to emulate or predict in the laboratory. This test must be interpreted with caution, realising that it is only a measure of nitrogen mineralised under specific laboratory conditions.

The test measures the long term potential of cultivated soil to provide nitrogen, but is not recommended for pasture soils. These soils invariably show very high levels, but may still

¹³ In-house trial comparing this method's OC with total carbon results by Leco Induction Furnace.

benefit from strategic use nitrogen fertiliser because of unfavourable conditions for the mineralisation of soil reserves at certain times of the year.

Level	Available Nitrogen kg/ha
Very Low	< 50
Low	50 - 150
Medium	150 - 250
High	250 - 350
Very High	> 350

The test involves incubating the sample for 7 days, so this test takes longer than other analyses.

Total Nitrogen

This test estimates the 'total' nitrogen content of the soil (excluding nitrate-nitrogen). It includes nitrogen that is unavailable to the plant. The major use of this test is to provide nitrogen levels for the carbon/nitrogen ratio.

Level	Total Nitrogen (%)
Very Low	< 0.1
Low	0.1 - 0.2
Medium	0.2 - 0.5
High	0.5 - 1.0
Very High	> 1.0

Exchangeable Aluminium

Aluminium is not present in a plant available form in soils with a pH above 5.5 and therefore tests for extractable aluminium need only be done on distinctly acid soils. In New Zealand, soils with a pH range of 4.5 - 5.5 are those most likely to be affected by aluminium toxicity.

Level	Exchangeable Aluminium (me/100g)
Low	< 0.5
Medium	0.5 - 1.0
High	1.0 - 2.5
Very High	> 2.5

Extractable Boron

Boron is an essential plant nutrient, but many crops are also susceptible to boron toxicity. The difference between adequate levels and toxic levels can be quite small.

The following guidelines may be used, although be aware of different crops' tolerance to boron. For example, avocado has a high boron requirement, but kiwifruit is sensitive to boron toxicity. This should be considered, especially when changing from one crop to another.

Level	Boron (µg/g)
Low	< 1
Medium	1 - 2
High	2 - 5
Very High	> 5

Reserve Magnesium

Reserve magnesium is used to estimate long-term magnesium reserves in the soil and is predominantly used in research investigations.

The difference between the slow, long term available magnesium and the exchangeable magnesium of the soil is called the Reserve Magnesium. Because the total magnesium content of soils is often very large, and the maintenance requirements of pasture and crops are relatively small, it is likely that slow weathering of magnesium containing minerals and clays can supply an appreciable proportion of plant requirements.

Level	Reserve Magnesium (me/100g)
Very Low	< 3
Low	3 - 7
Medium	7 - 15
High	15 - 30
Very High	> 30

Reserve Potassium

The amount of slowly released potassium is often more significant than the amount of immediately available exchangeable potassium. The Reserve Potassium test is used to estimate the long term potassium supplying potential of the soil, and appears to be unaffected by short term treatments.

Level	Reserve Potassium (me/100g)
Very Low	< 0.10
Low	0.10 - 0.20
Medium	0.20 - 0.35
High	0.35 - 0.50
Very High	> 0.50

Carbon:Nitrogen Ratio

The ratio of organic carbon and total nitrogen gives important information as to the nature of the organic matter present in the soil.

The organic carbon level is related to the organic matter by the following empirical relationship:

$$\text{Organic Carbon (\%)} = \frac{\text{Organic Matter (\%)}}{1.72}$$

From this the C:N Ratio can be calculated:

$$\text{Carbon: Nitrogen Ratio} = \frac{\text{Organic Carbon (\%)}}{\text{Total Nitrogen (\%)}}$$

Level	C/N Ratio
Very Low	< 8
Low	8 - 10
Medium	10 - 15
High	15 - 25
Very High	> 25

A ratio of 10 - 12 is normal for an arable soil with a good rate of organic matter decomposition, 15 - 20 indicates slow decomposition of the organic matter. Ratios greater than 25 suggests that the organic matter is not decomposing.

Trace Elements

For levels of trace elements¹⁴ (Mn, Zn, Cu, Co), Hill Laboratories considers that a plant tissue analysis is a preferred means of assessing the availability of these soil nutrients to the crop.

However, if there is a particular requirement for these trace elements to be determined in the soil, a Trace Element test is available.

Currently, no reliable soil tests exists for plant available iron (Fe), molybdenum (Mo), selenium (Se) or iodine (I).

Others

We also offer other specialist interest tests. Please contact the laboratory to discuss individual requests.

¹⁴ Refer to TN001: New Calibration Data for Soil Trace element Tests in NZ.

Agriculture		Horticulture					Test/Comments
Pasture	Crop	Tree Crop	Field Crop	Glass House	Forestry	Sports Turf	
✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	Basic Soil
✓✓	✓	✓	✓	-	✓	-	Sulphate Sulphur - where sulphur is likely to be lost by leaching i.e. sedimentary soils or if sulphur is not included in the fertiliser programme on a regular basis.
✓	✓	-	-	-	-	-	Organic Sulphur - where sulphate sulphur status is low and there is a requirement for more information on soil sulphur status.
✓✓	✓✓	*	*	-	*	-	Resin Phosphorus - where RPR or similar slow release P fertilisers have been used.
-	-	-	-	✓✓	-	-	Soluble Salts - in glasshouse soils where high fertiliser application rates and high evapo-transpiration rates often cause a build up of salts which may harm sensitive crops.
*	*	*	✓	-	-	✓	Soluble Salts (field) - where high salt levels due to fertiliser, irrigation water content, sea water contamination or other factors is suspected.
✓	✓	✓	✓	✓	✓	✓	Phosphate Retention - where capital application of P fertiliser is contemplated. The P retention value will influence the required application rate to reach a target level.
*	✓	✓	✓	✓	✓	*	Organic Matter - gives an indication of nutrient reserve, soil structure and moisture retention characteristics. Normally on cropping soils or in development situations.
-	✓✓	-	✓✓	-	-	-	Available Nitrogen - test is designed to estimate N status of cultivated soil.
*	-	-	-	-	*	-	Exchangeable Aluminium - where soil pH is low and the economics of lime application to counter Al toxicity is being investigated.
*	*	✓	*	✓	✓	-	Boron - where the soil boron status is required, normally in horticultural cropping situations where crops have a known requirement for this nutrient.
-	*	-	-	-	*	-	Total Nitrogen - used in conjunction with Organic Matter to determine C:N ratio as a measure of biological activity in the soil.
✓	-	*	-	-	✓	-	Reserve Potassium - where the soils capacity to provide slow release/long term potassium to pasture or crops, including tree crops is required.
-	✓	✓	✓	-	✓	-	Reserve Magnesium - where the soils capacity to provide slow release/long term magnesium to pasture or crops is required.

✓✓ Recommended
 ✓ Optional

* For specific investigations only
 - Not normally requested

Table 2: Soil test selection guide by enterprise description

Chapter four

Plant Tests and Interpretation

Sample Preparation

All plant tissue samples are oven dried at 80°C. All results are reported on this basis and no correction is made to an oven dried basis (103°C). In-house experiments have determined residual moisture to be typically 4%.

After drying, plant tissue samples are ground to pass through a 1mm sieve.

Plant Test Selection

We have organised our analysis into two sets. The first, our Basic Plant test, includes components of universal significance for all crops:

- nitrogen
- phosphorus
- potassium
- sulphur
- calcium
- magnesium
- sodium
- iron
- manganese
- zinc
- copper
- boron

Additional elements are sometimes important for the complete nutrition of certain crops, or for animal health. The following additional analyses are routinely available:

- molybdenum
- cobalt
- selenium
- iodine
- chloride
- sulphate-sulphur
- nitrate-nitrogen
- aluminium

The requirement for these varies with the crop under consideration. Refer to Table 3 and the appropriate **Crop Guide** for specific test recommendations.

If in doubt about your exact requirements, or if you require analyses not listed, please do not hesitate to inquire.

Interpretation of Results

As with soil testing, the usefulness of plant tissue analysis is limited by the availability of reliable interpretation data. For most of the established crops, this information is available, and **Crop Guides** have been compiled by the laboratory for many crops.

If no data is available for a particular crop, it is suggested that you contact the laboratory for further advice. We may have references that can help.

Plant tissue analysis is a powerful tool to diagnose nutrient imbalances, but the consultant should consider other possible causes of plant stress, such as drought, temperature or disease. Care must be taken to differentiate between abnormal levels that may be the result of some other problem, rather than the primary cause. An example would be low phosphorus levels in young maize plants being due to low soil temperatures, not a soil phosphate deficiency.

To help identify visual symptoms, Table 4 gives a summary of nutrient function and deficiency and toxicity symptoms.

Interpretation of plant tissue analyses is more difficult than for soil tests, but the greater reliability it provides justifies the extra effort. As with soil testing, the field consultant, and not the laboratory, should interpret the results, as other relevant factors that may be affecting plant health can then be taken into account.

Special Considerations for Mixed Pasture Interpretation

We are aware of the major role our histogram reports play in the interpretation of analysis results. It is not always an easy task to define the normal range for each element. For most crops, the normal nutrient levels are set for maximum yield, but for grazed crops, account must be taken of pasture composition and animal requirements.

Animal vs Pasture Requirements

We have taken the approach that in the case of mixed pasture, it is better that we set the normal ranges to be a compromise based on the animal and plant requirements, whichever is the greater.

It is well known that the nutrient requirements of grazing animals can be quite different from the levels required for maximum pasture production. Perhaps the best example of this is potassium. Maximum pasture production in the early spring requires potassium herbage levels of 2.5-3.5%, whereas a dairy cow with adequate pasture intake requires herbage levels of only 1.0%. At this level, pasture growth would be severely restricted, while at 3.5%, potassium would adversely affect the animals uptake of other essential minerals, particularly magnesium, calcium and sodium.

The farmer's main objective is to produce healthy animals to maximise live weights and/or milk production. While pasture production is a major factor in achieving this goal, it should not be the sole consideration. We believe the normal range levels adopted for pasture samples at this laboratory represents the best compromise between animal and plant requirements.

Pasture Composition

An attempt to assess the adequate supply of nutrients when more than one species has been samples must always be regarded as approximate only. Plants will not only have differing abilities to extract nutrients from the soil, but their normal range levels may also be quite different. For example, clover boron levels are typically 25 µg/g, while for ryegrass it is 10 µg/g. Our normal level assumes a 20% clover content is set at 10-15 µg/g. When interpreting pasture samples comprising several species, these compromises should be taken into consideration.

Agriculture		Horticulture						Test/Comments
Pasture	Crop	Fruit Crop	Veg. Crop	Kiwifruit	Forestry	Sports Turf	Ornamental Crop	
✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	Basic Plant
✓✓	-	-	✓	-	-	-	-	Molybdenum
✓✓	-	-	-	-	-	-	-	Cobalt
✓✓	-	-	-	-	-	-	-	Selenium
✓	-	-	-	-	-	-	-	Iodine
*	*	-	*	-	-	-	-	Chloride
-	*	-	*	-	-	-	-	Sulphate-S
-	-	-	-	-	-	-	-	Aluminium
*	*	-	*	-	-	-	-	Nitrate-N

✓✓ Recommended
 ✓ Optional

* For specific investigations only
 - Not normally requested

Table 3: Plant test selection guide by enterprise description

	Physiological Function/Unit	Deficiency Symptoms	Toxicity Symptoms
N	Amino acid, protein, nucleic acid, nucleotides, chlorophyll	In crop species, chlorosis of the whole plant, with reddening in cold weather; older leaves usually affected first. Plants much smaller than usual, leaf senescence accelerated.	Ammonium-N: Initial necrosis, blackening around edge and tip of leaves. Root damage may occur. Nitrate-N: Edge burn may be followed by interveinal collapse.
P	Energy storage and transfer, membrane integrity	In crop species, dark green foliage, reddening or purpling of leaves or petioles (similar to cold effects). Older leaves affected first.	Interveinal chlorosis in younger leaves, resembling iron deficiency, necrosis and tip die back may follow in susceptible species. Marginal scorch, interveinal necrosis, and shedding of older leaves.
K	Translocation, water relations, energy relations, stomatal opening, cellular pH control, osmo-regulation, cation-anion balance	Older leaves of crop species may show chlorosis and necrosis near margins or marginal burn; younger leaves may develop red pigmentation or become interveinally chlorotic and show a shiny surface. Leaves may be cupped. Older leaves are affected first	
S	Protein synthesis and function, energy transfer, structure	In crop species there is a chlorosis of the whole plant, often younger leaves affected first and more severely. Shortened internodes. Under severe deficiency, the young leaves become pale red, the leaf tips die and shrivel, and the terminal buds abort. Leaves which are uniformly yellow are indistinguishable from those suffering nitrogen deficiency. However, nitrogen deficiency symptoms first appear in mature leaves and the young leaves do not develop a red blush.	Sulphate-S: Severe stunting. Marginal chlorosis or necrosis of older leaves.
Ca	Membrane maintenance, cell division and elongation, cell wall stabilisation, cation-anion balance, osmo-regulation, second messenger in environmental signals	Growing point dies in crops. In fruit crops, disorders of fruit occur. In leaf crops, disorders such as leaf-tip burn occurs. Expanding leaves develop tip and marginal burns and the leaves appear distorted with rolled margins. Root tips are gelatinous and swollen. Young leaves are affected first.	
Mg	CO ₂ assimilation, cellular pH control, cation-anion balance, protein synthesis, carbohydrate partitioning	Marginal or interveinal chlorosis in older leaves of crops; green area of leaf may form an 'arrow-head' in woody plants. Strong red, orange or purple tints may border the chlorotic zone. Usually affects older leaves first	
Na	Conversion of pyruvate to phosphoenolpyruvate in C ₄ photosynthetic pathway		Marginal chlorosis and burn, more severe in older leaves.
Fe	Oxidation-reduction in electron transport	Interveinal chlorosis which in severe cases may mean bleaching of young foliage followed by necrosis. Young leaves affected first.	
Mn	Oxidation-reduction in electron transport, O ₂ evolution in photosynthesis	Interveinal chlorosis. Unlike iron deficiency, when severe, dark necrotic spots or streaks may form. Often occurs first on middle leaves.	Yellowing, beginning at the leaf edge of older leaves, sometimes with upward cupping; brown necrotic peppering on older leaves.
Zn	Auxin metabolism, nucleotide synthesis, membrane integrity	Little leaves, rosetting of terminal and lateral shoots, yellow-ivory chlorotic mottle in less severe cases.	Interveinal chlorosis in younger leaves in milder cases, resembling iron deficiency. Severe symptoms develop in older leaves as an interveinal chlorosis or necrosis.
Cu	Lignin synthesis, terminal oxidation in redox reactions, pollen formation and fertilisation	Death or permanent wilting of young leaves, not always chlorotic, failure of fertilisation and fruit set. Expanded leaves become twisted and cupped, and margins may be irregular in outline. Emerging leaves often trapped in subtending leaves.	
B	Nucleotide synthesis, assimilate translocation, cell wall biosynthesis and structure, plasma membrane integrity	Death of growing points. Axillary buds may burst giving a witches broom effect. Fruit may be distorted or show woody pits or cracking. Root tips enlarged.	Interveinal necrosis on older leaves, often spotty at first. Leaf tip and margin necrosis and burn in older leaves of trees and vines.
Mo	Nitrogen fixation, nitrate reduction	In legumes, general paleness. In non-legumes, mottled pale appearance, marginal burn of mature leaves. Whiptail in brassica, yellow spot in citrus. Older leaves affected first.	
Cl	Maintenance of electro-neutrality, internal turgor		Bronzing, chlorosis, marginal burn in older leaves; leaf drop may be premature. In some species, the marginal burn is accompanied by upward curling.
Al			Symptoms on shoots may resemble phosphorus deficiency. Roots frequently stunted, brown, with many short laterals.

Table 4: Nutrient function, deficiencies and toxicity symptoms^{15,16}
¹⁵ Reuter, D.J. and Robinson, J.B. (Eds) 1997. *Plant analysis: an interpretation manual*. Australia, CSIRO Publishing. p39-42.

¹⁶ Clark, C.J., Smith, G.S., Prasad, M., and Cornforth, I.H. (Eds) 1986. *Fertiliser recommendations for horticultural crops*. Wellington, MAF. p14-16.

Chapter five

Sample Submission and Reporting Options

We are always striving to find ways to make our services as easy for the consultant to use as possible. To do this we provide the following information and options:

Availability of Services

The laboratory's office hours are from 8 am to 5 pm, Monday to Friday. The Sample Reception Section stays open to receive samples till 5:30 on these days, and is open on Saturday morning. Outside these hours there are often laboratory staff on-site, but they are usually not the appropriate staff to handle client inquiries. If you have any special requirements to drop off samples or make contact with particular staff members, please phone during office hours to make suitable arrangements.

Augers

A good soil auger makes taking soil samples a lot easier. We continually hold a supply of augers that can be loaned or sold.

Sample Bags

We can supply soil and plant sample bags. If you don't have our bags with you when you go out to sample, other clean bags will be adequate. Remember that plant tissue samples are best submitted in either paper bags or plastic bags with ventilation holes.

Request Forms

The Request Form is an important document which serves a central role in the sampling and testing process.

- It tells us who the client is, where they live and how to contact them. (Here, client is used synonymously with the consultant/submitter.)
- It tells us who to charge and where to send reports to.

- It lists all the samples in the job, telling us how many accompanying sample bags there should be.
- It tells us what to test the samples for.
- It documents any special instructions for us.

Sample processing is streamlined when all this information is available. If you have no Request Forms handy, simply write the information on a note accompanying the samples. Also ask the office to send a supply of Request Forms to you for next time.

We currently have the following Request Forms available:

- Soil & Plant (Standard)
- Potting Media
- Feedstuffs
- Animal Dietary Mineral Balance
- Apple Fruitlet
- Apple Fruit (ENZA)

Sample Transportation

Samples can be sent to the laboratory either by mail, via a courier service or by personal delivery.

We can assist with the efficient transportation of samples in a number of different ways.

For company representatives who send in relatively large numbers of samples, we can supply pre-paid courier tickets for them to use on any parcels of samples they send us. Please inquire if this is of interest.

We can also supply Free Post bags if this is more convenient to the client. These bags hold about four to six samples each.

Analysis Turn-around Time

Sample analysis typically take three to ten days, depending on the test selection, the number of samples submitted and the time of year.

Reporting of Results

Options

Our standard report format shows the analytical results together with optimum ranges for that crop. For easy visual comparison, the results are presented in a histogram form as well.

Original reports are sent by mail to either the client or the submitter. On request, we will also mail a photocopy of this report to a second party. A photocopy of the original report is kept on file at the laboratory for future reference or if extra copies are required at a later date.

In order to get results to clients more quickly, we will also fax reports when required.

More of our clients are now using an email service. Several reporting options are available from a simple listing of results in a comma separated variable (CSV) file, to a more complete report including normal range levels and histograms.

All reports must go through a final check by an IANZ approved signatory at which time they are signed before being released. This precludes the office staff from giving unchecked results over the phone, even though the report may be complete.

Interim Reports

We are happy to provide interim reports in cases where not all tests are complete, and you urgently require whatever is available to date. Reports will be clearly marked as INTERIM.

Amended Reports

From time to time there is a requirement for us to alter a report that has already been completed and released. The main reason for alterations is an incorrect code being assigned to the sample, and consequently the report histogram being for the wrong crop. Another reason is when an error in the results is discovered and a correction needs to be made. Whatever the reason, we will reprint the report with AMENDED typed across the top to clearly indicate that the report is different to the one originally reported.

Confidentiality

Due to issues of confidentiality, we have a policy of releasing results only to the person who paid for the analysis, or their consultant who submitted the samples. We believe that both our principle client

(the consultant) and whoever pays for the work (usually the farmer or grower) are entitled to receive extra copies.

From time to time we get requests from third parties requesting copies of reports they are not entitled to under this policy. We believe most of these are genuine requests, but we have also had cases where this third party was in a dispute with the client.

To comply with our legal obligations, we have to adhere strictly to our policy.

If you require a copy of somebody else's report, please get *the original client or submitter* to contact us, preferably by fax, requesting that the additional copy be sent to you.

Simply telling us it's OK with the client will not be enough for us to comply with your request.

Retention of Samples

Samples are kept in storage for two months, in case additional tests or checks are requested at a later time. If you wish us to return them to you, you will need to advise the laboratory in time.

Appendix one

Other Testing Services

The focus of this document is mainly on soil and plant nutrient analysis. There are other tests available for a wide variety of materials that are listed below. Please contact the laboratory for more information.

Soil & Plant Division

Chemical testing for:

- Potting media
- Hydroponic nutrient solutions (NFT)
- Feedstuff

Tests include:

- Plant available nutrients
- pH and conductivity
- Protein, fibre, ash, dry matter

Environmental Division

Chemical testing for:

- Potable (drinking) waters
- Environmental monitoring
- Contaminated sites
- Resource consents
- Pollution control
- Trade wastes
- Effluent testing
- Landfill monitoring

Tests include:

- Nutrients
- Metals
- Hydrocarbons
- Pesticides and herbicides
- Other organic compounds
- Contaminants such as cyanide, phenols, sulphide

Industrial & Food Division

Chemical testing for:

- Fertilisers
- Compost and manures
- Industrial chemicals
- Foods and dairy products
- Drenches
- Biochemical and pharmaceutical raw materials

Tests include:

- Major and trace elements
- Heavy metals
- Specification assays
- Protein, fibre, fat and carbohydrates
- Iodine

Appendix two

Test Method Summary and References

The science behind soil and plant testing is well established and varied. There has been little change in the way samples are prepared and, with the exception of exchange membrane technology used in the Sulphate-S and Resin-P methods, in the way that nutrients are extracted. Subsequent determinations of various analytes of interest are based on traditional wet chemistry methods, as reflected by the large number of older references given below. More recently, with major improvements in analytical technology and computer capabilities, there has been a shift to greater use of instrumental methods to determine these analytes.

The following list gives a brief description of our tests, and a list of references pertaining to each one. Some methods have been modified from the original.

Soil

Sample Preparation

Soils are dried in a forced air convection drier at 35°C and crushed to pass through a 2mm sieve. No correction is made to an oven dried basis (103°C). In-house experiments have determined residual moistures to be typically 5%.

Volume Weight

A fixed volume (10 mL) of dried and ground soil is weighed.

pH

Ten mL of soil is slurried with 20 mL of water, and after standing overnight, the pH is measured.

1. 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 A1.1.
2. Metson, A.J. 1971. *Methods of chemical analysis for soil survey samples*. New Zealand, NZ DSIR. (NZ Soil Bureau Scientific Report 12. p 21.
3. Blakemore, L.C., Searle, P.L., Daly, B.K. 1987. *Methods for chemical analysis of soils*. New Zealand, NZ DSIR. (NZ Soil Bureau Scientific Report 80. p A1.1.
4. Brezinski, (1983). Kinetic, Static and Stirring Errors of Liquid Junction Reference Electrodes. *Analyst*. 108: 425.

Phosphorus

Phosphorus is extracted using Olsen's procedure (0.5M sodium bicarbonate, pH 8.5, 1:20 v/v soil:extractant ratio, 30 minutes extraction), and the extracted phosphate is determined colorimetrically by a molybdenum blue procedure.

1. Watanabe, F.S. and Olsen, S.R. (1965). Test of an ascorbic acid method for determining phosphorus in water and sodium bicarbonate extracts from soil. *Soil Science Proceeding*. p 677.
2. Murphy, J. and Riley, J.P. (1962). A modified single solution method for the determination of phosphate in natural waters. *Anal. Chim. Acta*. 27, p 31.
3. Council on Soil Testing and Plant Analysis, (1980). *Handbook on reference methods for soil testing*. p47.
4. Banderis, A., Barter, D.H. and Henderson, K. (1976). The use of polyacrylamide to replace carbon in the determination of "Olsen's" extractable phosphate in soil. *J Soil Sci*. 27:71-4.
5. Council on Soil Testing and Plant Analysis (1980). *Reference Methods for Soil Testing*.

- Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *USDA Circular 939*.

Cations

Cations (K, Ca, Mg, Na) are extracted using ammonium acetate (1.0M, pH 7, 1:20 v/v soil:extractant ratio, 30 minutes extraction), and determined by Atomic Absorption/Emission Spectroscopy. Levels found are converted to concentrations in the soil on a weight basis using the Volume Weight test result.

This extraction procedure does not extract all the cations as determined by the original leaching column procedure. Typically greater than 90% of the exchangeable potassium and sodium are extracted, with 80% of the exchangeable calcium and magnesium being measured. For general diagnostic work, this discrepancy is of little concern, but for research work it may need to be considered.

- Council on Soil Testing and Plant Analysis, (1980). *Handbook on reference methods for soil testing*. p58.
- Methods of soil analysis used in the State Testing Laboratory at Oregon State University*. Special Report 321, Agricultural Experiment station, Oregon State University, Corvallis.
- 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 A6.1.
- Metson, A.J. 1971. *Methods of chemical analysis for soil survey samples*. New Zealand, NZ DSIR. (NZ Soil Bureau Scientific Report 12. p 172.

Cation Exchange Capacity

Cation Exchange Capacity (CEC) is calculated by summation of the extractable cations and the extractable acidity. The extractable acidity is determined from the decrease in pH of the buffered ammonium acetate cation extract.

This method tends to slightly under estimate the CEC compared to that found by the leaching column procedure.

The CEC values for soils with either high soluble salts or free calcium carbonate will be overestimated by this summation method. Apart from some glasshouse soils, very few New Zealand soils are in these categories.

- Hesse, P.R. (1971). *A textbook of soil chemical analysis*. John Murray, p 35, 88.

Lime Requirement

Lime requirement is a calculation based on the soil's cation exchange capacity and base saturation.

- In-house calculations derived theoretically from first principles.
- Edmeades, D.C., Wheeler, D.M., Waller, J.E. (1984). Comparison of methods for determining lime requirements of New Zealand soils. *New Zealand Journal of Agricultural Research* 28: 93-100.

Soluble Salts

Glasshouse soil soluble salts are extracted with saturated calcium sulphate solution (1:2.5 w/v soil:extractant ratio, 1 hour shaking). A water extraction (1:5 w/v soil:extractant ratio, 30 minutes shaking) is used for field soils. In both cases, the conductivity of the extract is converted empirically to a percentage soluble salts in the soil.

- Windsor, G.W., Davies, J.N. and Massey, D.M. (1963). Salinity studies . I: Effect of calcium sulphate on the correlation between plant growth and electrical conductivity of soil extracts. *J. Sci. Fd Agric.*, 14:p42
- Page, A.L. et al (1982). *Methods of Soil Analysis. Part 2 - Chemical and Microbiological Properties*. Second Ed. Am. Soc. Agron. p167.
- 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.

Phosphate Retention

A standard solution containing 1000 mg/L P and buffered to pH 4.65 is used. After overnight shaking (1:5 w/v soil:extractant ratio), the P remaining in solution is determined colorimetrically. The P retained by the soil is calculated by difference and expressed as a percentage of the total.

1. 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 A5.6.
2. Saunders, W.M.H. (1965). Phosphate retention in New Zealand soils and its relation to free sesquioxides, organic matter and other soil properties. *New Zealand Journal of Agricultural Research*. 8:30.

Organic Matter

This is determined by a modified Walkley-Black procedure, where the organic matter is oxidised by dichromate and sulphuric acid. The chromium (III) produced is measured colorimetrically.

1. Walkley, A. and Black, I.A. (1934). An examination of the Degtjareff method of determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science*. 37:29.
2. 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 A3.7.

Available Nitrogen

The soil is incubated for seven days at 40°C, after which the ammonium-N is extracted with potassium chloride (2M potassium chloride, 1:5 v/v soil:extractant ratio, 15 minute shaking), and determined colorimetrically. The result is expressed as kg/ha, assuming a 15cm sampling depth.

1. Keeney, D.R. and Bremner, J.M. (1966). Comparison and evaluation of laboratory methods of obtaining an index of soil nitrogen availability. *Agron. Journal*. 58:498.
2. Hinds, A.A. and Lowe, L.E. (1980). Application of the Berthelot reaction to the determination of ammonium-N in soil extracts and soil digests. *Comm. Soil Sci. and Plant Anal.* 11:469.

Reserve Magnesium

Magnesium is extracted using boiling hydrochloric acid (1M, 1:40 w/v soil:extractant ratio, 15 minutes boiling). After filtration, magnesium is measured in the filtrate by Atomic Absorption Spectroscopy, and the magnesium from the Basic Soil test is subtracted. The difference is designated as the reserve magnesium.

1. Metson, A.J. (1975). Magnesium in New Zealand soils II. *New Zealand Journal of Agricultural Research*. 18:319.

Reserve Potassium

Readily available potassium is removed by extraction with nitric acid (1M, 1:100 w/v soil:extractant ratio, 20 minute boiling). The potassium removed by a subsequent extraction with nitric acid (1M, 1:25 w/v soil:extractant ratio, 10 minutes boiling) is designated as the reserve potassium. Potassium is measured in the filtrate by Atomic Emission Spectroscopy.

1. 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.
2. Metson, A.J., Arbuckle, R.H., and Saunders, M.L. (1956). The potassium-supplying power of New Zealand soils as determined by a modified normal-nitric-acid method. *Trans 6th Int Cong Soil Sci B*. 619-27.
3. Metson, A.J. (1968). The long-term potassium-supplying power of New Zealand soils. *Trans 9th Int Cong. Soil Sci 2*. 621-9.

Aluminium

Aluminium is extracted from the soil using potassium chloride (1M, 1:10 w/v soil:extractant ratio, 30 minutes shaking). Aluminium in the filtrate is measured by ICP-OES.

1. Westerman, R.L. (1990). *Soil Testing and Plant Analysis*. (Soil Science of America Book Series, 3rd Edition).
2. 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.

Resin P

Soluble and partially soluble sources of P are extracted using an ion exchange membrane and water extraction technique (1:30 w/v soil:extractant ratio, 16 hours shaking). Subsequent elution of P from the strip is done using nitric acid and P is determined colorimetrically.

1. Saggiar, S., Hedley, M.J. and White, R.E. (1990). A simplified resin membrane technique for extracting phosphorus from soils. *Fertiliser Research* 24. 173-180.
2. Saggiar, S., Hedley, M.J., White, R.E., Gregg, P.E.H., Perrott, K.W. and Cornforth, I.S. (1992). Development and evaluation of an improved soil test for phosphorus. 2. Comparison of the Olsen and mixed cation-anion exchange resin tests for predicting the yield of ryegrass grown in pots. *Fertiliser Research* 33. 135-144.

Boron

Boron is extracted using 'hot water' (0.01M CaCl₂, 1:2 w/v soil:extractant ratio, 10 minute boiling) and measured colorimetrically in the filtrate.

1. Gaines, T.P. and Mitchell, G.A. (1979). Boron determination in plant tissue by the azomethine-H method. *Comm Soil Sci. and Plant Anal.* 10:1099.
2. Wolf, B. (1971). The determination of boron in soil extracts, plant materials, composts, manures, waters and nutrient solutions. *Comm. Soil Sci. and Plant Anal.* 2:363.
3. Wolf, B. (1976). Improvements in the azomethine-H method for colorimetric determination of boron. *Comm. Soil Sci. and Plant Anal.* 7:331.

Sulphate-S

Sulphate-S is extracted using an ion exchange membrane and water extraction technique (1:10 v/v soil:extractant ratio, 16 hours shaking). Subsequent elution of S from the strip is done using nitric acid and S is determined by ICP-OES.

1. Searle, P.L. (1988). The determination of phosphate-extractable sulphate in soil with an anion-exchange membrane. *Comm. Soil Sci. and Pl. Anal.* 19(13), 1477-1493.
2. Garrido, L. (1964). The determination of sulphur in plant material. *Analyst.* 89:91.

Trace Metals

The trace metals manganese, zinc, copper and cobalt are extracted using buffered EDTA (0.02M, pH 5.5, 1:4 w/v soil:extractant ratio, 16 hour shaking). The metals in the filtrate are measured by ICP-OES.

1. Forbes, E.A. (1976). Cobalt, copper and zinc in yellow-brown pumice soils under grazed, permanent pasture. *New Zealand Journal of Agriculture Research.* 19:153-164.
2. Sherrel, C.G., Percival, N.S. and Gee, T.M. (1990). Effects of cobalt application on the cobalt status of pastures. 1. Pastures with history of regular cobalt application. *New Zealand Journal of Agriculture Research.* 33:295-304.
3. G.B.C. Scientific Equipment Pty Ltd. Flame methods manual for atomic absorption. Victoria, Australia.

Plant Tissue

Sample Preparation

Plant tissue samples are oven dried at 80°C and ground to pass through a 1mm sieve. No correction is made to an oven dried basis (103°C). In-house experiments have determined residual moistures to be typically 4%.

Nitrogen

Nitrogen is determined from a modified Kjeldahl digestion (sulphuric acid/hydrogen peroxide plus selenium catalyst). Ammonium-N in the digests is measured colorimetrically by the Berthelot reaction.

1. Gorsuch, T.T. (1970). *The destruction of organic matter*. New York. Pergamon Press.
2. Hinds, A.A. and Lowe, L.E. (1980). Application of the Berthelot reaction to the determination of ammonium-N in soil extracts and soil digests. *Comm. Soil Sci. and Plant Anal.* 11:469.
3. Searle, P.L., (1984). The Berthelot or indophenol reaction and its use in the analytical chemistry of nitrogen. *Analyst.*, 109:549.
4. Boltz, D.F. and Howell, J.A. (ed) (1987). *Nitrogen in colorimetric determination of non-metal*. Wiley.
5. Weatherburn, M.W. (1967). Phenol-hypochlorite reaction for determination of ammonia. *Anal. Chem.* 39:971-4.
6. National Institute of Water and Atmospheric Research. *A quantitative test for dissolved reactive-P, ammonium-N and nitrate-N: Autoanalyser technique*. AA-DRP/NH₄/NO₃.

Basic Plant Nitric/Perchloric Digestion

0.200g of the dried and ground tissue samples are digested at 205°C in a 2:1 mixture of concentrated nitric and perchloric acids. After dilution, the final concentration of the matrix is 5% in perchloric acid.

Phosphorus

Phosphorus is determined by ICP-OES from the Basic Plant digest.

1. Metson, A.J.. Determination of some major elements in plant materials. New Zealand, NZ DSIR. (NZ Soil Bureau Scientific Report 10B).
2. Anderson, K.A. (1996). Micro-digestion and ICP-AES analysis for the determination of macro and micro elements in plant tissue. *Atomic Spectroscopy*. Jan/Feb p 30.

Sulphur

Sulphur is determined by ICP-OES from the Basic Plant digest.

1. Garrido, L. (1964). The determination of sulphur in plant material. *Analyst*. 89:91.
2. Patterson, G.D. and Pappenhagen, J.M. (1978). *Sulphur in colorimetric determination of non-metals*. Ed. D.F. Boltz, J.A. Howell, Wiley. p464-472.
3. Blanchar, R.W., Rehm, G. and Caldwell, A.C. (1965). Sulphur in plant materials by digestion with nitric and perchloric acids. *Soil Sci Proc.* p71.
4. Tabatabani, M.A. and Bremner, J.M. (1970). A simple turbidimetric method for determining total sulphur in plant materials. *Agron J.* 62:805.
5. Anderson, K.A. (1996). Micro-digestion and ICP-AES analysis for the determination of macro and micro elements in plant tissue. *Atomic Spectroscopy*. Jan/Feb p 30.

Metals

Potassium, calcium, magnesium, sodium, iron, manganese, zinc and copper are determined by ICP-OES from the Basic Plant digest.

1. G.B.C. Scientific Equipment Pty Ltd. Flame methods manual for atomic absorption. Victoria, Australia.
2. Christian, G.D. and Feldman, F.J. (1970). *A.A. spectroscopy applications in agriculture, biology and medicine*. New York. Wiley-Interscience.
3. Anderson, K.A. (1996). Micro-digestion and ICP-AES analysis for the determination of macro and micro elements in plant tissue. *Atomic Spectroscopy*. Jan/Feb p 30.

Boron

Boron is determined by ICP-OES from the Basic Plant digest.

1. Gaines, T.P. and Mitchell, G.A. (1979). Boron determination in plant tissue by the azomethine-H method. *Comm Soil Sci. and Plant Anal.* 10:1099.
2. Wolf, B. (1971). The determination of boron in soil extracts, plant materials, composts, manures, waters and nutrient solutions. *Comm. Soil Sci. and Plant Anal.* 2:363.
3. Wolf, B. (1976). Improvements in the azomethine-H method for colorimetric determination of boron. *Comm. Soil Sci. and Plant Anal.* 7:331.
4. Anderson, K.A. (1996). Micro-digestion and ICP-AES analysis for the determination of macro and micro elements in plant tissue. *Atomic Spectroscopy*. Jan/Feb p 30.

Mo, Co, Se Nitric/Perchloric Digestion

1.00g of the dried and ground tissue samples are digested at 205°C in a 6:1 mixture of concentrated nitric and perchloric acids. After dilution, the final concentration of the matrix is 10% in perchloric acid.

Molybdenum

Molybdenum is determined by ICP-MS from the Mo,Co,Se digest.

1. Quin, B.F. and Brooks, R.R. (1975). The rapid colorimetric determination of molybdenum with dithiol in biological, geochemical and steel samples. *Anal. Chim. Acta.* 74:75.
2. Bingley, J.B. (1963). Determination of molybdenum in biological materials with dithiol. *J. Agric. Fd. Chem.* 11:130.
3. Heanes, D.L. (1981). The determination of trace metals in plant material by a dry ashing procedure. Part I. Molybdenum and cobalt. *Analyst.* 106:172.

Cobalt

Cobalt is determined by ICP-MS from the Mo,Co,Se digest.

1. Gelman, A.L. (1972). Determination of cobalt in plant material by atomic absorption. *J. Sci. Fd. Agric.* 23:299.
2. Mulford, C.E. (1966). Solvent extraction techniques for A.A. spectroscopy. *Atomic Absorption Newsletter.* 5:88.

Selenium

Selenium is determined by Hydride Generation-Atomic Absorption Spectroscopy from the Mo,Co,Se digest.

1. Clinton, O.E. (1977). Determination of selenium in blood and plant material by hydride generation and A.A. spectroscopy. *Analyst.* 102:187.
2. Analytical Methods Committee (1979). *Determination of small amounts of selenium in organic matter.* 104:778.

Iodine

Samples are dry ashed twice under alkaline conditions. After dissolution of the ash, iodine is determined colorimetrically.

1. Moxon, R.E.D. and Dixon, E.J. (1980). Semi-automated method for the determination of total iodine in food. *Analyst.* 105:344.

Nitrate-N

Nitrate is extracted from the dried and ground plant tissue acetic acid (2%, 1:250 w/v tissue:extractant ratio, 45 minute shaking). The nitrate is then determined using the salicylate colorimetry procedure.

1. Cataldo, D.A., Haroon, M., Shroder, L.E. and Younger, V.L. (1975). Rapid Colorimetric Determination of Nitrate in Plant Tissue by Nitration of Salicylic Acid. *Communication in Soil and Science and Plant Analysis.* 6, 71-80.

Sulphate-S

Sulphate-sulphur is extracted with acetic acid (2%, 1:25 w/v tissue:extractant ratio, 30 minutes shaking), and the extract is treated with activated carbon to remove organic matter. After acid digestion of the extract, sulphate-sulphur is then measured by turbidimetry.

1. Garrido, L. (1964). The Determination of Sulphur in Plant Material. *Analyst.* 89, p 61.

Chloride

Chloride is determined from a nitric acid extraction (2%, 1:50 w/v tissue:extractant ratio, 1 hour shaking), by titration with silver nitrate and with potentiometric end-point detection.

1. APHA (1985). *Standard Methods for the Examination of Waters and Wastewaters.* 16th Edition, APHA Method 407C.

2. Page, A.L. et al (Eds) (1982). *Methods of Soil Analysis, Pt 2. Chemical and Microbiological Properties*. Second Edition, SSSA., p 455.

Aluminium

Aluminium is determined by ICP-OES from the Basic Plant digest.

Crop Guides

Listed below are the crops for which Crop Guides are currently (July, 1998) available from Hill Laboratories.

Alstroemeria
Apple
Apricot
Asparagus
Avocado
Barley
Bean
Beetroot
Blackberry
Blackcurrant
Blueberry
Boysenberry
Brassica
Broccoli
Brussel Sprout
Cabbage
Calla Lily
Capsicum
Carnation
Carrot
Cauliflower
Celery
Cereal
Cherry
Chestnut
Choumoellier
Chrysanthemum

Citrus
Courgette
Cucumber
Cymbidium
Egg Plant
Feijoa
Garlic
Gooseberry
Grape
Grapefruit
Gypsophila
Kale
Kiwifruit
Lemon
Lettuce
Lisianthus
Lucerne
Macadamia
Maize
Mandarin
Mixed Pasture
Nashi
Nectarine
Oat
Olive
Onion
Orange

Oriental Lily
Parsnip
Passionfruit
Pea
Peach
Pear
Persimmon
Pinus Radiata
Plum
Potato
Protea
Pumpkin/Squash
Radish
Raspberry
Rose
Ryegrass
Sandersonia
Silverbeet
Spinach
Strawberry
Sweet Potato
Tamarillo
Tomato
Turnip
Vegetable
Wheat
White Clover



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Sampling

The nutritional status of this flower is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: Prior to flowering.

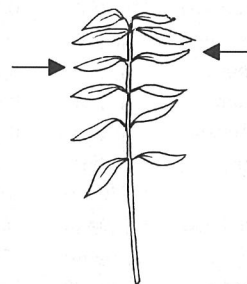
Plant Part: Youngest mature leaf.

Collect From: Mid portion of stems not yet showing flower buds.

Quantity per Sample: 25 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: Just prior to flowering or during early flowering is considered to be the appropriate time to sample. However, regular leaf analyses should be obtained through the growing season (e.g. 6 - 8 weekly intervals) in order to monitor the effect of liquid feeding programmes being used.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: From the root zone of the plants.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Soluble Salts (SG).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.7 - 5.6	pH	-	5.8 - 6.5
Phosphorus	(%)	0.30 - 0.75	Olsen P	(ug/ml)	40 - 120
Potassium	(%)	3.7 - 4.8	Potassium	(me/100g)	0.70 - 1.50
Sulphur	(%)	0.30 - 0.75	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.60 - 1.50	Magnesium	(me/100g)	1.50 - 3.00
Magnesium	(%)	0.20 - 0.50	Sodium	(me/100g)	0.10 - 0.60
Sodium	(%)	0.00 - 0.30	CEC	(me/100g)	15.0 - 30.0
Iron	(ug/g)	150 - 300	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	50 - 200	Sol.Salts (G/H)	(%)	0.00 - 0.20
Zinc	(ug/g)	30 - 60			
Copper	(ug/g)	4 - 50			
Boron	(ug/g)	13 - 50			

Comments:

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Soil and Plant Laboratory, Inc. Santa Ana, California. Pers. Comm.

Cresswell, G.C. and Weir, R.G. 1997. Plant nutrient disorders 5. Ornamental plants and shrubs. Inkata Press.

Disclaimer:

Normal Range levels quotes relate specifically to the sampling procedure given. The Normal Range levels and Comments provided are the most up to date levels available but may be altered without notification. Such alterations are implemented immediately in the laboratory histogram reports. It is recommended that a consultant or crop specialist be involved with interpretations and recommendations.



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Sampling

The nutritional status of apples trees is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: January and February.

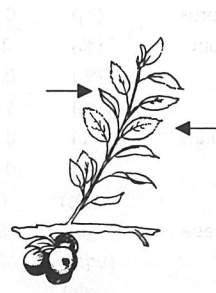
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Mid portion of the current season's non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 4 representative leaves from the periphery of each of 15 - 25 trees.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

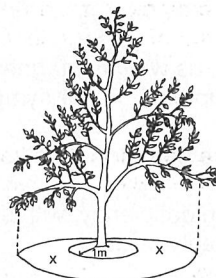
Core Depth: 20 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores from under trees selected at random from throughout the block.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.



Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 20 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	1.9 - 2.4	pH	-	5.8 - 6.8
Phosphorus	(%)	0.14 - 0.20	Olsen P	(ug/ml)	30 - 60
Potassium	(%)	1.1 - 1.5	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.15 - 0.25	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.00 - 2.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.25 - 0.35	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 250	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	50 - 160			
Zinc	(ug/g)	20 - 50			
Copper	(ug/g)	5 - 20			
Boron	(ug/g)	20 - 50			

Comments:

Nitrogen, magnesium, calcium, manganese, zinc and boron nutrient disorders are the most common.

Adequate levels of nitrogen are required at blossoming and fruit set to ensure good fruit set, particularly for green skinned varieties.

Calcium related disorders, as well as magnesium deficiencies, may be induced by high levels of potassium that depress calcium and magnesium uptake. Foliar symptoms are not necessarily evident.

Manganese toxicity is more common than its deficiency, and is often related to low soil pH or poor drainage.

Boron is the most common deficiency, with symptoms resembling those of bitter pit and fruit shape distortion. Foliar symptoms are not necessarily evident.

It has been suggested that the soil potassium level should be 3-4% of the CEC. Calcium should occupy 70-80% of the CEC sites and magnesium 10-15%.

Pipfruit trees take up phosphorus efficiently, even in highly retentive soils. The suggested optimum Olsen P level is 30 or higher.

Pipfruit will grow within a soil pH range of 5.8 - 6.8. To minimise calcium disorders in fruit, a topsoil pH of 6.5 or greater is considered desirable.

Normal ranges for sulphur and iron have been lowered from the referenced data, based on levels more typically found in New Zealand.

References:

- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Bennett, W.F. (Ed) 1993. Nutrient deficiencies & toxicities in crop plants. College of Agricultural Sciences and Natural Resources, Texas Tech University, Lubbock.
- Leece, D.R. 1976. Journal of the Australian Institute of Agricultural Science, March, pp 3-19.

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Sampling

To ensure maximum yields of quality apricots, plant nutrients must be maintained at optimum levels. The nutritional status of apricots is monitored using soil tests and plant analysis. Annual monitoring or crop logging is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: January and February.

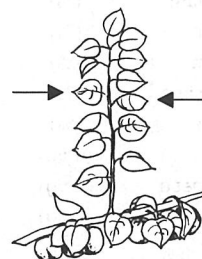
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Mid portion of the current season's non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 4 representative leaves from the periphery of each of 25 trees.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores from under trees selected at random from throughout the block.

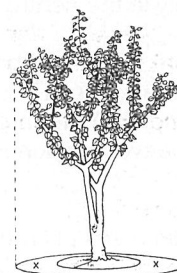
Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.4 - 3.0	pH	-	6.0 - 6.5
Phosphorus	(%)	0.14 - 0.25	Olsen P	(ug/ml)	15 - 35
Potassium	(%)	2.0 - 3.5	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.20 - 0.40	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	2.00 - 4.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 0.80	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 250	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	40 - 160			
Zinc	(ug/g)	20 - 50			
Copper	(ug/g)	5 - 16			
Boron	(ug/g)	20 - 60			

Comments:

The potassium normal range may be higher for apricots grown on apricot root stock than those grown on plum root stock.

Boron deficiency for most stonefruit is more obvious in fruit than foliage, with apricots being more susceptible than other stonefruit. In apricots, symptoms are severe external cracking, internal cork (particularly around the stone cavity), and a tendency to ripen prematurely in the centre.

Conversely, apricots are more tolerant of boron toxicity than other stonefruit. Except for old and non-fruiting trees, this crop has the ability to translocate boron from the leaves to the fruit and bark, so that leaf boron levels remain normal and the classic boron toxicity symptoms of marginally yellowed or burned leaves are consequently not observed. In extreme cases there is thickening of leaves, corkiness along the midribs and petioles, enlarged nodes, bark necrosis and death of the shoot tips.

Stonefruit will grow best within a soil pH range of 6.0 - 6.7. At lower pH, root growth and tree health are adversely affected by aluminium and manganese toxicity. At higher pH, trace element deficiencies can be induced.

It has been suggested that the soil potassium level should be 3-4% of the CEC. Calcium should occupy 70-80% of the CEC sites and magnesium, 10-15%.

Like all stonefruit, apricots prefer well draining soils.

References:

- Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
 Leece, D.R. 1976. Journal of the Australian Institute of Agricultural Science, March, pp 3-19.

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Sampling

Asparagus leaf samples can be collected just as the spears are emerging, or later when they are in fern. The latter growth stage is the preferred sampling period.

Fern

Sampling Time: February to March.

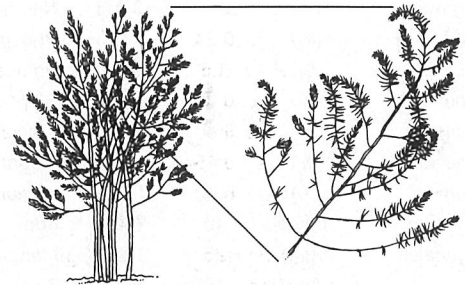
Plant Part: Fern.

Collect From: Upper 30 cm portion of the fern.

Quantity per Sample: 10 - 15 ferns.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Spear

Sampling Time: At spear emergence.

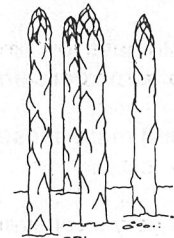
Plant Part: Spear.

Collect From: Upper 9 cm of the spear tips.

Quantity per Sample: 20 - 30 spears.

Recommended Tests: Basic Plant (BP).

Comments: This is not the recommended sampling time, but samples can be taken if a problem is suspected.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: Throughout the asparagus beds.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected plants. In these circumstances, a second sample taken for comparative purposes from the rooting zones of healthy plants may be useful.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Fern			Spear			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.4 - 3.8	Nitrogen	(%)	6.5 - 9.0	pH	-	6.0 - 6.7
Phosphorus	(%)	0.21 - 0.35	Phosphorus	(%)	0.60 - 0.90	Olsen P	(ug/ml)	30 - 50
Potassium	(%)	1.5 - 2.4	Potassium	(%)	3.0 - 4.6	Potassium	(me/100g)	0.60 - 1.00
Sulphur	(%)	0.25 - 0.40	Sulphur	(%)	0.70 - 0.90	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.40 - 0.80	Calcium	(%)	0.30 - 0.40	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.15 - 0.20	Magnesium	(%)	0.15 - 0.20	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.02 - 0.10	Sodium	(%)	0.01 - 0.05	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	40 - 150	Iron	(ug/g)	50 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 100	Manganese	(ug/g)	20 - 40			
Zinc	(ug/g)	10 - 60	Zinc	(ug/g)	80 - 120			
Copper	(ug/g)	6 - 12	Copper	(ug/g)	7 - 20			
Boron	(ug/g)	50 - 100	Boron	(ug/g)	50 - 100			

Comments:

Asparagus is a lime loving crop, preferring a soil pH above 6.0.

Asparagus is considered to have low phosphorus requirement, compared to other vegetable crops. It is, however, considered susceptible to boron deficiency.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

- Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.
- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
- Annual report of ministry of agriculture and fisheries. 1977, pg 177.
- Geraldson, C.M.; Klacan, G.R. and Lorenz, O.A. 1973. Soil testing and plant analysis. L. Walsh (Ed), Soil Science Society of America, Ch 22.

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Sampling

The nutritional status of avocado crops is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, leaf analysis is a valuable tool to assist with the diagnosis of the problem.

Sampling for nutrient monitoring should be done in March-April to coincide with cessation of the season's growth.

Leaf

Sampling Time: April to May, when the summer flush has ceased.

Plant Part: 2-4th leaf from the terminal bud (blade plus petiole).

Collect From: Shoots that are not flushing nor fruiting. Select from the canopy of the trees at shoulder height, and exclude boundary trees.



Quantity per Sample: 4-8 leaves from each of 20 trees selected at random from throughout the sampling area.

Recommended Tests: Basic Plant (BP), Chloride (CL).

Comments: Select trees that are sampled and identify them so that they can be sampled again the following year.

Ensure leaves from each tree are taken evenly from the sunny and shaded sides.

Do not mix cultivars or trees of different ages in the samples.

To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.

Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: The drip zone of the trees.

Quantity per Sample: One core from each of 15 - 20 trees.

Recommended Tests: Basic Soil (BS), Boron (BO).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.



Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

When sampling prior to orchard establishment, a 15 - 30 cm depth sample should also be taken, primarily to check the sub-soil pH.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected plants. In these circumstances, a second sample taken for comparative purposes from the rooting zones of normal plants may be useful.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.2 - 2.6	pH	-	6.0 - 6.6
Phosphorus	(%)	0.08 - 0.25	Olsen P	(ug/ml)	25 - 50
Potassium	(%)	0.8 - 2.0	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.20 - 0.60	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.00 - 3.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.25 - 0.80	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.25	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	30 - 500	Boron	(ug/g)	1.0 - 2.0
Zinc	(ug/g)	30 - 150			
Copper	(ug/g)	5 - 15			
Boron	(ug/g)	40 - 100			

Comments:

Avocado trees have a moderate nutrient demand and will tolerate a wide range of nutrients in the soil, provided there is good drainage. Avocado roots are extremely sensitive to low oxygen concentrations in the root zone.

The nutrients identified as being of concern in New Zealand are nitrogen, zinc and boron.

Normal Range nutrient levels for nitrogen apply to the Hass variety. Other varieties such as Fuerte have a lower leaf nitrogen levels of 1.6-2.0 %.

Avocado require high levels of nitrogen for adequate flowering and fruit set. However, excess nitrogen, which is not common in New Zealand, contributes to excessive vegetative growth at the expense of flowering, fruit set and fruit quality.

Zinc deficiencies affects young leaves. They tend to be small, narrow, chlorotic and often rosetted.

Boron deficiencies may inhibit the elongation of growing shoots, giving rise to short internodes. Pollination and fruit set can be poor, and developing fruit shape may become distorted. Leaves become thick and corky with necrotic patches, and the lower surface veins may split. Overcoming boron deficiencies has proven difficult in New Zealand, where standard applications rates of boron appear insufficient. Soil levels can be medium to high, but leaf analysis still show a very low boron status.

Calcium in the soil is also important, not so much as a nutrient, but as a means to manage the root fungus *Phytophthora*. For this, a pH over 6.2 is preferable.

Soil pH greater than 7 may induce iron deficiencies due to the immobilisation of iron. Symptoms are interveinal chlorosis of young leaves, with veins and older leaves remaining darker. Soil testing for iron is unreliable and not recommended by this laboratory.

References:

- Jones, W.W. and Embleton, T.W. 1978. Leaf analysis as a guide to avocado fertilisation. In Reisenauer, H.M. (Ed) (1978): Soil and Plant-Tissue Testing in California. Division of Agricultural Science, University of California.
- Cutting, J. 1997. Guidelines for drawing leaf analysis samples. Pers. Comm.
- Blackmore, L.C.; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- New Zealand Avocado Growers Association Manual.
- Banks, Alex 1992. Growing Avocados in Queensland.
- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

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Sampling

Plant growth stage has a major influence on the nutrient levels in the tissue. Two distinct growth stages are specified for sample collection; neither preferred over the other, though each is useful for a specific purpose.

Leaf - Late Tiller

Sampling Time: When the leaves have formed, and the leaf-sheaths are lengthening and becoming erect. Just prior to stem extenuation.

Plant Part: Whole above portion of the plant.

Collect From: Random sites throughout the sampling area.

Quantity per Sample: 30 to 40 plants.

Recommended Tests: Basic Plant (BP).

Comments: The advantage of sampling at this early stage is that there may be time to correct nutrient disorders observed in the current crop.



Leaf - Ear Emergence

Sampling Time: When stem extension is complete and the head of the ear emerges from the boot.

Plant Part: Whole above portion of the plant.

Collect From: Random sites throughout the sampling area.

Quantity per Sample: 20 to 30 plants.

Recommended Tests: Basic Plant (BP).

Comments: Testing at this later stage will indicate more accurately that the crop has accumulated the required nutrients successfully.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Random sites throughout the sampling area.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Soil samples are usually collected for analysis prior to planting the crop.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected areas. In these circumstances, a second sample taken for comparative purposes from the rooting zones of normal areas may be useful.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Late Tiller

Element	Unit	Normal Range
Nitrogen	(%)	2.5 - 5.0
Phosphorus	(%)	0.35 - 0.60
Potassium	(%)	3.0 - 5.5
Sulphur	(%)	0.30 - 0.45
Calcium	(%)	0.30 - 1.00
Magnesium	(%)	0.15 - 0.30
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	50 - 150
Manganese	(ug/g)	30 - 100
Zinc	(ug/g)	20 - 60
Copper	(ug/g)	6 - 12
Boron	(ug/g)	6 - 12

Leaf - Ear Emergence

Element	Unit	Normal Range
Nitrogen	(%)	2.0 - 3.0
Phosphorus	(%)	0.20 - 0.50
Potassium	(%)	1.5 - 3.0
Sulphur	(%)	0.15 - 0.40
Calcium	(%)	0.30 - 1.20
Magnesium	(%)	0.15 - 0.50
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	50 - 150
Manganese	(ug/g)	25 - 100
Zinc	(ug/g)	15 - 70
Copper	(ug/g)	5 - 25
Boron	(ug/g)	5 - 10

Soil

Element	Unit	Normal Range
pH	-	5.5 - 6.4
Olsen P	(ug/ml)	20 - 30
Potassium	(me/100g)	0.50 - 0.80
Calcium	(me/100g)	5.0 - 12.0
Magnesium	(me/100g)	0.80 - 3.00
Sodium	(me/100g)	0.00 - 0.50
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00

Comments:

Small grain production and quality are greatly influenced by fertilisation.

Nitrogen has been found to be the most important fertiliser element in New Zealand cereal crops. Significant responses to potassium, sulphur or magnesium have also been recorded.

Different cultivars have been found to have some differences in nutrient concentrations; however, these differences are relatively small, and one set of interpretation criteria can be used.

Improper growth stage identification can result in errors in interpretation. Nutrient uptake precedes dry matter accumulation occurring between tillering and head emergence. Consequently, nutrient concentrations generally decline between these stages.

Diagnosis of sulphur deficiency can be assisted by using the N:S ratio. A sulphur deficiency may exist when the N:S ratio is greater than 16:1. Severe deficiency is likely when the ratio is greater than 20:1.

References:

- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
- Lockman, R.B. 1969. Agronomy Abstracts, American Society of Agronomy, Wisconsin, pg 97.
- Ward, R.C.; Whitney, D.A. and Westfall, D.G. 1973. Plant analysis as an aid in fertilising small grains. Soil testing and plant analysis.
- Jones Jr, J.B 1967. Soil testing and plant analysis. Part 2. SSSA Special Publication Series, p 49-58.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

These guidelines apply to phaseolus beans (French, dwarf, snap and runner beans).

Leaf

Sampling Time: Early flowering.

Plant Part: Youngest mature leaf (without petiole).

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	4.0 - 6.0	pH	-	5.6 - 7.0
Phosphorus	(%)	0.35 - 0.50	Olsen P	(ug/ml)	35 - 75
Potassium	(%)	1.8 - 4.0	Potassium	(me/100g)	0.70 - 1.40
Sulphur	(%)	0.25 - 0.50	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.50 - 3.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.25 - 0.70	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.06	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 300	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	50 - 300			
Zinc	(ug/g)	30 - 100			
Copper	(ug/g)	6 - 50			
Boron	(ug/g)	40 - 60			

Comments:

Being a legume, beans are able to support rhizobia that can fix nitrogen. A small amount of nitrogen fertiliser is often still beneficial.

Beans are known to be susceptible to magnesium deficiency, as well as a range of micro nutrients such as iron, manganese, zinc, copper and molybdenum.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.
 Geraldson, C.M.; Klacan, G.R. and Lorenz, O.A. 1973. Soil testing and plant analysis. L. Walsh (Ed), Soil Science Society of America, Ch 22.

Disclaimer:

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: When the root is 4 - 6 cm in diameter.

Plant Part: Youngest mature leaf (blade & petiole).

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.5 - 5.0	pH	-	6.0 - 7.2
Phosphorus	(%)	0.25 - 0.40	Olsen P	(ug/ml)	30 - 55
Potassium	(%)	2.5 - 5.0	Potassium	(me/100g)	0.70 - 1.40
Sulphur	(%)	0.25 - 0.50	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.70 - 2.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 0.80	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.50 - 6.00	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	50 - 200			
Zinc	(ug/g)	20 - 80			
Copper	(ug/g)	5 - 20			
Boron	(ug/g)	25 - 80			

Comments:

Nitrogen deficiency will show as either purpling or yellowing of the older leaves, poor growth and small roots.

Beetroot are known to be susceptible to boron deficiency. This can cause a condition known as canker, which is scattered black lesions in the flesh of the root.

Deficiencies of zinc and manganese have also been recorded.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.

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Sampling

The nutritional status of blackberries is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: During fruit set.

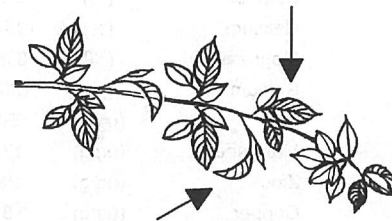
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Current season's non-fruiting canes.

Quantity per Sample: 5 representative leaves from each of 10 vines.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the rooting zone of the vines.

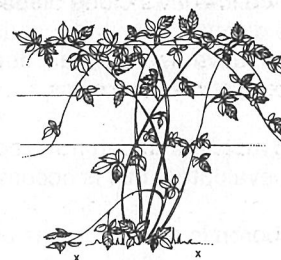
Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Soil samples are usually collected for analysis prior to planting the crop.

If trickle irrigation is used, the wetted zones of the soil should be sampled separately, as minerals in the water may produce abnormal test levels.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected vines. In these circumstances, a second sample taken for comparative purposes from the rooting zones of normal vines may be useful.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.8 - 3.7	pH	-	5.8 - 6.5
Phosphorus	(%)	0.17 - 0.34	Olsen P	(ug/ml)	40 - 60
Potassium	(%)	1.4 - 1.9	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.18 - 0.32	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.65 - 1.37	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.22 - 0.46	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	134 - 304			
Zinc	(ug/g)	28 - 60			
Copper	(ug/g)	8 - 29			
Boron	(ug/g)	38 - 57			

Comments:

Symptoms of boron deficiency include dieback and delayed bud break, or even complete bud break failure. Young leaves may become distorted with large petioles and necrotic border tissue. Leaves forming later are not affected. Less severely affected buds give rise to small, deeply indented leaflets which persist throughout the growing season. Primocanes tend not to show symptoms.

Boron in berryfruit is mobile and can translocate in young, fruiting crops. Symptoms and detection of boron toxicity may be more difficult to evaluate if this is occurring.

Caution in applying boron is necessary, as berryfruit are thought to be susceptible towards boron toxicity.

Optimum soil pH range for berryfruit is 5.8 - 6.5. Manganese and magnesium deficiencies may arise where soil pH values are in excess of 7.0.

Soil magnesium levels should be at least twice the potassium level.

All canefruit are vulnerable to salt stress. This is normally only a problem for low lying coastal areas, or where irrigation water has high dissolved solids.

Chloride toxicity is possible, and more so in irrigated or low summer rainfall areas.

References:

Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.

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Sampling

The nutritional status of blackcurrants is monitored using soil tests and plant analysis. Regular monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: During the 2 - 3 weeks prior to fruit ripening.

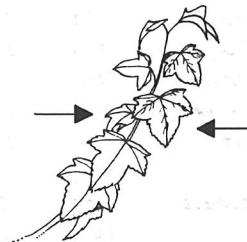
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Mid portion of the current season's extension growth.

Quantity per Sample: 5 representative leaves from each of 10 vines.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the rooting zone of the plants.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Soil samples are usually collected for analysis prior to planting the crop.

If trickle irrigation is used, the wetted zones of the soil should be sampled separately, as minerals in the water may produce abnormal test levels.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected plants. In these circumstances, a second sample taken for comparative purposes from the rooting zones of normal plants may be useful.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.9 - 3.0	pH	-	5.8 - 6.5
Phosphorus	(%)	0.26 - 0.30	Olsen P	(ug/ml)	15 - 30
Potassium	(%)	1.5 - 2.0	Potassium	(me/100g)	0.60 - 1.20
Sulphur	(%)	0.20 - 0.40	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.30 - 2.50	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.15 - 0.60	Sodium	(me/100g)	0.00 - 0.40
Sodium	(%)	0.00 - 0.05	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 100	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	30 - 100			
Zinc	(ug/g)	20 - 40			
Copper	(ug/g)	5 - 10			
Boron	(ug/g)	20 - 40			

Comments:

Most nutritional work on blackcurrants has been done in Britain and Eastern Europe, with little local information being available.

Foliar deficiency symptoms are rare in New Zealand, the most likely one being for nitrogen. Symptoms are bright orange, red or purplish red leaves.

Potassium deficiency symptoms start as red purplish leaves gradually going to necrotic marginal scorching.

Calcium and magnesium requirements are low.

Blackcurrants are sensitive to high levels of chloride, so chloride forms of fertiliser should be minimised.

Crop performance is best with a soil pH above 5.8.

References:

- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Mills, H. A. and Jones, Jr, J B 1996. Plant analysis handbook II.
- Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
- Ballinger, W.E.and Goldstone, E.F. 1967. North Carolina, Agric. Expt. Tech. Bulletin, No. 178.
- Doughty, C. Horticulturist, Washington State University. Pers Comm.

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Sampling

The nutritional status of blueberries is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: From three weeks prior to and during the first week in which 35% of the crop is harvested.

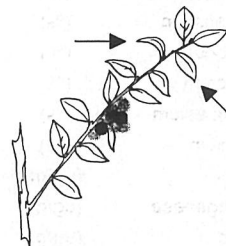
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Current season's fruiting shoots.

Quantity per Sample: 5 representative leaves from each of 10 plants.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the root zone of the bushes.

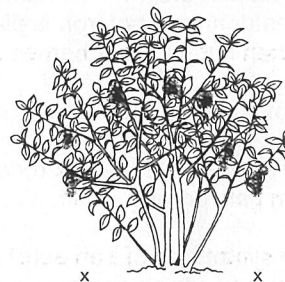
Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Soil samples are usually collected for analysis prior to planting the crop.

If trickle irrigation is used, the wetted zones of the soil should be sampled separately, as minerals in the water may produce abnormal test levels.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected plants. In these circumstances, a second sample taken for comparative purposes from the rooting zones of normal plants may be useful.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	1.8 - 2.1	pH	-	4.0 - 5.0
Phosphorus	(%)	0.12 - 0.40	Olsen P	(ug/ml)	15 - 25
Potassium	(%)	0.35 - 0.65	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.13 - 0.20	Calcium	(me/100g)	3.0 - 10.0
Calcium	(%)	0.40 - 0.80	Magnesium	(me/100g)	0.80 - 3.00
Magnesium	(%)	0.12 - 0.25	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.05	CEC	(me/100g)	12.0 - 30.0
Iron	(ug/g)	60 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	50 - 350			
Zinc	(ug/g)	8 - 30			
Copper	(ug/g)	5 - 20			
Boron	(ug/g)	30 - 70			

Comments:

Possibly the most important soil test for blueberries is the pH. The optimum pH range is 4.0 - 5.0, although higher and lower pH soils can support growth. The low pH requirement is in part due to blueberries being inefficient utilisers of iron. At the low pH, a greater amount of iron is plant available for it to draw on. Furthermore, at this pH, nitrogen is present as ammonium rather than nitrate. Blueberries prefer the ammonium form.

Consequently, the most common deficiencies encountered are those of nitrogen and iron.

Nitrogen deficiency shows as a gradual reddening of the whole leaf. Young shoot from the base of the plant tend to be pink at first and then pale green.

Young leaves show symptoms of iron deficiency as interveinal chlorosis. The symptoms are easily confused with those of manganese deficiency, which can be differentiated by the wider band of green tissue around the veins.

Boron and zinc deficiencies have also been reported in New Zealand. Boron deficiency causes small, distorted and blueish-green shoot tip leaves. In more severe cases, shoot dieback becomes quite prominent.

References:

- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Ballinger, W.E.and Goldstone, E.F. 1967. North Carolina, Agric. Expt. Tech. Bulletin, No. 178.
 Doughty, C. Horticulturist, Washington State University. Pers Comm.

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Sampling

The nutritional status of boysenberries is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: During fruit set.

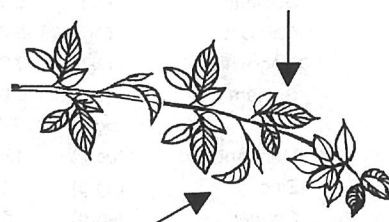
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Current season's non-fruiting canes.

Quantity per Sample: 5 representative leaves from each of 10 vines.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the rooting zone of the vines.

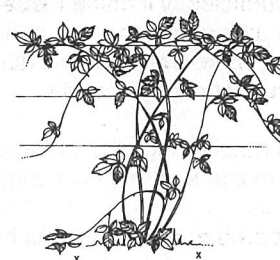
Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Soil samples are usually collected for analysis prior to planting the crop.

If trickle irrigation is used, the wetted zones of the soil should be sampled separately, as minerals in the water may produce abnormal test levels.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected vines. In these circumstances, a second sample taken for comparative purposes from the rooting zones of normal vines may be useful.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.8 - 3.7	pH	-	5.8 - 6.5
Phosphorus	(%)	0.17 - 0.34	Olsen P	(ug/ml)	40 - 60
Potassium	(%)	1.4 - 1.9	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.18 - 0.32	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.65 - 1.37	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.22 - 0.46	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	134 - 304			
Zinc	(ug/g)	28 - 60			
Copper	(ug/g)	8 - 29			
Boron	(ug/g)	38 - 57			

Comments:

Symptoms of boron deficiency include dieback and delayed bud break, or even complete bud break failure. Young leaves may become distorted with large petioles and necrotic border tissue. Leaves forming later are not affected. Less severely affected buds give rise to small, deeply indented leaflets which persist throughout the growing season. Primocanes tend not to show symptoms.

Boron in berryfruit is mobile and can translocate in young, fruiting crops. Symptoms and detection of boron toxicity may be more difficult to evaluate if this is occurring.

Caution in applying boron is necessary, as berryfruit are thought to be susceptible towards boron toxicity.

Optimum soil pH range for berryfruit is 5.8 - 6.5. Manganese and magnesium deficiencies may arise where soil pH values are in excess of 7.0.

Soil magnesium levels should be at least twice the potassium level.

All canefruit are vulnerable to salt stress. This is normally only a problem for low lying coastal areas, or where irrigation water has high dissolved solids.

Chloride toxicity is possible, and more so in irrigated or low summer rainfall areas.

References:

Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.

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Sampling

This is a general guide that applies to brassica crops, including cabbage, broccoli, brussel sprouts; cauliflower and choumoellier.

Leaf

Sampling Time: Mid-growth, or when the plant is starting to head.

Plant Part: For cabbages and cauliflower beginning to head, sample the wrapper leaf; for all other brassica crops sample recently matured leaves.

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP), Molybdenum (MO).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.

Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 5.5	pH	-	6.0 - 6.8
Phosphorus	(%)	0.26 - 0.70	Olsen P	(ug/ml)	30 - 80
Potassium	(%)	2.0 - 5.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.30 - 0.80	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.50 - 4.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.20 - 0.70	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 1.00	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 300			
Zinc	(ug/g)	20 - 200			
Copper	(ug/g)	5 - 25			
Boron	(ug/g)	25 - 150			

Comments:

Brassica are noted for their deficiencies of boron (club roots, hollow stem) and molybdenum (whiptail in cauliflower). Other deficiencies that occasionally occur are of nitrogen, sulphur and zinc.

Nitrogen deficiency will appear as a purple pink coloration in the foliage. This symptom can also be induced by other factors such as cold weather, root damage from nematodes, drought stress and water logging.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

- Blackmore, L.C.; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Scaife, A. and Turner, M. 1983. Diagnosis of mineral disorders in plants. Volume 2, Vegetables. MAFF/ARC London.
 Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
 Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: Mid growth when the curd is starting to form.

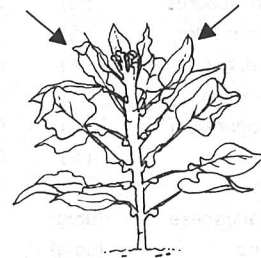
Plant Part: Youngest mature leaf.

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP), Molybdenum (MO).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.5 - 5.5	pH	-	6.0 - 7.2
Phosphorus	(%)	0.30 - 0.70	Olsen P	(ug/ml)	35 - 75
Potassium	(%)	2.0 - 4.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.30 - 0.80	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.20 - 2.50	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.20 - 0.70	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 1.00	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 200			
Zinc	(ug/g)	20 - 200			
Copper	(ug/g)	5 - 20			
Boron	(ug/g)	25 - 60			

Comments:

Broccoli has a moderate to high fertility requirement.

Sulphur and molybdenum deficiencies are known to occur in brassica crops.

Broccoli is also susceptible to deficiencies of most nutrients including nitrogen, phosphorus, potassium, magnesium, iron, copper and boron deficiency.

Manganese deficiency and toxicity has also been observed.

Nitrogen deficiency will appear as a purple pink coloration in the foliage. This symptom can also be induced by other factors such as cold weather, root damage from nematodes, drought stress and water logging.

Boron deficiency will appear as a browning of the internal stem tissue in the developing curd.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Scaife, A. and Turner, M. 1983. Diagnosis of mineral disorders in plants. Volume 2, Vegetables. MAFF/ARC London.
 Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
 Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: Mid growth when the plants are beginning to head.

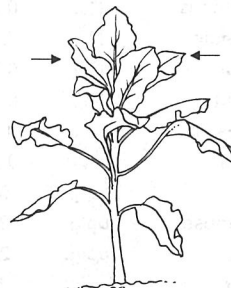
Plant Part: Youngest mature upper leaves.

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP), Molybdenum (MO).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 5.0	pH	-	5.6 - 7.0
Phosphorus	(%)	0.26 - 0.60	Olsen P	(ug/ml)	35 - 75
Potassium	(%)	2.5 - 4.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.30 - 0.80	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.50 - 2.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.20 - 0.70	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 1.00	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 200			
Zinc	(ug/g)	20 - 200			
Copper	(ug/g)	5 - 20			
Boron	(ug/g)	25 - 60			

Comments:

Brussel sprouts have a moderate to high fertility requirement, and like all brassica, are susceptible to boron and molybdenum deficiencies. Other known deficiencies are of nitrogen, sulphur and zinc.

Nitrogen deficiency will appear as a purple pink coloration in the foliage. This symptom can also be induced by other factors such as cold weather, root damage from nematodes, drought stress and water logging.

Brussel sprouts are less likely to develop deficiencies than other brassica crops.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Scaife, A. and Turner, M. 1983. Diagnosis of mineral disorders in plants. Volume 2, Vegetables. MAFF/ARC London.
- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
- Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: Mid growth, just as the plant is beginning to head.

Plant Part: Youngest mature wrapper leaf.

Collect From: -



Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP), Molybdenum (MO).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.

Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 5.0	pH	-	5.6 - 7.0
Phosphorus	(%)	0.30 - 0.50	Olsen P	(ug/ml)	35 - 75
Potassium	(%)	3.0 - 4.5	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.30 - 0.80	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.50 - 3.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.20 - 0.70	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 1.00	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 200			
Zinc	(ug/g)	20 - 200			
Copper	(ug/g)	5 - 20			
Boron	(ug/g)	25 - 60			

Comments:

Cabbage has a moderate to high fertility requirement, and like all brassica, are susceptible to boron and molybdenum deficiencies.

Nitrogen deficiency will appear as a purple pink coloration in the foliage. This symptom can also be induced by other factors such as cold weather, root damage from nematodes, drought stress and water logging.

Cabbage is also fairly susceptible to deficiencies of calcium, magnesium, manganese and copper.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Scaife, A. and Turner, M. 1983. Diagnosis of mineral disorders in plants. Volume 2, Vegetables. MAFF/ARC London.
 Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
 Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

The nutritional status of this flower is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Blade - Calla

Sampling Time: Mid season.

Plant Part: Youngest mature leaf.

Collect From: -

Quantity per Sample: 30 - 50 leaves.

Recommended Tests: Basic Plant (BP).

Comments: Just prior to flowering or during early flowering is considered to be the appropriate time to sample. However, regular leaf analyses should be obtained through the growing season (e.g. 6 - 8 weekly intervals) in order to monitor the effect of liquid feeding programmes being used.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: From the root zone of the plants.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Soluble Salts (SG).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Blade - Calla

<i>Element</i>	<i>Unit</i>	<i>Normal Range</i>
Nitrogen	(%)	3.0 - 5.0
Phosphorus	(%)	0.25 - 0.50
Potassium	(%)	3.5 - 5.5
Sulphur	(%)	0.30 - 0.60
Calcium	(%)	0.70 - 1.50
Magnesium	(%)	0.13 - 0.30
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	60 - 200
Manganese	(ug/g)	50 - 200
Zinc	(ug/g)	30 - 100
Copper	(ug/g)	6 - 15
Boron	(ug/g)	15 - 35

Soil

<i>Element</i>	<i>Unit</i>	<i>Normal Range</i>
pH	-	5.8 - 6.5
Olsen P	(ug/ml)	25 - 50
Potassium	(me/100g)	0.50 - 1.00
Calcium	(me/100g)	6.0 - 12.0
Magnesium	(me/100g)	1.00 - 3.00
Sodium	(me/100g)	0.00 - 0.50
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00
Sol.Salts (G/H)	(%)	0.00 - 0.20

Comments:

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Capsicum can be grown under glass or as a field crop. The interpretive data provided here are for glasshouse crops.

Leaf

Sampling Time: At flowering or early fruiting.

Plant Part: Upper youngest mature leaf (blade & petiole).

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.5 - 5.5	pH	-	5.4 - 6.8
Phosphorus	(%)	0.30 - 0.60	Olsen P	(ug/ml)	50 - 100
Potassium	(%)	4.0 - 5.5	Potassium	(me/100g)	0.70 - 1.40
Sulphur	(%)	0.30 - 1.30	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.50 - 3.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.40 - 0.80	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.25	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	80 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	40 - 200			
Zinc	(ug/g)	30 - 60			
Copper	(ug/g)	6 - 20			
Boron	(ug/g)	30 - 90			

Comments:

Nitrogen levels decline as the season progresses. The critical level of 4% drops to 3% during fruiting.

Calcium deficiency can produce blossom end rot in pepper fruit, as for tomatoes. The problem is exacerbated by high salt levels in the growing media.

Peppers are not as tolerant of high salt levels as tomatoes. Ensure salt levels do not exceed 0.15%.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

If the capsicums are grown in the field, the normal levels for nitrogen, phosphorus and potassium will tend to be lower than the levels quoted for glasshouse production.

References:

- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.
 Windsor, G. and Adams, P. 1987. Diagnosis of mineral disorders in plants. Volume 3, Glasshouse crops. MAFF/ARC London.

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Sampling

The nutritional status of this flower is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Regular soil and plant analyses should be obtained through the growing season (e.g. six weekly intervals) in order to monitor the effect of liquid feeding programmes being used. In this way, imbalances may be rectified before any adverse effects on the crop health occurs.

Leaf - Glasshouse

Sampling Time: 6 - 8 weeks after planting, then every 2 months.

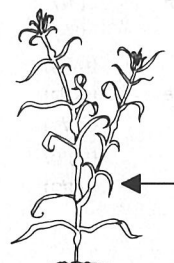
Plant Part: 5th and 6th leaf pair from the top.

Collect From: Non-flowering stems.

Quantity per Sample: 50 leaves.

Recommended Tests: Basic Plant (BP).

Comments: Just prior to flowering or during early flowering is considered to be the appropriate time to sample. However, regular leaf analyses should be obtained through the growing season (e.g. 6 - 8 weekly intervals) in order to monitor the effect of liquid feeding programmes being used.



Soil - Glasshouse

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: From the root zone of the plants.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Soluble Salts (SG).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Glasshouse

Element	Unit	Normal Range
Nitrogen	(%)	3.3 - 4.2
Phosphorus	(%)	0.26 - 0.40
Potassium	(%)	2.8 - 4.0
Sulphur	(%)	0.27 - 0.35
Calcium	(%)	1.13 - 1.64
Magnesium	(%)	0.29 - 0.39
Sodium	(%)	0.10 - 0.50
Iron	(ug/g)	51 - 120
Manganese	(ug/g)	50 - 250
Zinc	(ug/g)	20 - 60
Copper	(ug/g)	6 - 10
Boron	(ug/g)	30 - 100

Soil - Glasshouse

Element	Unit	Normal Range
pH	-	5.7 - 6.5
Olsen P	(ug/ml)	70 - 150
Potassium	(me/100g)	1.50 - 4.00
Calcium	(me/100g)	10.0 - 20.0
Magnesium	(me/100g)	2.00 - 4.00
Sodium	(me/100g)	0.20 - 0.60
CEC	(me/100g)	15.0 - 30.0
Volume Weight	(g/ml)	0.60 - 1.00
Sol.Salts (G/H)	(%)	0.00 - 0.15

Comments:

Carnations are thought to be more susceptible to high salt levels than other glasshouse flowers. The soil soluble salts should be maintained at less than 0.15%. Apart from this, they are regarded as being quite tolerant with respect to nutrient levels, showing less chlorosis and variation in leaf colour because of nutrient imbalances than many other glasshouse crops.

Potassium deficiencies are occasionally observed in carnations, with the upper middle leaves developing yellowish necrotic spots. The affected regions become dry and shrivelled.

Manganese deficiency is not likely to occur, but manganese toxicity has been observed, particularly after steam sterilisation of the soil.

Boron deficiencies have also been observed in carnations. Visual symptoms are a shortening of the internodes and deformation of the flowers. The crop is relatively tolerant of boron toxicity.

Because carnations are sensitive to chloride, the sulphate form of fertilisers should be used whenever possible.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
- Cresswell, G.C. and Weir, R.G. 1997. Plant nutrient disorders 5. Ornamental plants and shrubs. Inkata Press.
- Scaife, A. and Turner, M. 1983. Diagnosis of mineral disorders in plants. Volume 2, Vegetables. MAFF/ARC London.
- Greenhouse Production of Carnations. Peters Professional Technical Bulletin G12.
- Bunt, A.C. 1976. Modern potting compost. George Allen and Unwin, p 129.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: When the root is 1-3 cm in diameter.

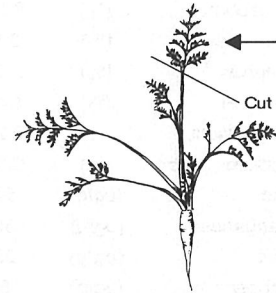
Plant Part: Youngest mature leaf, with extended main petiole removed.

Collect From: -

Quantity per Sample: 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: Cut and discard the petiole between the leaf blades and the crown of the carrot.



This sampling time is also described as when the root tuber is half grown.

To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.

Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.0 - 3.5	pH	-	5.6 - 6.7
Phosphorus	(%)	0.20 - 0.50	Olsen P	(ug/ml)	35 - 75
Potassium	(%)	2.5 - 4.5	Potassium	(me/100g)	0.70 - 1.40
Sulphur	(%)	0.20 - 0.40	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.40 - 3.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.20 - 0.50	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 2.00	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 350	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	30 - 350			
Zinc	(ug/g)	25 - 50			
Copper	(ug/g)	5 - 25			
Boron	(ug/g)	30 - 60			

Comments:

Carrots are susceptible to nitrogen, copper and boron deficiencies.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Scaife, A. and Turner, M. 1983. Diagnosis of mineral disorders in plants. Volume 2, Vegetables. MAFF/ARC London.
 Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: When the head first appears (buttoning).

Plant Part: Youngest mature wrapper leaf.

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP), Molybdenum (MO).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 5.0	pH	-	6.0 - 6.8
Phosphorus	(%)	0.30 - 0.70	Olsen P	(ug/ml)	35 - 75
Potassium	(%)	3.0 - 4.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.30 - 0.80	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.00 - 2.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.20 - 0.70	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 1.00	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 200			
Zinc	(ug/g)	20 - 200			
Copper	(ug/g)	5 - 20			
Boron	(ug/g)	25 - 60			

Comments:

Cauliflower have a high fertility requirement, and like all brassica, are very susceptible to boron and molybdenum deficiencies.

Molybdenum deficiency is common and results in a narrow, twisted leaves known as Whiptail.

Boron deficiency causes hollow stems and bronze coloured curds.

Nitrogen deficiency will appear as a purple pink coloration in the foliage. This symptom can also be induced by other factors such as cold weather, root damage from nematodes, drought stress and water logging.

Cauliflower is also fairly susceptible to deficiencies of sulphur, potassium, magnesium, manganese, zinc and copper.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Scaife, A. and Turner, M. 1983. Diagnosis of mineral disorders in plants. Volume 2, Vegetables. MAFF/ARC London.
 Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: When plants are half grown.

Plant Part: Youngest mature leaf (blade & petiole).

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 5.0	pH	-	6.1 - 7.0
Phosphorus	(%)	0.30 - 0.70	Olsen P	(ug/ml)	45 - 90
Potassium	(%)	3.5 - 7.0	Potassium	(me/100g)	0.60 - 1.20
Sulphur	(%)	0.50 - 1.50	Calcium	(me/100g)	6.0 - 15.0
Calcium	(%)	1.60 - 3.50	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.20 - 0.60	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.40 - 1.80	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	20 - 50			
Zinc	(ug/g)	30 - 100			
Copper	(ug/g)	8 - 50			
Boron	(ug/g)	30 - 60			

Comments:

Celery is susceptible to boron deficiency, with some varieties being more so than others.

Celery has a high requirement for nitrogen, phosphorus and potassium, and fertiliser inputs are usually quite high.

Nitrogen deficiency first appears in older leaves, turning them uniform yellow and eventually white.

Calcium deficiency can occur, causing a disorder known as Black Heart, where the growing tips blacken and die off. This can be caused by drought conditions, or excess levels of potassium and sodium.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
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Sampling

Plant growth stage has a major influence on the nutrient levels in the tissue. Two distinct growth stages are specified for sample collection; neither preferred over the other, though each is useful for a specific purpose.

Leaf - Late Tiller

Sampling Time: When the leaves have formed, and the leaf-sheaths are lengthening and becoming erect. Just prior to stem extension.

Plant Part: Whole above portion of the plant.

Collect From: Random sites throughout the sampling area.

Quantity per Sample: 30 to 40 plants.

Recommended Tests: Basic Plant (BP).

Comments: The advantage of sampling at this early stage is that there may be time to correct nutrient disorders observed in the current crop.



Leaf - Ear Emergence

Sampling Time: When stem extension is complete and the head of the ear emerges from the boot.

Plant Part: Whole above portion of the plant.

Collect From: Random sites throughout the sampling area.

Quantity per Sample: 20 to 30 plants.

Recommended Tests: Basic Plant (BP).

Comments: Testing at this later stage will indicate more accurately whether the crop was adequately supplied with the required nutrients.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Random sites throughout the sampling area.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Soil samples are usually collected for analysis prior to planting the crop.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected areas. In these circumstances, a second sample taken for comparative purposes from the rooting zones of normal areas may be useful.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Late Tiller

Leaf - Ear Emergence

Soil

Element	Unit	Normal Range	Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.5 - 5.0	Nitrogen	(%)	2.0 - 3.0	pH	-	5.5 - 6.4
Phosphorus	(%)	0.30 - 0.60	Phosphorus	(%)	0.20 - 0.50	Olsen P	(ug/ml)	20 - 30
Potassium	(%)	3.0 - 5.8	Potassium	(%)	1.5 - 3.0	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.30 - 0.45	Sulphur	(%)	0.15 - 0.40	Calcium	(me/100g)	5.0 - 12.0
Calcium	(%)	0.30 - 1.00	Calcium	(%)	0.20 - 1.20	Magnesium	(me/100g)	0.80 - 3.00
Magnesium	(%)	0.12 - 0.30	Magnesium	(%)	0.15 - 0.50	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 150	Iron	(ug/g)	25 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	30 - 100	Manganese	(ug/g)	25 - 100			
Zinc	(ug/g)	20 - 70	Zinc	(ug/g)	15 - 70			
Copper	(ug/g)	6 - 15	Copper	(ug/g)	5 - 25			
Boron	(ug/g)	5 - 15	Boron	(ug/g)	5 - 10			

Comments:

Small grain production and quality are greatly influenced by fertilisation.

Nitrogen has been found to be the most important fertiliser element in New Zealand cereal crops. Significant responses to potassium, sulphur or magnesium have also been recorded.

Different cultivars have been found to have some differences in nutrient concentrations; however, these differences are relatively small, and one set of interpretation criteria can be used.

Improper growth stage identification can result in errors in interpretation. Nutrient uptake precedes dry matter accumulation occurring between tillering and head emergence. Consequently, nutrient concentrations generally decline between these stages.

Diagnosis of sulphur deficiency can be assisted by using the N:S ratio. A sulphur deficiency may exist when the N:S ratio is greater than 16:1. Severe deficiency is likely when the ratio is greater than 20:1.

References:

- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
- Lockman, R.B. 1969. Agronomy Abstracts, American Society of Agronomy, Wisconsin, pg 97.
- Ward, R.C.; Whitney, D.A. and Westfall, D.G. 1973. Plant analysis as an aid in fertilising small grains. Soil testing and plant analysis.
- Jones Jr, J.B 1967. Soil testing and plant analysis. Part 2. SSSA Special Publication Series, p 49-58.

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Sampling

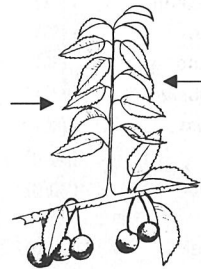
To ensure maximum yields of quality cherries, plant nutrients must be maintained at optimum levels. The nutritional status of cherries is monitored using soil tests and plant analysis. Annual monitoring or crop logging is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: January and February.

Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Mid portion of the current season's non-fruiting laterals (extension growth), taken at shoulder height.



Quantity per Sample: 4 representative leaves from the periphery of each of 25 trees.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.

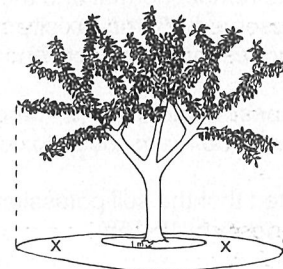
Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores from under trees selected at random from throughout the block.



Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.2 - 2.6	pH	-	6.0 - 6.5
Phosphorus	(%)	0.14 - 0.25	Olsen P	(ug/ml)	15 - 35
Potassium	(%)	1.6 - 3.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.20 - 0.40	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.40 - 2.40	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 0.80	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 250	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	40 - 160			
Zinc	(ug/g)	20 - 50			
Copper	(ug/g)	5 - 16			
Boron	(ug/g)	20 - 60			

Comments:

Boron deficiency for most stonefruit is more obvious in fruit than foliage. Cherries exhibit pale chlorotic skins which may crack and develop grey spots within the fruit.

Except for old and non-fruiting trees, cherries have the ability to translocate boron from the leaves to the fruit and bark, so that leaf boron levels remain normal and the classic boron toxicity symptoms of marginally yellowed or burned leaves are consequently not observed. Boron toxicity symptoms include thickening of leaves, corkiness along the midribs and petioles, enlarged nodes, bark necrosis and death of the shoot tips.

Stonefruit will grow best within a soil pH range of 6.0 - 6.7. At lower pH, root growth and tree health are adversely affected by aluminium and manganese toxicity. At higher pH, trace element deficiencies can be induced.

It has been suggested that the soil potassium level should be 3-4% of the CEC. Calcium should occupy 70-80% of the CEC sites and magnesium, 10-15%.

Like all stonefruit, cherries prefer well draining soils.

References:

- Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
 Leece, D.R. 1976. Journal of the Australian Institute of Agricultural Science, March, pp 3-19.

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Sampling

Very little information is available on chestnuts nutrient requirements. Data presented here is from some Japanese research, from published Australian guidelines, and from survey work of New Zealand orchards from 1990 to 1996.

Leaf

Sampling Time: January and February.

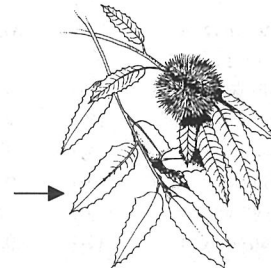
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Current season's non-fruiting shoots.

Quantity per Sample: 2-3 representative leaves from each of 30 trees.

Recommended Tests: Basic Plant (BP).

Comments: Although non-fruiting shoots are the recommended leaf sampling portion, New Zealand research has shown little difference in mineral levels from that of fruiting shoots.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

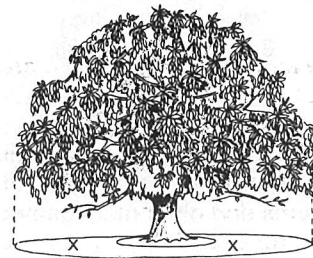
Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.



Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH. Sample depths of 40 - 60 cm have also been suggested.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Very little data is available to interpret chestnut nutrient levels. The normal range levels shown below should be regarded as tentative.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.4 - 2.9	pH	-	5.0 - 6.0
Phosphorus	(%)	0.14 - 0.30	Olsen P	(ug/ml)	15 - 50
Potassium	(%)	0.8 - 1.6	Potassium	(me/100g)	0.50 - 1.20
Sulphur	(%)	0.15 - 0.25	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.60 - 1.40	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.25 - 0.70	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	10 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	50 - 700			
Zinc	(ug/g)	17 - 100			
Copper	(ug/g)	4 - 20			
Boron	(ug/g)	30 - 80			

Comments:

Although Japan is recognised as a major area for chestnut growing, there is little research data that can be adopted for New Zealand conditions. In the absence of extensive trials, it is recommended that growers keep good records of yields, fertiliser applications and other management practices, and use regular soil and plant analysis to build up a knowledge of their crop.

Soils to be used for chestnut growing should be free draining, allowing unrestricted root development in the top 60 cm of the soil.

Soil testing on its own will always be of limited value for such a deep rooting tree crop. Better information can be obtained if done together with plant analysis.

Extremely high manganese levels have been observed in New Zealand crops. This may be due to acidic and poorly aerated sub-soils where these trees are grown. It is uncertain at this time whether these high levels are having any adverse effects.

References:

- Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Robinson, P.G. 1997. Waikato Chestnut Growers Association. Pers. Comm.
 Clark, C.J. 1987. Assessing the fertiliser needs of chestnuts. Growing Today, Aug/Sept, pp 8-11.
 Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 1. Temperate and subtropical fruit and nut crops. Inkata Press.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: Mid growth.

Plant Part: Youngest mature leaf.

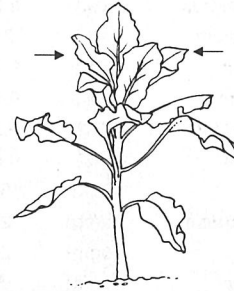
Collect From: -

Quantity per Sample: 20 leaves.

Recommended Tests: Basic Plant (BP), Molybdenum (MO).

Comments: This guide is to establish whether any nutrient imbalances exist to limit plant growth. An alternative approach is to evaluate its feed value for grazing livestock. In this case, the samples collected should be typical of the animals intake and include some stem material as well.

To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 5.5	pH	-	5.8 - 6.5
Phosphorus	(%)	0.26 - 0.70	Olsen P	(ug/ml)	20 - 30
Potassium	(%)	2.0 - 5.0	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.30 - 0.80	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.50 - 4.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.20 - 0.70	Sodium	(me/100g)	0.10 - 0.30
Sodium	(%)	0.00 - 1.00	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 300			
Zinc	(ug/g)	20 - 200			
Copper	(ug/g)	5 - 25			
Boron	(ug/g)	25 - 150			

Comments:

Sulphur and molybdenum deficiencies are known to occur in brassica crops.

Nitrogen deficiency will appear as a purple pink coloration in the foliage. This symptom can also be induced by other factors such as cold weather, root damage from nematodes, drought stress and water logging.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.

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Sampling

The nutritional status of this flower is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf - Glasshouse

Sampling Time: From bud start to harvest.

Plant Part: 4th leaf from the tip. Omit unfurled leaves.

Collect From: -

Quantity per Sample: 20-30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: Just prior to flowering or during early flowering is considered to be the appropriate time to sample. However, regular leaf analyses should be obtained through the growing season (e.g. 6 - 8 weekly intervals) in order to monitor the effect of liquid feeding programmes being used.



Soil - Glasshouse

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: From the rooting zone of the plants.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Soluble Salts (SG).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Glasshouse

Element	Unit	Normal Range
Nitrogen	(%)	3.5 - 5.0
Phosphorus	(%)	0.23 - 0.70
Potassium	(%)	3.5 - 5.0
Sulphur	(%)	0.25 - 0.70
Calcium	(%)	1.20 - 2.50
Magnesium	(%)	0.25 - 1.00
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	50 - 250
Manganese	(ug/g)	50 - 250
Zinc	(ug/g)	20 - 250
Copper	(ug/g)	6 - 30
Boron	(ug/g)	25 - 75

Soil - Glasshouse

Element	Unit	Normal Range
pH	-	5.7 - 6.5
Olsen P	(ug/ml)	70 - 150
Potassium	(me/100g)	1.50 - 4.00
Calcium	(me/100g)	10.0 - 20.0
Magnesium	(me/100g)	2.00 - 4.00
Sodium	(me/100g)	0.20 - 0.60
CEC	(me/100g)	15.0 - 30.0
Volume Weight	(g/ml)	0.60 - 1.00
Sol.Salts (G/H)	(%)	0.00 - 0.20

Comments:

Ammonia toxicity has been observed in chrysanthemums where ammonium based fertilisers were used on high pH (>7) soils. The free ammonia damages the root hairs, reduces growth rates in the plant, and in severe cases eventually causes death of the plant.

The potassium content declines as the plant matures, especially during flower formation.

Magnesium deficiencies are less common in chrysanthemums than in other major glasshouse crops.

Both manganese deficiency and toxicity can arise in chrysanthemums.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiencies have been observed, but symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

- Cresswell, G.C. and Weir, R.G. 1997. Plant nutrient disorders 5. Ornamental plants and shrubs. Inkata Press.
 Scaife, A. and Turner, M. 1983. Diagnosis of mineral disorders in plants. Volume 2, Vegetables. MAFF/ARC London.
 Bunt, A.C. 1976. Modern potting compost. George Allen and Unwin, p 129.

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Sampling

The nutritional status of citrus is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: February to March.

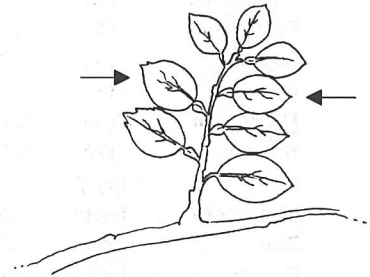
Plant Part: 5 -7 month old leaves (blade & petiole).

Collect From: Spring flush growth from non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 40-60 leaves from trees selected at random from throughout the block.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores from under trees selected at random from throughout the block.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 20 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.4 - 2.6	pH	-	5.5 - 6.5
Phosphorus	(%)	0.12 - 0.16	Olsen P	(ug/ml)	30 - 50
Potassium	(%)	0.7 - 1.1	Potassium	(me/100g)	0.60 - 1.20
Sulphur	(%)	0.20 - 0.30	Calcium	(me/100g)	5.0 - 12.0
Calcium	(%)	3.00 - 5.50	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.26 - 0.60	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.16	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 120	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 200			
Zinc	(ug/g)	25 - 100			
Copper	(ug/g)	5 - 16			
Boron	(ug/g)	31 - 100			

Comments:

The most common nutrient disorders in citrus in New Zealand are nitrogen, phosphorus, magnesium, manganese and zinc deficiencies:

Nitrogen deficiencies may become evident just prior to or during flower and fruit set. Treatment with excess nitrogen, as well as high phosphorus and potassium levels, may adversely affects fruit quality.

Phosphorus deficiency symptoms are usually only evident in poor fruit quality. Excessive rates of phosphorus fertiliser may suppress the uptake of zinc.

Potassium in the soil and foliage is often high in New Zealand orchards, especially if they have been established from old kiwifruit orchards.

Magnesium deficiencies occur occasionally, particularly during years of heavy crops. It may be induced by high rates of potassium fertiliser on soils with marginal magnesium levels.

Manganese and zinc deficiencies often occur together and tend to occur in soils with a pH higher than 6.5, particularly for the most common citrus root stock grown in New Zealand, Poncirus trifoliata.

Lemons have a higher potassium requirement than most other citrus crops.

References:

- Embleton, T.W. and Jones, W.W.; Platt, R.G. 1978. Leaf analysis as a guide to citrus fertilisation. In Reisenauer, H.M. (Ed) (1978): Soil and Plant-Tissue Testing in California. Division of Agricultural Science, University of California.
- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
- Leece, D.R. 1976. Journal of the Australian Institute of Agricultural Science, March, pp 3-19.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Courgettes are also known as zucchinis. They are members of the curcubits family that includes cucumber, rock melon and pumpkin.

Leaf

Sampling Time: Early flowering.

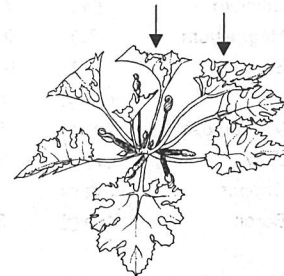
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: -

Quantity per Sample: 15 - 20 leaves.

Recommended Tests: Basic Plant (BP), Molybdenum (MO).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.5 - 4.5	pH	-	5.6 - 6.7
Phosphorus	(%)	0.30 - 0.70	Olsen P	(ug/ml)	35 - 75
Potassium	(%)	2.5 - 4.0	Potassium	(me/100g)	0.70 - 1.10
Sulphur	(%)	0.30 - 1.00	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	2.50 - 5.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 1.50	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.35	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 300	Base Saturatio	(%)	50 - 85
Manganese	(ug/g)	60 - 400	Volume Weight	(g/ml)	0.60 - 1.00
Zinc	(ug/g)	20 - 60			
Copper	(ug/g)	8 - 20			
Boron	(ug/g)	30 - 200			

Comments:

Courgettes require a moderate level of fertility to obtain good levels of production.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Cucumber can be grown under glass or as a field crop. The interpretive data provided here are for glasshouse crops.

Leaf - Glasshouse

Sampling Time: Early flowering.

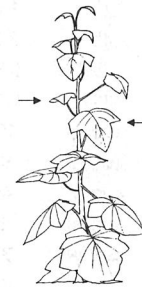
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: 30-45 cm from the growth tip of the plant.

Quantity per Sample: 20 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil - Glasshouse

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Glasshouse

Element	Unit	Normal Range
Nitrogen	(%)	5.0 - 6.0
Phosphorus	(%)	0.70 - 1.00
Potassium	(%)	4.5 - 5.5
Sulphur	(%)	1.00 - 2.00
Calcium	(%)	2.00 - 4.00
Magnesium	(%)	0.50 - 1.00
Sodium	(%)	0.05 - 0.25
Iron	(ug/g)	100 - 150
Manganese	(ug/g)	60 - 150
Zinc	(ug/g)	40 - 80
Copper	(ug/g)	8 - 20
Boron	(ug/g)	35 - 60

Soil - Glasshouse

Element	Unit	Normal Range
pH	-	5.7 - 7.0
Olsen P	(ug/ml)	80 - 120
Potassium	(me/100g)	1.00 - 2.00
Calcium	(me/100g)	8.0 - 15.0
Magnesium	(me/100g)	2.00 - 4.00
Sodium	(me/100g)	0.20 - 0.60
CEC	(me/100g)	15.0 - 30.0
Volume Weight	(g/ml)	0.60 - 1.00

Comments:

Glasshouse cucumber tend to have higher nutrient levels than field grown crops.

Cucumber are more sensitive to salt stress than tomatoes.

Magnesium is a common disorder of cucumbers, causing a mottled chlorosis and brown spotting of the leaves.

Manganese and molybdenum deficiencies have been reported for cucumber crops.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.

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Sampling

The nutritional status of this flower is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: Not specified.

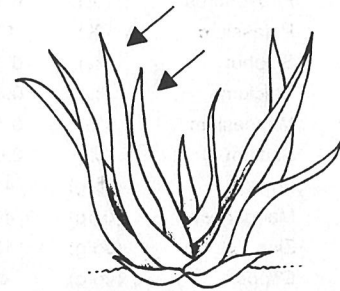
Plant Part: Recently matured 5th or 6th leaves, cut at the base of the leaves.

Collect From: -

Quantity per Sample: 20-30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: Remove any white, hard tissue from the very base of the leaves. The sample should consist of green tissue only.



Media

Sampling Time: Prior to crop establishment.

Sampling Depth: 2 - 20 cm.

Collect From: From the root zone of the plants.

Quantity per Sample: 0.5 - 1 litre.

Recommended Tests: Basic Media (BM).

Comments: Orchids are usually grown in coarse, relatively inert potting media, and are therefore grown essentially by hydroponics.

If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Media		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	1.3 - 2.1	pH	-	5.2 - 6.5
Phosphorus	(%)	0.15 - 0.24	Conductivity	(mS/cm)	0.5 - 1.2
Potassium	(%)	1.3 - 2.5	Nitrate-N	(mg/l)	20 - 50
Sulphur	(%)	0.12 - 0.27	Ammonium-N	(mg/l)	1 - 15
Calcium	(%)	0.41 - 1.50	Phosphorus	(mg/l)	5 - 15
Magnesium	(%)	0.12 - 0.22	Potassium	(mg/l)	20 - 50
Sodium	(%)	0.00 - 0.40	Calcium	(mg/l)	15 - 40
Iron	(ug/g)	41 - 120	Magnesium	(mg/l)	6 - 15
Manganese	(ug/g)	40 - 300	Sodium	(mg/l)	5 - 30
Zinc	(ug/g)	18 - 22			
Copper	(ug/g)	4 - 15			
Boron	(ug/g)	20 - 120			

Comments:

Most orchids are grown in soil-less media, usually with good drainage characteristics.

The normal range leaf levels are based on samples analysed by MAF during 1979 and 1980, with slight modifications based on data obtained through this laboratory.

References:

Dorofaeff, F.D. 1980. Orchids cymbidiums: Nutrient testing of leaves. Horticultural Produce & Practice 193. MAF (NZ).

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Egg plant can be grown under glass or as a field crop. The interpretive data provided here are for glasshouse crops.

Egg plants are also now as aubergines.

Blade

Sampling Time: When in full bloom at a mid growth stage.

Plant Part: Youngest mature blade, minus petiole.

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Blade			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.5 - 4.5	pH	-	5.4 - 6.4
Phosphorus	(%)	0.30 - 0.60	Olsen P	(ug/ml)	35 - 75
Potassium	(%)	3.0 - 5.5	Potassium	(me/100g)	0.70 - 1.40
Sulphur	(%)	0.25 - 0.50	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	3.00 - 9.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 0.90	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.20	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 300	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	40 - 300			
Zinc	(ug/g)	24 - 60			
Copper	(ug/g)	6 - 30			
Boron	(ug/g)	30 - 60			

Comments:

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

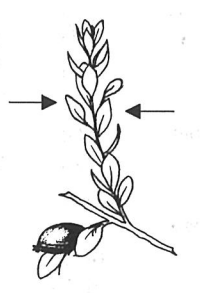
For maximum yields of quality fruit, plant nutrients must be maintained at optimum levels. Annual monitoring or crop logging is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: February and March.

Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Mid portion of the current season's non-fruiting laterals (extension growth), taken at shoulder height.



Quantity per Sample: 40-60 leaves from trees selected at random from throughout the block.

Recommended Tests: Basic Plant (BP).

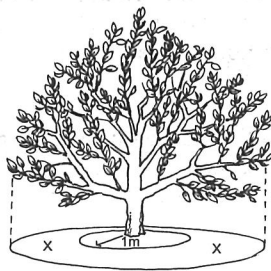
Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.

Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.



Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the root zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the vines which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf

Element	Unit	Normal Range
Nitrogen	(%)	1.3 - 1.5
Phosphorus	(%)	0.06 - 0.08
Potassium	(%)	0.6 - 1.0
Sulphur	(%)	0.12 - 0.16
Calcium	(%)	1.50 - 2.00
Magnesium	(%)	0.20 - 0.25
Sodium	(%)	0.03 - 0.05
Iron	(ug/g)	70 - 100
Manganese	(ug/g)	400 - 600
Zinc	(ug/g)	15 - 20
Copper	(ug/g)	2 - 5
Boron	(ug/g)	40 - 60

Soil

Element	Unit	Normal Range
pH	-	5.8 - 6.8
Olsen P	(ug/ml)	30 - 50
Potassium	(me/100g)	0.50 - 1.00
Calcium	(me/100g)	6.0 - 12.0
Magnesium	(me/100g)	1.00 - 3.00
Sodium	(me/100g)	0.00 - 0.50
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00

Comments:

The feijoa is a native of South America. In New Zealand it appears to be a hardy crop, tolerating a range of climates and soil conditions. They can thrive in soils that are naturally low in plant nutrients.

Water logged or alkaline soils should be avoided with this crop.

Foliar nutrient applications have been reported to adversely affect the keeping quality of the feijoa fruit.

References:

Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: Bulbing.

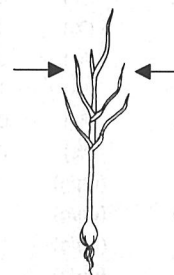
Plant Part: Youngest matured leaves (without the white).

Collect From: -

Quantity per Sample: 30-50 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.4 - 4.5	pH	-	5.6 - 7.0
Phosphorus	(%)	0.28 - 0.50	Olsen P	(ug/ml)	45 - 90
Potassium	(%)	3.0 - 4.5	Potassium	(me/100g)	0.70 - 1.10
Sulphur	(%)	0.60 - 0.90	Calcium	(me/100g)	5.0 - 12.0
Calcium	(%)	1.00 - 1.80	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.23 - 0.30	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.50	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	50 - 150			
Zinc	(ug/g)	18 - 30			
Copper	(ug/g)	8 - 15			
Boron	(ug/g)	20 - 50			

Comments:

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.

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Sampling

The nutritional status of gooseberries is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: During fruit set.

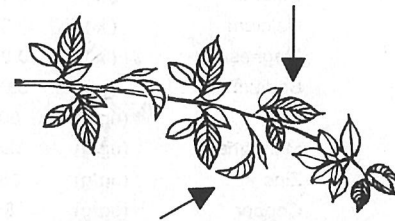
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Current season's non-fruiting canes.

Quantity per Sample: 5 representative leaves from each of 10 vines.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the rooting zone of the vines.

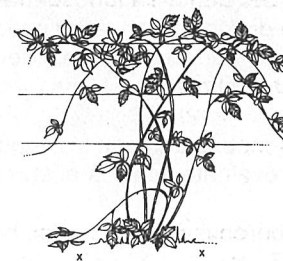
Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Soil samples are usually collected for analysis prior to planting the crop.

If trickle irrigation is used, the wetted zones of the soil should be sampled separately, as minerals in the water may produce abnormal test levels.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected vines. In these circumstances, a second sample taken for comparative purposes from the rooting zones of normal vines may be useful.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.8 - 3.7	pH	-	5.8 - 6.5
Phosphorus	(%)	0.17 - 0.34	Olsen P	(ug/ml)	40 - 60
Potassium	(%)	1.4 - 1.9	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.18 - 0.32	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.65 - 1.37	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.22 - 0.46	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	134 - 304			
Zinc	(ug/g)	28 - 60			
Copper	(ug/g)	8 - 29			
Boron	(ug/g)	38 - 57			

Comments:

Symptoms of boron deficiency include dieback and delayed bud break, or even complete bud break failure. Young leaves may become distorted with large petioles and necrotic border tissue. Leaves forming later are not affected. Less severely affected buds give rise to small, deeply indented leaflets which persist throughout the growing season. Primocanes tend not to show symptoms.

Boron in berryfruit is mobile and can translocate in young, fruiting crops. Symptoms and detection of boron toxicity may be more difficult to evaluate if this is occurring.

Caution in applying boron is necessary, as berryfruit are thought to be susceptible towards boron toxicity.

Optimum soil pH range for berryfruit is 5.8 - 6.5. Manganese and magnesium deficiencies may arise where soil pH values are in excess of 7.0.

Soil magnesium levels should be at least twice the potassium level.

All canefruit are vulnerable to salt stress. This is normally only a problem for low lying coastal areas, or where irrigation water has high dissolved solids.

Chloride toxicity is possible, and more so in irrigated or low summer rainfall areas.

References:

Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.

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Sampling

Two sampling periods recommended for grape leaf tissue analysis: At flowering, a petiole sample may be collected, or later in the season during fruit ripening, a leaf blade only sample can be taken. The earlier sampling time has the advantage that corrective actions are possible for the current season's crop. The later sample would better reflect the nutrient supply for a larger part of the season, and will be of value for planning the next season's fertiliser programme.

Petiole - Flowering

Sampling Time: During flowering at full bloom (November-December).

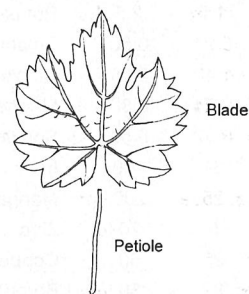
Plant Part: Leaf petioles only. Remove petioles immediately after sampling.

Collect From: Opposite the basal cluster, from exposed shoots on the outside of the vine.

Quantity per Sample: 40 petioles.

Recommended Tests: Nitrate-N (BT), Basic Plant (BP).

Comments:



Blade - Ripening

Sampling Time: During fruit ripening.

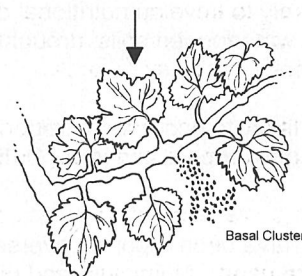
Plant Part: Leaf blades only. Remove petioles immediately after sampling.

Collect From: Opposite the basal cluster, from exposed shoots on the outside of the vine.

Quantity per Sample: 40 leaf blades.

Recommended Tests: Basic Plant (BP).

Comments: This sampling time is especially useful to diagnose problems later in the season.

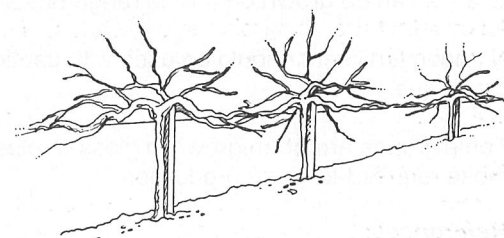


Soil - Vineyard

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: The root zone of the vines. A fixed distance of 1 meter from the base of vines may be useful to ensure similar samples are collected each year.



Quantity per Sample: 15 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Grapes have a low fertiliser requirement, making soil tests of lesser value than leaf analysis in assessing the nutrient status of a vineyard. Plant analysis is recommended to identify any specific needs of the crop.

Soil samples should be collected in the same manner and at the same time every year, so that the grower can monitor changes in the nutrient levels over a period of years. These changes, coupled with leaf analysis data, will demonstrate the adequacy, or otherwise, of the fertiliser programme.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Petiole - Flowering

Element	Unit	Normal Range
Nitrate-N	(ug/g)	570 - 1750
Phosphorus	(%)	0.21 - 0.50
Potassium	(%)	1.5 - 2.5
Sulphur	(%)	0.21 - 0.50
Calcium	(%)	1.40 - 2.50
Magnesium	(%)	0.31 - 0.80
Sodium	(%)	0.02 - 0.50
Iron	(ug/g)	31 - 100
Manganese	(ug/g)	25 - 200
Copper	(ug/g)	5 - 20
Zinc	(ug/g)	25 - 50
Boron	(ug/g)	31 - 50
Chloride	(%)	0.50 - 1.50

Blade - Ripening

Element	Unit	Normal Range
Nitrogen	(%)	1.5 - 2.8
Phosphorus	(%)	0.16 - 0.25
Potassium	(%)	1.1 - 1.6
Sulphur	(%)	0.21 - 0.40
Calcium	(%)	2.00 - 4.00
Magnesium	(%)	0.20 - 0.50
Sodium	(%)	0.05 - 0.12
Iron	(ug/g)	40 - 100
Manganese	(ug/g)	41 - 100
Zinc	(ug/g)	26 - 40
Copper	(ug/g)	18 - 34
Boron	(ug/g)	31 - 50
Chloride	(%)	0.00 - 0.50

Soil - Vineyard

Element	Unit	Normal Range
pH	-	5.8 - 6.8
Olsen P	(ug/ml)	15 - 40
Potassium	(me/100g)	0.40 - 0.80
Calcium	(me/100g)	6.0 - 12.0
Magnesium	(me/100g)	1.00 - 3.00
Sodium	(me/100g)	0.00 - 0.40
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00

Comments:

Grapes are less likely to develop nutritional deficiencies than other horticultural crops in New Zealand. Other problems, such as diseases, waterlogged soils, drought stress and herbicide damage can produce symptoms that can be mistaken for nutrient disorders.

Deficiencies most likely to occur are nitrogen, potassium, magnesium and boron. Less common deficiencies are sulphur, manganese, zinc, phosphorus and iron. Deficiencies of calcium, copper and molybdenum are considered unlikely to occur.

Chloride toxicities have been reported overseas, but would only be likely to occur in New Zealand where high chloride irrigation waters are used. Aluminium and manganese toxicities may also occur on very acid soils with a pH less than 5.0.

High levels of manganese, zinc and copper may arise as a result of spray residues.

Grapes can be grown on a wide range of soil types, but nutritional problems are more likely to occur on sandy soils.

Nitrogen fertilisers should be used with caution, as excessive nitrogen promotes vigorous shoot growth to the detriment of grape quality.

Table grapes are often grown in glass or plastic houses. Soil fertility levels for this purpose will be much higher than those required for wine production.

References:

- Christensen, P., Kasimatis, A., Jensen, F. 1978. Grapevine nutrition and fertilisation in the San Joaquin Valley. University of California, Priced Publication 4087, USA.
- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

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Sampling

The nutritional status of grapefruit is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: February to March.

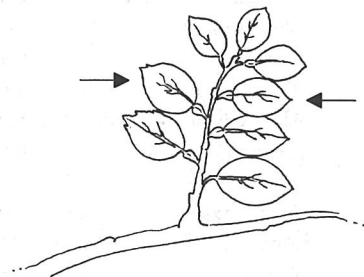
Plant Part: 5 -7 month old leaf (blade & petiole).

Collect From: Spring flush growth from non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 40-60 leaves from trees selected at random from throughout the block.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores from under trees selected at random from throughout the block.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 20 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf

Element	Unit	Normal Range
Nitrogen	(%)	2.4 - 2.6
Phosphorus	(%)	0.12 - 0.16
Potassium	(%)	0.7 - 1.1
Sulphur	(%)	0.20 - 0.30
Calcium	(%)	3.00 - 5.50
Magnesium	(%)	0.26 - 0.60
Sodium	(%)	0.00 - 0.16
Iron	(ug/g)	60 - 120
Manganese	(ug/g)	25 - 200
Zinc	(ug/g)	25 - 100
Copper	(ug/g)	5 - 16
Boron	(ug/g)	31 - 100

Soil

Element	Unit	Normal Range
pH	-	5.5 - 6.5
Olsen P	(ug/ml)	30 - 50
Potassium	(me/100g)	0.50 - 0.80
Calcium	(me/100g)	5.0 - 12.0
Magnesium	(me/100g)	1.00 - 3.00
Sodium	(me/100g)	0.00 - 0.50
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00

Comments:

The most common nutrient disorders in citrus in New Zealand are nitrogen, phosphorus, magnesium, manganese and zinc deficiencies:

Nitrogen deficiencies may become evident just prior to or during flower and fruit set. Treatment with excess nitrogen, as well as high phosphorus and potassium levels, may adversely affect fruit quality.

Phosphorus deficiency symptoms are usually only evident in poor fruit quality. Excessive rates of phosphorus fertiliser may suppress the uptake of zinc.

Potassium in the soil and foliage is often high in New Zealand orchards, especially if they have been established from old kiwifruit orchards.

Magnesium deficiencies occur occasionally, particularly during years of heavy crops. It may be induced by high rates of potassium fertiliser on soils with marginal magnesium levels.

Manganese and zinc deficiencies often occur together and tend to occur in soils with a pH higher than 6.5.

References:

- Embleton, T.W. and Jones, W.W.; Platt, R.G. 1978. Leaf analysis as a guide to citrus fertilisation. In Reisenauer, H.M. (Ed) (1978): Soil and Plant-Tissue Testing in California. Division of Agricultural Science, University of California.
- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR. Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
- Leece, D.R. 1976. Journal of the Australian Institute of Agricultural Science, March, pp 3-19.

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Sampling

The nutritional status of this flower is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: Mid season.

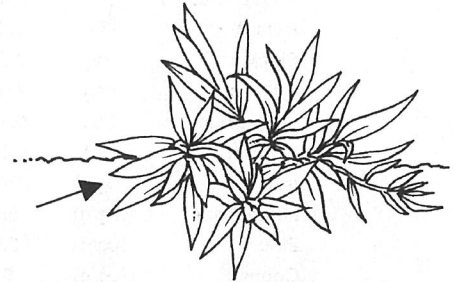
Plant Part: Youngest mature leaf.

Collect From: -

Quantity per Sample: 40 - 60 leaves.

Recommended Tests: Basic Plant (BP).

Comments: Just prior to flowering or during early flowering is considered to be the appropriate time to sample. However, regular leaf analyses should be obtained through the growing season (e.g. 6 - 8 weekly intervals) in order to monitor the effect of liquid feeding programmes being used.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: From the root zone of the plants.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Soluble Salts (SG).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	4.3 - 6.0	pH	-	5.7 - 6.5
Phosphorus	(%)	3.00 - 0.70	Olsen P	(ug/ml)	70 - 150
Potassium	(%)	3.5 - 4.5	Potassium	(me/100g)	1.50 - 4.00
Sulphur	(%)	0.25 - 0.70	Calcium	(me/100g)	10.0 - 20.0
Calcium	(%)	2.60 - 4.00	Magnesium	(me/100g)	2.00 - 4.00
Magnesium	(%)	0.40 - 1.00	Sodium	(me/100g)	0.20 - 0.60
Sodium	(%)	0.00 - 0.20	CEC	(me/100g)	15.0 - 30.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	50 - 200	Sol.Salts (G/H)	(%)	0.00 - 0.20
Zinc	(ug/g)	25 - 200			
Copper	(ug/g)	9 - 25			
Boron	(ug/g)	25 - 100			

Comments:

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Cresswell, G.C. and Weir, R.G. 1997. Plant nutrient disorders 5. Ornamental plants and shrubs. Inkata Press.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: At mid-growth.

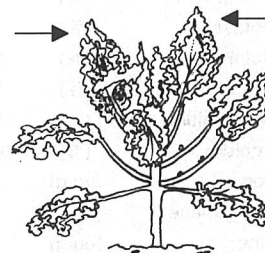
Plant Part: Youngest mature leaf.

Collect From: -

Quantity per Sample: 20-30 leaves.

Recommended Tests: Basic Plant (BP), Molybdenum (MO).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 5.5	pH	-	6.0 - 6.8
Phosphorus	(%)	0.26 - 0.70	Olsen P	(ug/ml)	30 - 80
Potassium	(%)	2.0 - 5.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.30 - 0.80	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.50 - 4.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.20 - 0.70	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 1.00	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 300			
Zinc	(ug/g)	20 - 200			
Copper	(ug/g)	5 - 25			
Boron	(ug/g)	25 - 150			

Comments:

In general, boron and molybdenum deficiencies are known to occur in brassica crops.

Nitrogen deficiency will appear as a purple pink coloration in the foliage. This symptom can also be induced by other factors such as cold weather, root damage from nematodes, drought stress and water logging.

Deficiencies of sulphur have also been reported.

Boron deficiency will appear as a browning of the internal stem tissue in the developing curd.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.

Disclaimer:

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Sampling

Leaf analysis provides a more accurate and reliable assessment of the nutrient status of the kiwifruit plant than does soil testing. Greater emphasis, therefore, should be placed on the plant tissue results. Two sampling options are described below. Data is available for optimum levels for virtually the whole growing season, from late October to early April.

Leaf - Autumn

Sampling Time: February and March.

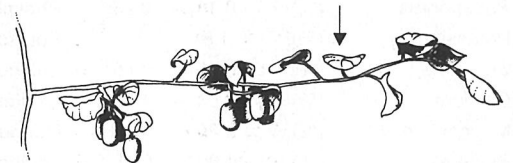
Plant Part: Leaf & petiole.

Collect From: Second leaf past the final fruit cluster from non-terminated female vines.

Quantity per Sample: 2-4 leaves from each of 20 vines.

Recommended Tests: Basic Plant (BP), Chloride (CL).

Comments: This is regarded as the standard sampling time because nutrient levels will have stabilised. These mid-season samples should also reflect the effectiveness of the fertiliser programme adopted and the nutrient availability during the spring growth period.



Leaf - Spring

Sampling Time: November.

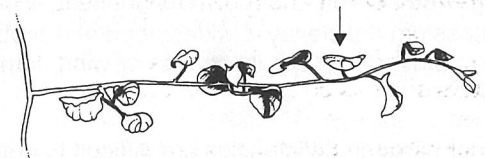
Plant Part: Leaf & petiole.

Collect From: Youngest mature leaf.

Quantity per Sample: 2-4 leaves from each of 20 vines.

Recommended Tests: Basic Plant (BP), Chloride (CL).

Comments: Diagnosing deficiencies at this early stage may allow time to correct them for the current season's crop, whereas sampling after December is considered too late. These deficiencies will be more pronounced than later in the season, when the plants will have adapted to their growing conditions.



Soil

Sampling Time: Prior to crop establishment and annually during autumn and early winter.

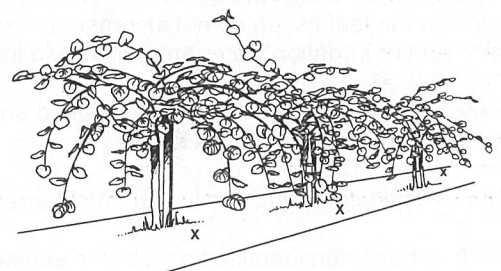
Core Depth: 15 cm.

Collect From: From the root zone of the vines.

Quantity per Sample: 15 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.



Where fertiliser has been broadcast, sample from the root zone of the vines. Where fertiliser has been banded, samples should only be taken from areas under the vines which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.

Interpretation

The interpretive levels for kiwifruit are very closely linked to the physiological growth stage of the crop, due to the rapidly changing leaf nutrient levels during the growing season. It is important to take this into account, especially when considering results from older or younger leaves. Normal Range levels are based on research on the Hayward variety.

Leaf - Autumn

Element	Unit	Normal Range
Nitrogen	(%)	2.2 - 3.0
Phosphorus	(%)	0.18 - 0.25
Potassium	(%)	1.8 - 3.0
Sulphur	(%)	0.25 - 0.45
Calcium	(%)	2.00 - 4.00
Magnesium	(%)	0.30 - 0.70
Sodium	(%)	0.00 - 0.05
Iron	(ug/g)	80 - 200
Manganese	(ug/g)	50 - 400
Zinc	(ug/g)	15 - 28
Copper	(ug/g)	10 - 25
Boron	(ug/g)	30 - 60
Chloride	(%)	0.40 - 1.00

Leaf - Spring

Element	Unit	Normal Range
Nitrogen	(%)	2.4 - 4.0
Phosphorus	(%)	0.25 - 0.70
Potassium	(%)	2.0 - 2.8
Sulphur	(%)	0.35 - 0.50
Calcium	(%)	1.50 - 3.00
Magnesium	(%)	0.25 - 0.45
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	60 - 150
Manganese	(ug/g)	50 - 150
Zinc	(ug/g)	20 - 60
Copper	(ug/g)	10 - 20
Boron	(ug/g)	30 - 50
Chloride	(%)	0.60 - 1.50

Soil

Element	Unit	Normal Range
pH	-	5.8 - 6.5
Olsen P	(ug/ml)	30 - 60
Potassium	(me/100g)	0.60 - 1.20
Calcium	(me/100g)	6.0 - 12.0
Magnesium	(me/100g)	1.00 - 3.00
Sodium	(me/100g)	0.00 - 0.40
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00

Comments:

Potassium deficiency is widespread and probably the most serious deficiency in kiwifruit grown in New Zealand. It may be confused with drought stress or wind damage. Crop requirements for this element have been underestimated in the past.

Minor nitrogen deficiencies are difficult to detect and require early season leaf analyses.

Magnesium deficiencies are not usually observed until February, and then only in older leaves of the current season's extension growth. The later-season sample results, therefore, will probably show more clearly magnesium deficiencies than the spring samples.

Early season deficiencies may manifest as smaller and/or fewer fruit and smaller leaves, rather than reduced mineral concentrations in the leaf.

Irrigation waters high in sodium can cause problems, as kiwifruit cannot tolerate high levels of this element. The sodium levels in the leaf tissue do not increase appreciably, making diagnosis of this problem difficult from plant tissue alone. Soil tests and/or irrigation water analysis would indicate if this toxicity is likely.

Manganese deficiency has been identified on high pH soils (pH 6.8). In contrast, manganese toxicity has also been identified on low pH soils (pH 5.2).

Zinc deficiencies occur rarely and must be remedied quickly before or soon after leaf emergence.

Kiwifruit has been identified as a boron sensitive crop. The effect of excessive boron is reduction of fruit yield and also premature ripening in cool storage. Irrigation water with high boron levels may induce boron toxicity.

There is an inverse relationship between the availability of nitrate and the uptake of chloride, i.e. higher nitrate levels will suppress chloride uptake.

References:

- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
 Blackmore, L.C.; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Smith, G.S.; Asher, C.J. and Clark, C.J. 1985. Kiwifruit nutrition. Diagnosis of nutritional disorders. AgPress Communications Ltd, Wellington.

Disclaimer:

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Sampling

The nutritional status of lemons is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: February to March.

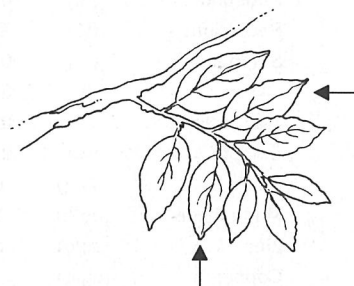
Plant Part: 5 -7 month old leaf (blade & petiole).

Collect From: Spring flush growth from non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 40-60 leaves from trees selected at random from throughout the block.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores from under trees selected at random from throughout the block.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 20 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.4 - 2.6	pH	-	5.5 - 6.5
Phosphorus	(%)	0.12 - 0.16	Olsen P	(ug/ml)	30 - 50
Potassium	(%)	0.7 - 1.1	Potassium	(me/100g)	0.60 - 1.20
Sulphur	(%)	0.20 - 0.30	Calcium	(me/100g)	5.0 - 12.0
Calcium	(%)	3.00 - 5.50	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.26 - 0.60	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.16	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 120	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 200			
Zinc	(ug/g)	25 - 100			
Copper	(ug/g)	5 - 16			
Boron	(ug/g)	31 - 100			

Comments:

The most common nutrient disorders in citrus in New Zealand are nitrogen, phosphorus, magnesium, manganese and zinc deficiencies:

Nitrogen deficiencies may become evident just prior to or during flower and fruit set. Treatment with excess nitrogen, as well as high phosphorus and potassium levels, may adversely affect fruit quality.

Phosphorus deficiency symptoms are usually only evident in poor fruit quality. Excessive rates of phosphorus fertiliser may suppress the uptake of zinc.

Potassium in the soil and foliage is often high in New Zealand orchards, especially if they have been established from old kiwifruit orchards.

Magnesium deficiencies occur occasionally, particularly during years of heavy crops. It may be induced by high rates of potassium fertiliser on soils with marginal magnesium levels.

Manganese and zinc deficiencies often occur together and tend to occur in soils with a pH higher than 6.5, particularly for the most common citrus root stock grown in New Zealand, Poncirus trifoliata.

Lemons have a higher potassium requirement than most other citrus crops.

References:

- Embleton, T.W. and Jones, W.W.; Platt, R.G. 1978. Leaf analysis as a guide to citrus fertilisation. In Reisenauer, H.M. (Ed) (1978): Soil and Plant-Tissue Testing in California. Division of Agricultural Science, University of California.
- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
- Leece, D.R. 1976. Journal of the Australian Institute of Agricultural Science, March, pp 3-19.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Lettuce can be grown under glass or as a field crop. The interpretive data provided here are for glasshouse crops.

Leaf - Glasshouse

Sampling Time: When the head has reached half size.

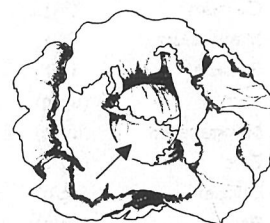
Plant Part: Wrapper leaf.

Collect From: -

Quantity per Sample: 20-30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: The recommended sampling time is when the head is half size. If sampling prior to this, select the youngest mature leaves.



To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.

Soil - Glasshouse

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Glasshouse

Element	Unit	Normal Range
Nitrogen	(%)	3.1 - 4.5
Phosphorus	(%)	0.35 - 0.60
Potassium	(%)	4.5 - 8.0
Sulphur	(%)	0.20 - 0.30
Calcium	(%)	0.80 - 2.00
Magnesium	(%)	0.30 - 0.70
Sodium	(%)	0.00 - 0.30
Iron	(ug/g)	50 - 100
Manganese	(ug/g)	50 - 300
Zinc	(ug/g)	25 - 250
Copper	(ug/g)	7 - 80
Boron	(ug/g)	25 - 55

Soil - Glasshouse

Element	Unit	Normal Range
pH	-	6.3 - 7.3
Olsen P	(ug/ml)	35 - 90
Potassium	(me/100g)	0.60 - 1.00
Calcium	(me/100g)	6.0 - 12.0
Magnesium	(me/100g)	1.00 - 3.00
Sodium	(me/100g)	0.00 - 0.50
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00

Comments:

Winter lettuce requires higher levels of fertility than summer lettuces, in particular nitrogen and phosphorus.

Lettuce can also develop calcium, manganese and copper deficiencies.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
- Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.
- van Eysinga, J.P.; Roorda, N.L. and Smilde, K W 1981. Nutritional disorders in glasshouse tomatoes, cucumbers & lettuce, Wageningen.

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Sampling

The nutritional status of this flower is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: Mid season.

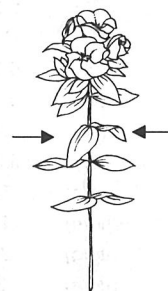
Plant Part: Youngest mature leaf.

Collect From: -

Quantity per Sample: 30 - 50 leaves.

Recommended Tests: Basic Plant (BP).

Comments: Just prior to flowering or during early flowering is considered to be the appropriate time to sample. However, regular leaf analyses should be obtained through the growing season (e.g. 6 - 8 weekly intervals) in order to monitor the effect of liquid feeding programmes being used.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: From the root zone of the plants.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Soluble Salts (SG).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.7 - 4.3	pH	-	5.8 - 6.5
Phosphorus	(%)	0.20 - 0.40	Olsen P	(ug/ml)	40 - 120
Potassium	(%)	2.0 - 3.5	Potassium	(me/100g)	0.70 - 1.50
Sulphur	(%)	0.25 - 0.60	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.35 - 1.00	Magnesium	(me/100g)	1.50 - 3.00
Magnesium	(%)	0.40 - 0.60	Sodium	(me/100g)	0.10 - 0.60
Sodium	(%)	0.00 - 0.40	CEC	(me/100g)	15.0 - 30.0
Iron	(ug/g)	70 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	40 - 120	Sol.Salts (G/H)	(%)	0.00 - 0.20
Zinc	(ug/g)	25 - 75			
Copper	(ug/g)	3 - 10			
Boron	(ug/g)	25 - 60			

Comments:

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Hill Laboratories data.

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Sampling

Lucerne has a very deep rooting system that renders normal soil sampling of limited usefulness. Because of this, greater emphasis should be placed on the results of plant analysis when assessing the nutrient status of this crop.

Leaf

Sampling Time: At a vegetative growth stage.

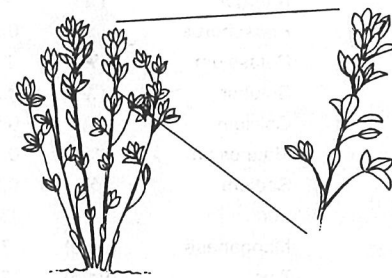
Plant Part: Plant tops.

Collect From: The top 15 cm of the plant.

Quantity per Sample: 20-30 plant tops.

Recommended Tests: Basic Plant (BP), Molybdenum (MO).

Comments: If samples are taken as part of an on-going monitoring programme, then collect samples over the entire area, in a random manner. If a nutritional deficiency is suspected, then selectively sample the worst affected plants. The problem should be more pronounced in such a sample compared to samples collected in a random manner.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: Randomly selected areas of the field.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Sulphate-S (SU), Organic-S (OS).

Comments: There is no recommended time of the year for soil sampling. However, it is advisable to always collect samples at the same time every year, in the same manner. This will then provide data that shows whether nutrient levels are declining or increasing over the time (i.e. crop logging).

When sampling prior to crop establishment, there is an opportunity to correct sub-soil pH by incorporating lime. Take 15 - 30 cm deep samples to check the sub-soil pH.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	4.5 - 5.0	pH	-	6.0 - 6.5
Phosphorus	(%)	0.26 - 0.70	Olsen P	(ug/ml)	20 - 40
Potassium	(%)	2.5 - 3.8	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.26 - 0.50	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.51 - 3.00	Magnesium	(me/100g)	0.80 - 3.00
Magnesium	(%)	0.31 - 1.00	Sodium	(me/100g)	0.10 - 0.50
Sodium	(%)	0.00 - 0.05	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	30 - 250	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	30 - 100			
Zinc	(ug/g)	20 - 70			
Copper	(ug/g)	10 - 30			
Boron	(ug/g)	30 - 80			
Molybdenum	(ug/g)	0.90 - 2.00			

Comments:

The following nutrient deficiencies have been observed in New Zealand lucerne crops: Phosphorus, sulphur, potassium, boron, copper and magnesium.

Boron toxicity can be suspected if leaf levels exceed 100 ug/g.

Samples taken prior to flowering will show higher levels of nitrogen, phosphorus, potassium and sulphur. Post bloom samples will have lower levels for most nutrients.

Lucerne is a natrophobe, i.e. it does not accumulate sodium in the above ground portion of the plant. Sodium supplementation may therefore be required for livestock with lucerne as a major component of their diet.

Lucerne, being a legume, will support rhizobia and can fix nitrogen.

If the crop is regularly cut for hay, there will be a significant nutrient removal from the area, and the fertiliser programme should reflect this.

Lucerne is very sensitive to soil acidity. The soil pH should be greater than 5.9 for successful nodulation to occur. Root growth is restricted by soil pH levels below 5.6. This factor may mean that acid sub-soils will prevent deep root activity and therefore limit the plants ability to absorb water from greater depths when topsoils are under drought stress.

References:

Cornforth, I.S. and Sinclair, A.G. 1984. Fertiliser recommendations for pastures and crops in New Zealand. MAF Publication, Wellington.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Martin, W.D. and Matocha, J.E. 1973. Soil testing and plant analysis.

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Sampling

Sampling and interpretive information for macadamia trees was originally sourced from Queensland, but has recently been modified by local research and experience.

Yields of macadamia from New Zealand orchards are generally low compared to overseas crops, but there are some trees that yield as well as those overseas. This suggests the potential for macadamia production is far from being fully realised. While mineral nutrition may contribute to this, other factors considered to be important include cultivars, climate, carbohydrate supply and pollination.

Leaf

Sampling Time: April and May.

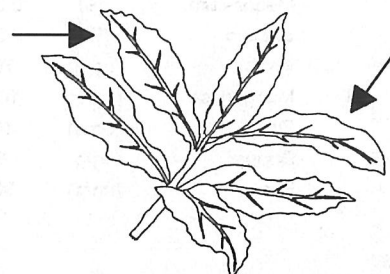
Plant Part: Leaf, with petiole.

Collect From: First leaf below the non-fruiting, non-flushing growth terminals.

Quantity per Sample: 2-3 representative leaves from each of 30 trees.

Recommended Tests: Basic Plant (BP).

Comments: Australian recommendations are to sample in the spring. The leaf nutrient levels are relatively stable then, as the main growth flush in Australia occurs in the summer period. In New Zealand, these levels are not stable then, due to active vegetative growth at this time. Leaf nutrient levels have been found to be more stable in the autumn period.



Note that the Australian sampling guidelines recommend collecting leaves from the second whorl. The New Zealand recommendation is now to sample at a non-flushing time, and taking the leaves from the first whorl back from the terminal tip.

Leaves should be selected from trees of the same age, cultivar, management regime, and grown in the same soil type. Considerable differences have been found between apparently similar trees growing in close proximity.

Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

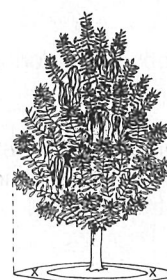
Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.



Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	1.3 - 1.4	pH	-	5.5 - 6.5
Phosphorus	(%)	0.10 - 0.12	Olsen P	(ug/ml)	10 - 25
Potassium	(%)	0.60 - 0.70	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.20 - 0.26	Calcium	(me/100g)	5.0 - 10.0
Calcium	(%)	0.80 - 0.90	Magnesium	(me/100g)	0.80 - 3.00
Magnesium	(%)	0.09 - 0.15	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.04	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	70 - 80	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	100 - 500			
Zinc	(ug/g)	10 - 15			
Copper	(ug/g)	5 - 15			
Boron	(ug/g)	30 - 50			

Comments:

In New Zealand, macadamia are generally produced on the more cool tolerant 'Macadamia tetraphylla' or hybrid cultivars, rather than the 'M. integrifolia' cultivars grown in Hawaii.

Comparing local data with Australian guidelines has resulted in some modifications to the interpretation data. Except for calcium and sulphur, all the major nutrient levels are lower than those found in Australia. This may be due at least in part to the different patterns of growth flushes between the two countries. The decision to standardise in New Zealand on autumn sampling was to ensure stable leaf levels have been obtained.

Extremely high manganese levels have been observed in New Zealand crops. This may be due to acidic and poorly aerated sub-soils where these trees are grown in Northland. It is uncertain at this time whether these high levels are having any adverse effects.

Very low zinc and boron levels have also been observed. Both of these nutrients have been known to restrict yields in Australia.

Iron deficiencies have been observed during cool spring conditions. Iron deficiency can also be induced by high levels of phosphorus.

Because of the variability that can occur between trees, it is recommended that growers keep records of individual tree performance. Soil type, fertiliser history and other management practices, as well as variations between cultivars, can significantly influence leaf nutrient levels.

References:

- Richardson, A.C. and Dawson, T.E. 1993. The nutrition of macadamia trees in New Zealand. *The Orchardist of New Zealand* 66(9): 37-40.
- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Richardson, A.C. and Dawson, T.E. 1991. New Zealand macadamias: The industry and its research needs. *The Orchardist of New Zealand*, 64(6): 30-33.
- Reuter, D. J. and Robinson, J. B. (Eds) 1997. *Plant analysis. An interpretation manual. Second edition.*
- Loebel, R. District Horticulturalist, Lismore, Dept of Agriculture, NSW. *Pers Comm.*

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Sampling

It is important that each sampling area is of the same soil type, has a similar cropping and fertiliser history. When leaf sampling, ensure that different varieties of maize are sampled separately.

Leaf - 50% Silk

Sampling Time: When approximately half the crop is in silk.

Plant Part: Whole leaf.

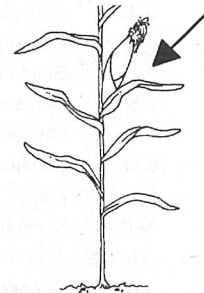
Collect From: The ear node.

Quantity per Sample: 20-25 leaves.

Recommended Tests: Basic Plant (BP).

Comments: Avoid sampling the outside rows of the crop, which are often atypical, and exclude leaves showing obvious signs of mechanical, insect or disease damage.

Sampling within 2-3 weeks of the recommended sampling time is acceptable, as the nutrient levels would not change significantly during this period.



Leaf - Seedling

Sampling Time: When less than 30 cm tall.

Plant Part: The whole above ground portion of the plant.

Collect From: 1-2 cm above the ground.

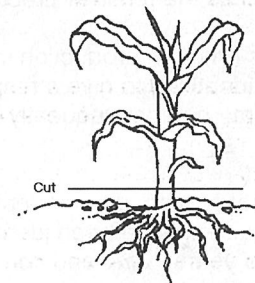
Quantity per Sample: 20 - 25 plants selected at random from the affected area.

Recommended Tests: Basic Plant (BP).

Comments: Sampling at the seedling stage is not recommended for routine monitoring, as the plant nutrient status will be greatly influenced by the nearby starter fertiliser. General soil deficiencies will not become apparent until later in the growth cycle, when the plant is sourcing the nutrients from the soil reserves.

Sampling at the seedling stage is only recommended if a nutritional disorder is suspected, and the grower intends to take remedial action.

Care should be taken to prevent soil contamination when collected whole plant samples.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Select at random from the sampling area.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Available Nitrogen (AN).

Comments: Available N is the most important additional test for maize growing. Others that may be useful are Organic Matter and Trace Metals.

Interpretation

The leaf interpretation data is based on published US data, but have been modified by the results of surveys and trials undertaken in New Zealand.

Leaf - 50% Silk

Element	Unit	Normal Range
Nitrogen	(%)	2.3 - 3.3
Phosphorus	(%)	0.18 - 0.32
Potassium	(%)	1.7 - 3.0
Sulphur	(%)	0.12 - 0.30
Calcium	(%)	0.40 - 0.80
Magnesium	(%)	0.13 - 0.25
Sodium	(%)	0.00 - 0.06
Iron	(ug/g)	30 - 250
Manganese	(ug/g)	18 - 140
Zinc	(ug/g)	22 - 85
Copper	(ug/g)	8 - 20
Boron	(ug/g)	4 - 25

Leaf - Seedling

Element	Unit	Normal Range
Nitrogen	(%)	3.5 - 5.0
Phosphorus	(%)	0.40 - 0.80
Potassium	(%)	3.0 - 5.0
Sulphur	(%)	0.20 - 0.30
Calcium	(%)	0.90 - 1.60
Magnesium	(%)	0.30 - 0.80
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	50 - 300
Manganese	(ug/g)	50 - 160
Zinc	(ug/g)	20 - 60
Copper	(ug/g)	7 - 20
Boron	(ug/g)	7 - 25

Soil

Element	Unit	Normal Range
pH	-	5.6 - 6.4
Olsen P	(ug/ml)	14 - 30
Potassium	(me/100g)	0.50 - 0.80
Calcium	(me/100g)	5.0 - 12.0
Magnesium	(me/100g)	0.80 - 3.00
Sodium	(me/100g)	0.00 - 0.50
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00
Avail N	(kg/ha)	100 - 150

Comments:

As for many crops, high yields are dependent on successful weed control, favourable climatic conditions and suitable variety selection, as well as the fertiliser practices adopted.

Extensive fertiliser trials on grain production in this country in the early 1980's produced few positive responses; nitrogen being the only element identified to give a response. However, nutrient removal by silage crops is much higher, particularly for potassium, and consequently higher input levels are necessary to maintain optimum nutrient levels during repeat silage cropping.

Maize is a particularly hardy crop, and nutrient deficiencies are not common. As well as nitrogen responses, potassium and magnesium deficiencies have been identified, but only on soils inherently low in these nutrients and having been cropped for a number of years. Zinc and iron deficiencies have also been observed on certain peat soils.

Varietal differences can be important as different varieties have different abilities to harvest nutrients from the soil. One variety may show clear magnesium deficiencies, while another variety growing in the same soil may show no deficiency symptoms at all.

Sometimes seedlings will develop a purpling coloration, which is indicative of a phosphorus deficiency (certain varieties are especially prone to this). It is a transient condition, possibly due to low soil temperature, and usually corrects itself without the need for any further action. If the plants are also very stunted, then the absence of phosphorus starter fertiliser should be suspected.

New Zealand trials have also indicated an Olsen P level of 14 ug/mL as adequate for maize cropping in New Zealand, presuming starter fertiliser is being used.

The soil Normal Ranges shown above are for mineral soils. Much of New Zealand's maize production is on peat soils, which will have different nutrient levels.

References:

- Cornforth, I.S. and Steele, K.W. 1981: Interpretation of maize leaf analysis in New Zealand. N.Z. Journal of Experimental Agriculture 9:91-96.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Jones, J.B. and Eck, H.V. 1973. Plant analysis as an aid in fertilising corn and grain sorghum. In Walsh, L.M. & Beaton, J.D. eds. Soil testing and plant analysis. Soil Science Society of America, Madison, Wisconsin, pp349-364.

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Sampling

The nutritional status of mandarins is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: February to March.

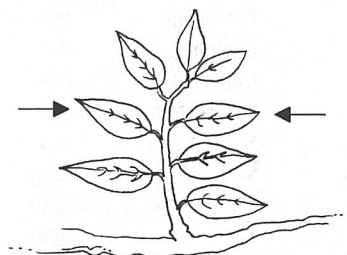
Plant Part: 5-7 month old leaf (blade & petiole).

Collect From: Spring flush growth from non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 40-60 leaves from trees selected at random from throughout the block.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12-20 cores from under trees selected at random from throughout the block.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 20-40 cm depth sample should also be taken, primarily to check the sub-soil pH.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.4 - 2.6	pH	-	5.5 - 6.5
Phosphorus	(%)	0.12 - 0.16	Olsen P	(ug/ml)	30 - 50
Potassium	(%)	0.7 - 1.1	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.20 - 0.30	Calcium	(me/100g)	5.0 - 12.0
Calcium	(%)	3.00 - 5.50	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.26 - 0.60	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.16	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 120	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 200			
Zinc	(ug/g)	25 - 100			
Copper	(ug/g)	5 - 16			
Boron	(ug/g)	31 - 100			

Comments:

The most common nutrient disorders in citrus in New Zealand are nitrogen, phosphorus, magnesium, manganese and zinc deficiencies:

Nitrogen deficiencies may become evident just prior to or during flower and fruit set. Treatment with excess nitrogen, as well as high phosphorus and potassium levels, may adversely affect fruit quality.

Phosphorus deficiency symptoms are usually only evident in poor fruit quality. Excessive rates of phosphorus fertiliser may suppress the uptake of zinc.

Potassium in the soil and foliage is often high in New Zealand orchards, especially if they have been established from old kiwifruit orchards.

Magnesium deficiencies occur occasionally, particularly during years of heavy crops. It may be induced by high rates of potassium fertiliser on soils with marginal magnesium levels.

Manganese and zinc deficiencies often occur together and tend to occur in soils with a pH higher than 6.5.

References:

Embleton, T.W. and Jones, W.W.; Platt, R.G. 1978. Leaf analysis as a guide to citrus fertilisation. In Reisenauer, H.M. (Ed) (1978): Soil and Plant-Tissue Testing in California. Division of Agricultural Science, University of California.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR. Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

Leece, D.R. 1976. Journal of the Australian Institute of Agricultural Science, March, pp 3-19.

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Sampling

Mixed pasture (i.e. clover/ryegrass sward) samples are taken primarily to assess the pasture as a feed for grazing animals. Some assessment can be made as to the adequacy of nutrients for maximum pasture growth, but because there are usually at least two plant species present in pasture, this cannot be done with great accuracy. If plant growth is of concern, then clover only samples should be collected.

Leaf - Dairy

Sampling Time: At a vegetative growth stage, usually during late spring or autumn.

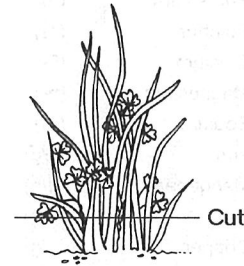
Plant Part: Cut sward at grazing height (upper 2/3).

Collect From: Randomly selected areas of the field.

Quantity per Sample: 500g.

Recommended Tests: Basic Plant (BP), Molybdenum (MO), Cobalt (CO), Selenium (SE), Iodine (IO).

Comments: When collecting a mixed pasture sample, realise that the sample is essentially a feedstuff sample. Collect the sample from areas likely to be selected by the grazing animal, avoid dung and urine patches, and other areas of rank growth.



Some consultants ensure the sample collected has approximately 25% clover content. By standardising this ratio of clover to grass, a more reliable assessment of the nutrient requirement for plant growth is possible.

When collecting a sample to evaluate the grazing animal's needs, the sampling time or growth stage is not critical, even though the mineral levels vary according to the season. Provided the sample represents the animal's intake, it may even be taken during periods of drought stress. However, because some interpretation about the adequacy of nutrients for plant growth is also usually made, a vegetative growth stage is recommended. The spring growth period also coincides with the animals' peak production period, and when metabolic problems are more likely.

Soil contamination of the herbage sample should be avoided, as it will produce elevated levels of some elements, particularly cobalt.

Soil

Sampling Time: Two to three yearly, at the same time each year, but not within two months of a fertiliser application.

Core Depth: 7.5 cm.

Collect From: Randomly selected areas of the field.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Organic-S (OS), Sulphate-S (SU), Phosphate Retention (PR), Resin-P (RP).

Comments: When collecting soil samples, realise that the prime areas of concern are those that are not performing well. Avoid localised high fertility areas, such as dung and urine patches. If these are included in the composite sample then the deficiencies in the low fertility areas will not be revealed.

Collecting to the specified sampling depth is critical. Soils under permanent pasture are extremely fertile in the top few millimetres, where fertiliser and plant residues are being added to the soil. As this fertility declines rapidly with depth, it is important to adhere to the fixed sampling depth, otherwise variable amounts of the deeper soil will alter the levels found.

Interpretation

Suggested optimum levels differ according to the source of the data. The Normal Ranges below focus mostly on dairy cow requirements, but take into account plant requirements for those nutrients that are more critical to plant growth (N, P, K, Mo). Interpretation for dry stock requirements is also available.

Leaf - Dairy			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	4.0 - 5.0	pH	-	5.8 - 6.3
Phosphorus	(%)	0.35 - 0.45	Resin P	(ug/g)	40 - 75
Potassium	(%)	2.5 - 3.0	Olsen P	(ug/ml)	20 - 30
Sulphur	(%)	0.30 - 0.40	Potassium	(me/100g)	0.50 - 0.80
Calcium	(%)	0.45 - 1.00	Calcium	(me/100g)	6.0 - 12.0
Magnesium	(%)	0.20 - 0.25	Magnesium	(me/100g)	1.00 - 3.00
Sodium	(%)	0.15 - 0.25	Sodium	(me/100g)	0.20 - 0.50
Iron	(ug/g)	100 - 250	CEC	(me/100g)	12.0 - 25.0
Manganese	(ug/g)	40 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Zinc	(ug/g)	30 - 50	Sulphate-S	(ug/g)	7 - 15
Copper	(ug/g)	9 - 12	Org. Sulphur	(ug/g)	10 - 20
Boron	(ug/g)	10 - 15			
Molybdenum	(ug/g)	0.50 - 2.00			
Cobalt	(ug/g)	0.10 - 0.15			
Selenium	(ug/g)	0.05 - 0.10			

Comments:

Interactions between nutrients and other influences make accurate assessments difficult, and the results should be assessed in conjunction with animal tests, visual symptoms and a knowledge of identified deficiencies of the area. Some known interactions are as follows:

Copper, Molybdenum, Sulphur: The availability of copper in the feed is influenced by molybdenum and sulphur levels. High levels of molybdenum (3 - 10 mg/kg) and sulphur (0.35 - 0.50 %) mean that higher levels of copper may be required.

Iron, Copper, Zinc: High iron levels (possibly arising from soil contamination) can affect zinc and copper availability, and consequently higher levels of these minerals are desirable.

Potassium, Sodium, Magnesium: High potassium in feed will not only suppress sodium and magnesium uptake by the plant, but also the absorption of these elements by the animal. It is therefore important that the potassium level is not excessive in the mixed herbage.

It should be realised that these levels are concentrations in the feed. Also of importance is the amount of feed available. When it is abundant, marginal nutrient levels may adequately supply the animal's requirements, but during a feed shortage, the same levels may be inadequate.

Animals may also obtain nutrients from sources other than the herbage. For example, some waters may contain significant amounts of sodium.

High iron levels (greater than 300 mg/kg) often indicate a soil contaminated pasture sample, which will also elevate the cobalt level significantly and, to a lesser extent, copper and zinc.

References:

- Edmeades, D.C., Sinclair, A.G., Watkinson, J.H., Ledgard, S.F., Ghani, A., Thorrold, B.S., Boswell, C.C., Braithwaite, A.C. and Brown, M.W. 1994. Some recent developments in sulphur research in New Zealand agriculture. Sulphur in Agriculture, Vol 18.
- Turner, M. A. 1977. Trace elements in human and animal health in New Zealand. Proceedings. August.
- Cornforth, I.S. and Sinclair, A.G. 1984. Fertiliser recommendations for pastures and crops in New Zealand. MAF Publication, Wellington.
- McNaught, K.J. 1970. Proceedings of the XI international grassland conference. p334.
- NZ Society of Animal Production, 1983. The mineral requirements of grazing ruminants.

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Sampling

The nutritional status of nashi trees is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

The standard leaf sampling period is mid to late summer. Data is also available for sampling in late spring if this should be necessary.

Leaf - Mid Season

Sampling Time: January and February.

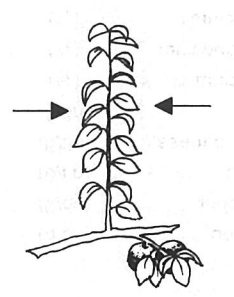
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Mid portion of the current season's non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 4 representative leaves from the periphery of each of 15 - 25 trees.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores.

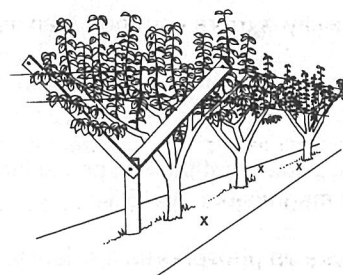
Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the root zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the vines which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Mid Season

Element	Unit	Normal Range
Nitrogen	(%)	2.3 - 3.1
Phosphorus	(%)	0.23 - 0.39
Potassium	(%)	1.7 - 2.5
Sulphur	(%)	0.13 - 0.19
Calcium	(%)	0.71 - 1.63
Magnesium	(%)	0.20 - 0.33
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	53 - 104
Manganese	(ug/g)	63 - 222
Zinc	(ug/g)	28 - 61
Copper	(ug/g)	16 - 29
Boron	(ug/g)	27 - 52

Soil

Element	Unit	Normal Range
pH	-	5.8 - 6.8
Olsen P	(ug/ml)	30 - 60
Potassium	(me/100g)	0.50 - 1.00
Calcium	(me/100g)	6.0 - 12.0
Magnesium	(me/100g)	1.00 - 3.00
Sodium	(me/100g)	0.00 - 0.50
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00

Comments:

Nitrogen, magnesium, calcium, manganese, zinc and boron nutrient disorders are the most common.

Adequate levels of nitrogen are required at blossoming and fruit set to ensure good fruit set.

Calcium related disorders, as well as magnesium deficiencies, may be induced by high levels of potassium that depress calcium and magnesium uptake. Foliar symptoms are not necessarily evident.

Manganese toxicity is more common than its deficiency, and is often related to low soil pH or poor drainage.

Boron is the most common deficiency, with symptoms of fruit shape distortion. Foliar symptoms are not necessarily evident.

It has been suggested that the soil potassium level should be 3-4% of the CEC. Calcium should occupy 70-80% of the CEC sites and magnesium 10-15%.

Pipfruit trees take up phosphorus efficiently, even in highly retentive soils. The suggested optimum Olsen P level is 30 or higher.

Pipfruit will grow within a soil pH range of 5.8 - 6.8. To minimise calcium disorders in fruit, a topsoil pH of 6.5 or greater is considered desirable.

References:

Nashi survey results, Nashi News - New Zealand Nashi Growers Association Inc. July, 1989.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.

Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

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Sampling

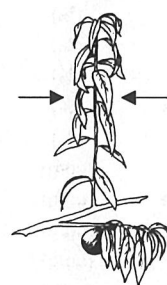
To ensure maximum yields of quality nectarines, plant nutrients must be maintained at optimum levels. The nutritional status of nectarines is monitored using soil tests and plant analysis. Annual monitoring or crop logging is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: January and February.

Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Mid portion of the current season's non-fruiting laterals (extension growth), taken at shoulder height.



Quantity per Sample: 4 representative leaves from the periphery of each of 25 trees.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.

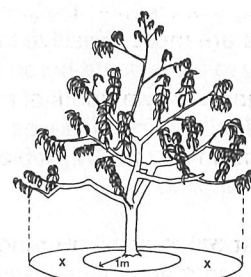
Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores from under trees selected at random from throughout the block.



Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 3.5	pH	-	6.0 - 6.5
Phosphorus	(%)	0.14 - 0.25	Olsen P	(ug/ml)	15 - 35
Potassium	(%)	2.0 - 3.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.20 - 0.40	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.80 - 2.70	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 0.80	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 250	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	40 - 160			
Zinc	(ug/g)	20 - 50			
Copper	(ug/g)	5 - 16			
Boron	(ug/g)	20 - 60			

Comments:

Fruit quality may be improved if nitrogen is kept at the lower end of the normal range.

Boron deficiency for most stonefruit is more obvious in fruit than foliage, with nectarines being less susceptible than most other stonefruit. Symptoms include small and abnormal fruit with internal necrotic patches.

Conversely, nectarines are more sensitive to boron toxicity than other stonefruit. Except for old and non-fruiting trees, this crop has the ability to translocate boron from the leaves to the fruit and bark, so that leaf boron levels remain normal and the classic boron toxicity symptoms of marginally yellowed or burned leaves are consequently not observed. In extreme cases there is thickening of leaves, corkiness along the midribs and petioles, enlarged nodes, bark necrosis and death of the shoot tips. Boron toxicity problems can arise in newly planted areas that were previously in apples and where boron had been applied.

Stonefruit will grow best within a soil pH range of 6.0 - 6.7. At lower pH, root growth and tree health are adversely affected by aluminium and manganese toxicity. At higher pH, trace element deficiencies can be induced.

It has been suggested that the soil potassium level should be 3-4% of the CEC. Calcium should occupy 70-80% of the CEC sites and magnesium, 10-15%.

Like all stonefruit, nectarines prefer well draining soils.

References:

- Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
- Leece, D.R. 1976. Journal of the Australian Institute of Agricultural Science, March, pp 3-19.

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Sampling

Plant growth stage has a major influence on the nutrient levels in the tissue. Two distinct growth stages are specified for sample collection; neither preferred over the other, though each is useful for a specific purpose.

Leaf - Late Tiller

Sampling Time: When the leaves have formed, and the leaf-sheaths are lengthening and becoming erect. Just prior to stem extension.

Plant Part: Whole above portion of the plant.

Collect From: Random sites throughout the sampling area.

Quantity per Sample: 30 to 40 plants.

Recommended Tests: Basic Plant (BP).

Comments: The advantage of sampling at this early stage is that there may be time to correct nutrient disorders observed in the current crop.



Leaf - Ear Emergence

Sampling Time: When stem extension is complete and the head of the ear emerges from the boot.

Plant Part: Whole above portion of the plant.

Collect From: Random sites throughout the sampling area.

Quantity per Sample: 20 to 30 plants.

Recommended Tests: Basic Plant (BP).

Comments: Testing at this later stage will indicate more accurately that the crop has accumulated the required nutrients successfully.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Random sites throughout the sampling area.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Soil samples are usually collected for analysis prior to planting the crop.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected areas. In these circumstances, a second sample taken for comparative purposes from the rooting zones of normal areas may be useful.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Late Tiller

Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 5.0
Phosphorus	(%)	0.35 - 0.60
Potassium	(%)	4.5 - 5.8
Sulphur	(%)	0.30 - 0.45
Calcium	(%)	0.50 - 1.00
Magnesium	(%)	0.20 - 0.30
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	50 - 150
Manganese	(ug/g)	40 - 100
Zinc	(ug/g)	25 - 70
Copper	(ug/g)	6 - 12
Boron	(ug/g)	6 - 12

Leaf - Ear Emergence

Element	Unit	Normal Range
Nitrogen	(%)	2.0 - 3.0
Phosphorus	(%)	0.20 - 0.50
Potassium	(%)	1.5 - 3.0
Sulphur	(%)	0.15 - 0.40
Calcium	(%)	0.20 - 0.50
Magnesium	(%)	0.15 - 0.50
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	40 - 150
Manganese	(ug/g)	25 - 100
Zinc	(ug/g)	15 - 70
Copper	(ug/g)	5 - 25
Boron	(ug/g)	5 - 10

Soil

Element	Unit	Normal Range
pH	-	5.1 - 6.0
Olsen P	(ug/ml)	20 - 30
Potassium	(me/100g)	0.50 - 0.80
Calcium	(me/100g)	5.0 - 12.0
Magnesium	(me/100g)	0.80 - 3.00
Sodium	(me/100g)	0.00 - 0.50
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00

Comments:

Small grain production and quality are greatly influenced by fertilisation.

Nitrogen has been found to be the most important fertiliser element in New Zealand cereal crops. Significant responses to potassium, sulphur or magnesium have also been recorded.

Different cultivars have been found to have some differences in nutrient concentrations; however, these differences are relatively small, and one set of interpretation criteria can be used.

Improper growth stage identification can result in errors in interpretation. Nutrient uptake precedes dry matter accumulation occurring between tillering and head emergence. Consequently, nutrient concentrations generally decline between these stages.

Diagnosis of sulphur deficiency can be assisted by using the N:S ratio. A sulphur deficiency may exist when the N:S ratio is greater than 16:1. Severe deficiency is likely when the ratio is greater than 20:1.

References:

- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
 Lockman, R.B. 1969. Agronomy Abstracts, American Society of Agronomy, Wisconsin, pg 97.
 Ward, R.C.; Whitney, D.A. and Westfall, D.G. 1973. Plant analysis as an aid in fertilising small grains. Soil testing and plant analysis.
 Jones Jr, J.B 1967. Soil testing and plant analysis. Part 2. SSSA Special Publication Series, p 49-58.

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Sampling

The nutritional status of olives is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: January and February.

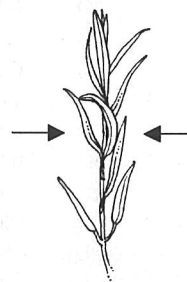
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Mid portion of the current season's non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 4 representative leaves from the periphery of each of 15 - 25 trees.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.



Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	1.5 - 2.0	pH	-	6.0 - 6.5
Phosphorus	(%)	0.10 - 0.30	Olsen P	(ug/ml)	15 - 30
Potassium	(%)	0.8 - 1.2	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.10 - 0.25	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.00 - 2.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.10 - 0.35	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.20	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	20 - 200			
Zinc	(ug/g)	10 - 30			
Copper	(ug/g)	4 - 25			
Boron	(ug/g)	19 - 150			

Comments:

Symptoms described below have been induced under research conditions. In practice, nitrogen, potassium and boron are the only likely deficiencies to be observed.

Nitrogen deficiency shows as small, yellow leaves, with heavy defoliation. Shoots tend to be less than 20 cm. Fewer, but normal looking fruit will be present.

Potassium deficiency symptoms are light green leaves, tip burn and dead areas in the tree. Leaf yellowing is more obvious in the basal leaves than in the terminal ones. Fruit appear normal. Leaf internodes will be characteristically short.

Terminal leaves curling, yellowing and eventual necrosis of their leaf tips are symptomatic of calcium deficiency. Fruit production tends to be reduced.

Magnesium deficiency causes basal leaves to become chlorotic and drop, while terminal leaves remain normal in size and colour. Just before leaf drop, banding develops as the tips and base of leaves become yellow while the mid section remains greener.

Low iron levels cause small whitish leaves, particularly the terminal ones.

Zinc deficiency is not common, but if present, young leaves will be lighter than older leaves. Fruit may also mature earlier than normal.

Boron deficiency results in deformed fruit known as "Monkey Face". New growth will be short and branched, with limb dieback and rough bark. Leaves may be small with some tip dieback.

References:

Freeman, M., Uriu, K. and Hartmann, H.T. 1994. The olive tree and fruit. Diagnosing and correcting nutrient problems. From Olive Production Manual. Ferguson, L., Sibbett, G.S. and Martin, G.C. (eds). University of California Publication 3353.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: Mid-growth.

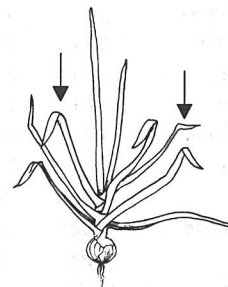
Plant Part: Youngest mature leaf.

Collect From: -

Quantity per Sample: 30-50 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.5 - 4.0	pH	-	5.6 - 7.0
Phosphorus	(%)	0.25 - 0.40	Olsen P	(ug/ml)	45 - 90
Potassium	(%)	2.5 - 5.0	Potassium	(me/100g)	0.70 - 1.10
Sulphur	(%)	0.50 - 1.00	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.00 - 2.50	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.15 - 0.30	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.40	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 300	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	30 - 300			
Zinc	(ug/g)	25 - 100			
Copper	(ug/g)	6 - 20			
Boron	(ug/g)	25 - 50			

Comments:

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

The nutritional status of oranges is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: February to March.

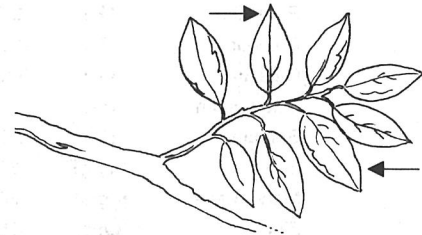
Plant Part: 5 -7 month old leaf (blade & petiole).

Collect From: Spring flush growth from non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 40-60 leaves from trees selected at random from throughout the block.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores from under trees selected at random from throughout the block.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 20 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.4 - 2.6	pH	-	5.5 - 6.5
Phosphorus	(%)	0.12 - 0.16	Olsen P	(ug/ml)	30 - 50
Potassium	(%)	0.7 - 1.1	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.20 - 0.30	Calcium	(me/100g)	5.0 - 12.0
Calcium	(%)	3.00 - 5.50	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.26 - 0.60	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.16	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 120	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 200			
Zinc	(ug/g)	25 - 100			
Copper	(ug/g)	5 - 16			
Boron	(ug/g)	31 - 100			

Comments:

The most common nutrient disorders in citrus in New Zealand are nitrogen, phosphorus, magnesium, manganese and zinc deficiencies:

Nitrogen deficiencies may become evident just prior to or during flower and fruit set. Treatment with excess nitrogen, as well as high phosphorus and potassium levels, may adversely affect fruit quality.

Phosphorus deficiency symptoms are usually only evident in poor fruit quality. Excessive rates of phosphorus fertiliser may suppress the uptake of zinc.

Potassium in the soil and foliage is often high in New Zealand orchards, especially if they have been established from old kiwifruit orchards.

Magnesium deficiencies occur occasionally, particularly during years of heavy crops. It may be induced by high rates of potassium fertiliser on soils with marginal magnesium levels.

Manganese and zinc deficiencies often occur together and tend to occur in soils with a pH higher than 6.5.

References:

- Embleton, T.W. and Jones, W.W.; Platt, R.G. 1978. Leaf analysis as a guide to citrus fertilisation. In Reisenauer, H.M. (Ed) (1978): Soil and Plant-Tissue Testing in California. Division of Agricultural Science, University of California.
- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
- Leece, D.R. 1976. Journal of the Australian Institute of Agricultural Science, March, pp 3-19.

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Sampling

The nutritional status of this flower is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf - Oriental

Sampling Time: Mid season.

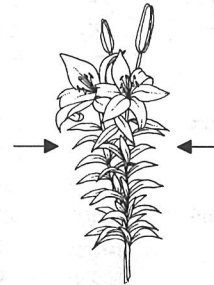
Plant Part: Youngest mature leaf.

Collect From: -

Quantity per Sample: 30 - 50 leaves.

Recommended Tests: Basic Plant (BP).

Comments: Just prior to flowering or during early flowering is considered to be the appropriate time to sample. However, regular leaf analyses should be obtained through the growing season (e.g. 6 - 8 weekly intervals) in order to monitor the effect of liquid feeding programmes being used.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: From the root zone of the plants.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Soluble Salts (SG).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Oriental

Element	Unit	Normal Range
Nitrogen	(%)	2.3 - 4.0
Phosphorus	(%)	0.15 - 0.35
Potassium	(%)	2.5 - 4.5
Sulphur	(%)	0.15 - 0.35
Calcium	(%)	1.00 - 2.20
Magnesium	(%)	0.15 - 0.35
Sodium	(%)	0.00 - 0.20
Iron	(ug/g)	90 - 200
Manganese	(ug/g)	60 - 150
Zinc	(ug/g)	25 - 70
Copper	(ug/g)	4 - 12
Boron	(ug/g)	20 - 40

Soil

Element	Unit	Normal Range
pH	-	5.8 - 6.5
Olsen P	(ug/ml)	40 - 120
Potassium	(me/100g)	0.70 - 1.50
Calcium	(me/100g)	6.0 - 12.0
Magnesium	(me/100g)	1.50 - 3.00
Sodium	(me/100g)	0.10 - 0.60
CEC	(me/100g)	15.0 - 30.0
Volume Weight	(g/ml)	0.60 - 1.00
Sol.Salts (G/H)	(%)	0.00 - 0.20

Comments:

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Disclaimer:

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: Mid growth when the root is 1 - 3 cm in diameter.

Plant Part: Youngest mature leaf.

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.2 - 4.8	pH	-	5.6 - 7.1
Phosphorus	(%)	0.30 - 0.70	Olsen P	(ug/ml)	35 - 75
Potassium	(%)	3.5 - 6.0	Potassium	(me/100g)	0.70 - 1.40
Sulphur	(%)	0.40 - 0.50	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.20 - 2.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.40 - 0.80	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.20	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 500	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	40 - 200			
Zinc	(ug/g)	20 - 40			
Copper	(ug/g)	6 - 30			
Boron	(ug/g)	25 - 60			

Comments:

Although adequate fertility is important, parsnip do not generally require inputs as high as some other vegetable crops.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

The nutritional status of passionfruit is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

There has not been very much research undertaken for the growing of passionfruit in New Zealand. Information in this Guide is based largely on published Australian data.

Leaf

Sampling Time: September, prior to active vegetative growth and fertiliser application.

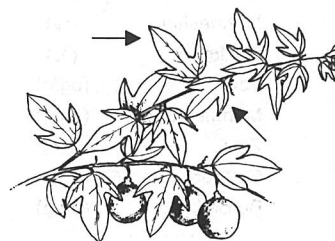
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Well developed, actively growing laterals from vines selected at random from throughout the block.

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected vines for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the root zone of the vines.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the root zone of the vines. Where fertiliser has been banded, samples should only be taken from areas under the vines which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	4.3 - 5.3	pH	-	5.7 - 6.5
Phosphorus	(%)	0.15 - 0.25	Olsen P	(ug/ml)	30 - 60
Potassium	(%)	2.0 - 3.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.20 - 0.40	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.75 - 2.75	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 0.40	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.08	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	100 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	100 - 500			
Zinc	(ug/g)	50 - 80			
Copper	(ug/g)	5 - 20			
Boron	(ug/g)	40 - 60			

Comments:

Problems with excess nitrogen have been reported. Luxurious growth may occur, and this may adversely affect fruit quality.

Known nutritional deficiencies in New Zealand include zinc and manganese deficiencies.

Zinc deficiency manifests in small leaves, distorted growing tips and yellow interveinal mottling of young leaves.

Passionfruit require free draining soils to minimise the risk of root disease.

Manganese deficiency is usually induced by high soil pH (pH>7).

There is little published data on optimum soil test levels. The Normal Range levels shown above are those typically found in high producing orchards.

References:

Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR. Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: At flowering.

Plant Part: Youngest mature compound leaf.

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 4.5	pH	-	5.1 - 6.0
Phosphorus	(%)	0.30 - 0.50	Olsen P	(ug/ml)	30 - 55
Potassium	(%)	2.0 - 3.0	Potassium	(me/100g)	0.70 - 1.40
Sulphur	(%)	0.20 - 0.40	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.50 - 2.50	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.25 - 0.40	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.40	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 100	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	30 - 300			
Zinc	(ug/g)	20 - 100			
Copper	(ug/g)	5 - 20			
Boron	(ug/g)	20 - 80			

Comments:

Being a legume, peas are able to support rhizobia that can fix nitrogen. A small amount of nitrogen fertiliser is often still beneficial.

Manganese deficiencies can occur in pea crops, particularly if grown on high pH organic soils.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

To ensure maximum yields of quality peaches, plant nutrients must be maintained at optimum levels. The nutritional status of peaches is monitored using soil tests and plant analysis. Annual monitoring or crop logging is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: January and February.

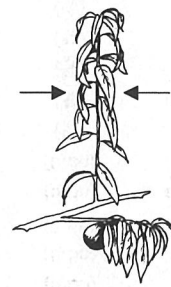
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Mid portion of the current season's non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 4 representative leaves from the periphery of each of 25 trees.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores from under trees selected at random from throughout the block.

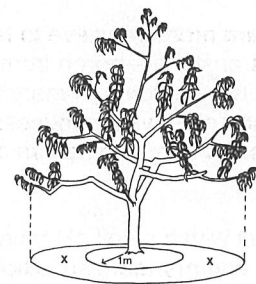
Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 3.5	pH	-	6.0 - 6.5
Phosphorus	(%)	0.14 - 0.25	Olsen P	(ug/ml)	15 - 35
Potassium	(%)	2.0 - 3.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.20 - 0.40	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.80 - 2.70	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 0.80	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 250	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	40 - 160			
Zinc	(ug/g)	20 - 50			
Copper	(ug/g)	5 - 16			
Boron	(ug/g)	20 - 60			

Comments:

Fruit quality may be improved if nitrogen is kept at the lower end of the normal range.

Boron deficiency for most stonefruit is more obvious in fruit than foliage, with peaches being less susceptible than most other stonefruit. Symptoms include small and abnormal fruit with internal necrotic patches.

Conversely, peaches are more sensitive to boron toxicity than other stonefruit. Except for old and non-fruiting trees, this crop has the ability to translocate boron from the leaves to the fruit and bark, so that leaf boron levels remain normal and the classic boron toxicity symptoms of marginally yellowed or burned leaves are consequently not observed. In extreme cases there is thickening of leaves, corkiness along the midribs and petioles, enlarged nodes, bark necrosis and death of the shoot tips. Boron toxicity problems can arise in newly planted areas that were previously in apples and where boron had been applied.

Stonefruit will grow best within a soil pH range of 6.0 - 6.7. At lower pH, root growth and tree health are adversely affected by aluminium and manganese toxicity. At higher pH, trace element deficiencies can be induced.

It has been suggested that the soil potassium level should be 3-4% of the CEC. Calcium should occupy 70-80% of the CEC sites and magnesium, 10-15%.

Like all stonefruit, peaches prefer well draining soils.

References:

- Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
 Leece, D.R. 1976. Journal of the Australian Institute of Agricultural Science, March, pp 3-19.

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Sampling

The nutritional status of pear trees is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: January and February.

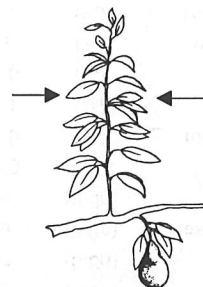
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Mid portion of the current season's non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 4 representative leaves from the periphery of each of 15 - 25 trees.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 20 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores from under trees selected at random from throughout the block.

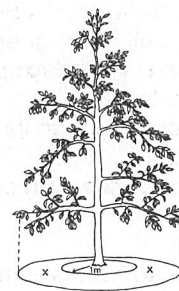
Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 20 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.3 - 2.7	pH	-	5.8 - 6.8
Phosphorus	(%)	0.14 - 0.20	Olsen P	(ug/ml)	30 - 60
Potassium	(%)	1.2 - 2.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.17 - 0.26	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.50 - 2.10	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 0.50	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 200	Base Saturatio	(%)	60 - 85
Manganese	(ug/g)	60 - 120	Volume Weight	(g/ml)	0.60 - 1.00
Zinc	(ug/g)	20 - 50			
Copper	(ug/g)	9 - 20			
Boron	(ug/g)	20 - 40			

Comments:

Nitrogen, magnesium, calcium, manganese, zinc and boron nutrient disorders are the most common.

Adequate levels of nitrogen are required at blossoming and fruit set to ensure good fruit set.

Calcium related disorders, as well as magnesium deficiencies, may be induced by high levels of potassium that depress calcium and magnesium uptake. Foliar symptoms are not necessarily evident.

Manganese toxicity is more common than its deficiency, and is often related to low soil pH or poor drainage.

Boron is the most common deficiency, with symptoms of fruit shape distortion. Foliar symptoms are not necessarily evident.

It has been suggested that the soil potassium level should be 3-4% of the CEC. Calcium should occupy 70-80% of the CEC sites and magnesium 10-15%.

Pipfruit trees take up phosphorus efficiently, even in highly retentive soils. The suggested optimum Olsen P level is 30 or higher.

Pipfruit will grow within a soil pH range of 5.8 - 6.8. To minimise calcium disorders in fruit, a topsoil pH of 6.5 or greater is considered desirable.

References:

- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Bennett, W.F. (Ed) 1993. Nutrient deficiencies & toxicities in crop plants. College of Agricultural Sciences and Natural Resources, Texas Tech University, Lubbock.
 Leece, D.R. 1976. Journal of the Australian Institute of Agricultural Science, March, pp 3-19.

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Sampling

For maximum yields of quality fruit, plant nutrients must be maintained at optimum levels. Annual monitoring or crop logging is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

The standard leaf sampling period is February/March. Data is also available for sampling in December if this should be necessary.

Leaf - March

Sampling Time: February and March.

Plant Part: Youngest mature leaf (blade & petiole).

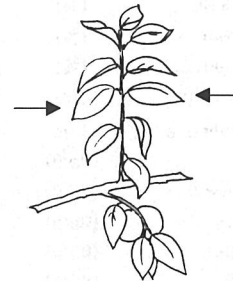
Collect From: Mid portion of the current season's non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 4 representative leaves from the periphery of each of 15 trees.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.

In young blocks, not yet producing fruit, collect young mature leaves from the most recent vegetative growth. The most recently matured leaves produced during the summer months are generally a lighter green colour than the older leaves produced in the spring.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 20 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 15 - 20 cores.

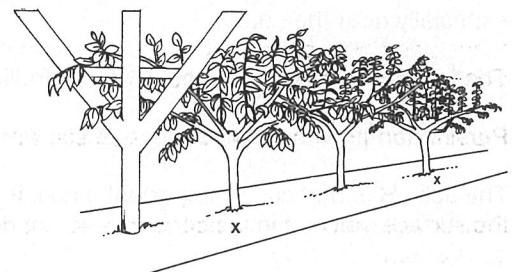
Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 20 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

The information below is based on surveys and studies on Fuyu persimmon varieties in New Zealand and Japan.

Leaf - March			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	1.6 - 2.6	pH	-	6.0 - 6.8
Phosphorus	(%)	0.10 - 0.19	Olsen P	(ug/ml)	25 - 50
Potassium	(%)	1.9 - 3.7	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.21 - 0.44	Calcium	(me/100g)	7.0 - 15.0
Calcium	(%)	1.35 - 3.11	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.17 - 0.46	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.01 - 0.04	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	56 - 124	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	238 - 928			
Zinc	(ug/g)	5 - 36			
Copper	(ug/g)	1 - 8			
Boron	(ug/g)	48 - 93			

Comments:

The disorder "Green Blotch" can appear in persimmon fruit and is associated with a high manganese/low calcium imbalance. Even though the leaf manganese levels can be very high, there are usually no symptoms apparent in the leaf, only in the fruit. Corrective action in the form of increased liming have not been entirely satisfactory.

Magnesium and manganese are the prevalent deficiencies reported in New Zealand orchards.

Magnesium deficiency symptoms appear as interveinal necrotic tissue in young summer growth in March.

Calcium and iron deficiencies have been observed in seedlings. Symptoms include puckered and crinkled leaves, especially near their apex.

The Normal Range levels above are for fruiting trees. Non-fruiting trees tend to have lower nitrogen and calcium levels.

Persimmon grow on a wide range of soil types, but prefer deep, fertile, well drained soils.

The soil pH is particularly important, and it is recommended that it be maintained at close to 6.5. This is important, both in the surface soil and in the zone 20 - 40 cm deep.

Manganese deficiency tends to be induced by soil pH levels exceeding 7.

References:

- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Clark, C.J. 1986. National survey of fruiting persimmon orchards (RH331), July.

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Sampling

The information in this Guide is derived mostly from Australian and New Zealand research. The interpretive data is for mature trees.

Leaf

Sampling Time: February to March.

Plant Part: Youngest mature foliage.

Collect From: Second order new growth on second order branches from the top third of the crown.

Quantity per Sample: Two branches from each of 15 - 20 trees.

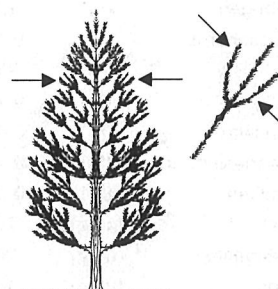
Recommended Tests: Basic Plant (BP).

Comments: The recommended sampling time is during maximum stress and when nutrient levels are relatively stable.

Ensure samples are taken from sections of the trees that are not inhibited by shade or space from adjacent trees.

Samples should be taken from dominant or co-dominant trees.

Although the recommended sampling technique can be difficult, the interpretive information available for it is more consistent.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores from under trees selected at random from throughout the block.

Recommended Tests: Basic Soil (BS).

Comments: Soil testing for plant available nutrients is of limited value for such a deep rooting crop with a life span of 20 - 30 years, except when soil test are used for seedling production. For mature trees, consideration should also be given to measuring the soil's capacity to supply nutrients long term.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	1.2 - 2.0	pH	-	5.5 - 6.5
Phosphorus	(%)	0.14 - 0.30	Olsen P	(ug/ml)	12 - 30
Potassium	(%)	0.5 - 0.8	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.13 - 0.20	Calcium	(me/100g)	4.0 - 12.0
Calcium	(%)	0.08 - 0.45	Magnesium	(me/100g)	0.80 - 3.00
Magnesium	(%)	0.10 - 0.40	Sodium	(me/100g)	0.20 - 0.50
Sodium	(%)	0.00 - 0.05	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	70 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	25 - 400			
Zinc	(ug/g)	14 - 64			
Copper	(ug/g)	3 - 9			
Boron	(ug/g)	16 - 70			

Comments:

Symptoms of soil nutrient deficiency usually show evenly in a cluster of trees, rather than in individual trees. If an individual tree shows symptoms, suspect other causes such as animal or mechanical damage, or disease. Similarly, deficiency symptoms should be distributed in regular patterns within the trees.

Nitrogen deficiency shows as uniform chlorosis over the whole tree, with shorter than normal needles.

Chlorosis of the current season's needle tips is symptomatic of phosphorus deficiency.

Golden chlorosis of the previous season's needle tips are indicative of magnesium deficiency.

Potassium deficiency symptoms are similar to those of magnesium, except that they show earlier in the year. Needles are yellow, rather than golden.

Deficiencies of phosphorus, copper and boron may cause fused needle symptoms.

Copper, and to a some extent potassium and boron deficiencies may cause branch twisting.

Boron deficiency causes shoot and bud dieback. This symptom has also be induced experimentally by low calcium, but at levels unlikely to occur in the field.

If manganese and iron deficiencies are present, these are most likely to be induced by high soil pH.

Nitrogen responses may be limited to the availability of sulphur.

References:

Will, G. 1985. Nutrient deficiencies and fertiliser use in New Zealand exotic forests. FRI Bulletin No. 97.
Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.

Disclaimer:

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Sampling

To ensure maximum yields of quality plums, plant nutrients must be maintained at optimum levels. The nutritional status of plums is monitored using soil tests and plant analysis. Annual monitoring or crop logging is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: January and February.

Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Mid portion of the current season's non-fruiting laterals (extension growth), taken at shoulder height.

Quantity per Sample: 4 representative leaves from the periphery of each of 25 trees.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the drip zone of the trees.

Quantity per Sample: 12 - 20 cores from under trees selected at random from throughout the block.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.

Where fertiliser has been broadcast, sample from the drip zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the drip zone which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.4 - 3.0	pH	-	6.0 - 6.5
Phosphorus	(%)	0.14 - 0.25	Olsen P	(ug/ml)	15 - 35
Potassium	(%)	1.6 - 3.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.20 - 0.40	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.50 - 3.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 0.80	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	60 - 250	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	40 - 160			
Zinc	(ug/g)	20 - 50			
Copper	(ug/g)	6 - 16			
Boron	(ug/g)	25 - 60			

Comments:

Boron deficiency for most stonefruit is more obvious in fruit than foliage, with plums being more susceptible than most other stonefruit except apricots. Symptoms include brown sunken areas and gum pockets in the flesh.

Conversely, plums are more tolerant of boron toxicity than other stonefruit. Except for old and non-fruiting trees, this crop has the ability to translocate boron from the leaves to the fruit and bark, so that leaf boron levels remain normal and the classic boron toxicity symptoms of marginally yellowed or burned leaves are consequently not observed. In extreme cases there is thickening of leaves, corkiness along the midribs and petioles, enlarged nodes, bark necrosis and death of the shoot tips.

Stonefruit will grow best within a soil pH range of 6.0 - 6.7. At lower pH, root growth and tree health are adversely affected by aluminium and manganese toxicity. At higher pH, trace element deficiencies can be induced.

It has been suggested that the soil potassium level should be 3-4% of the CEC. Calcium should occupy 70-80% of the CEC sites and magnesium, 10-15%.

Like all stonefruit, plums prefer well draining soils.

References:

- Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR. Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
 Leece, D.R. 1976. Journal of the Australian Institute of Agricultural Science, March, pp 3-19.

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Sampling

Two approaches are used for tissue testing of a potato crop: (i) analysing the petiole through the season, in particular to monitor the nitrogen status, and (ii) leaf analysis at mid season, to evaluate the status of all plant essential nutrients.

Petiole - Early Season

Sampling Time: Starting early in the season, and continuing as required.

Plant Part: Petiole

Collect From: Fourth or fifth leaves from the top.

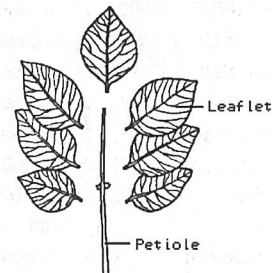
Quantity per Sample: 30 petioles from randomly selected plants.

Recommended Tests: Nitrate-N (PN).

Comments: Petiole analysis is recommended for monitoring the status of nitrogen, which is a key nutrient in potato production. If using this technique, however, we recommend that you consult a local advisor or crop specialist who could provide more specific data for your particular growing conditions.

Separate the leaflets from the petiole immediately after the petiole has been removed from the plant stem.

It can also be useful to analyse the petioles for P, K and Mg.



Leaf - Mid Season

Sampling Time: When the tubers are half grown.

Plant Part: Youngest mature compound leaf (leaflet & petiole).

Collect From: Fourth or fifth leaves from the top.

Quantity per Sample: 25-50 leaves from 25 randomly selected plants.

Recommended Tests: Basic Plant (BP).

Comments:



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Select at random from the whole growing area.

Quantity per Sample: 15 - 20 cores.

Recommended Tests: Basic Soil (BS), Available-N (AN).

Comments: Soil samples are usually collected for analysis prior to planting the crop.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected plants. In these circumstances, a second sample taken for comparative purposes from the rooting zones of healthy plants may be useful.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation criteria given here are based on the best information available and relate specifically to the sampling instructions given.

Petiole - Early Season

Element	Unit	Normal Range
Nitrate-N	(ug/g)	10000 - 20000
Phosphorus	(%)	0.30 - 0.50
Potassium	(%)	10.0 - 15.0
Magnesium	(%)	0.25 - 0.80

Leaf - Mid Season

Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 5.0
Phosphorus	(%)	0.20 - 0.30
Potassium	(%)	5.0 - 8.0
Sulphur	(%)	0.25 - 0.60
Calcium	(%)	1.50 - 3.00
Magnesium	(%)	0.25 - 0.80
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	70 - 150
Manganese	(ug/g)	30 - 450
Zinc	(ug/g)	20 - 40
Copper	(ug/g)	6 - 15
Boron	(ug/g)	30 - 50

Soil

Element	Unit	Normal Range
pH	-	5.4 - 5.8
Olsen P	(ug/ml)	30 - 60
Potassium	(me/100g)	0.50 - 1.00
Calcium	(me/100g)	4.0 - 10.0
Magnesium	(me/100g)	1.00 - 3.00
Sodium	(me/100g)	0.00 - 0.50
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00

Comments:

The suggested interpretation levels for petioles are from U.S. and Australian sources and should be regarded as guideline values only. Unpublished work in New Zealand has shown the levels found in NZ potato crops will vary according to the variety, the area in which they are grown and on seasonal factors (for example, a dry season will result in a lower than normal nitrate-N petiole levels.)

Normal Range levels for Early Season Petioles are given in the table above. Mid season nitrate-N levels will drop to 6,000-10,000 ug/g, P to 0.20-0.40% and K to 8.0-12.0%. Late season levels are normally 3,000-6,000 ug/g for nitrate-N, 0.15-0.25% for P and 5.0-9.0% for K. Magnesium levels tend to be constant throughout the season.

Optimum leaf levels have been obtained from overseas publications, but modifications based on NZ findings have been made. Normal leaf magnesium levels are now lower than those quoted in the overseas references (typically 0.5 - 1.0%). Crops in N.Z. showing no visible stress symptoms have been found to have magnesium levels as low as 0.20%.

Potassium levels also tend to be higher in N.Z. crops, particularly for North Island crops and in 30 cm tall plants. The optimum ranges for potassium adopted at this laboratory have been modified to reflect this observation. (This difference may be due to petioles having especially high potassium levels; the overseas references do not state whether they apply to leaf blades only, or leaf blade plus petiole. We recommend a sampling approach that includes the petiole.)

Potatoes are regarded as having a medium nitrogen requirement and are semi-tolerant towards boron.

Soil pH should be maintained in the range 5.4 - 5.8. While potatoes will thrive at soil pH levels of 6.0, a lower pH is normally recommended to suppress development of potato scab.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron levels cannot be reliably assessed from leaf analysis, due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

- Geraldson, C.M.; Klacan, G.R. and Lorenz, O.A. 1973. Soil testing and plant analysis. L. Walsh (Ed), Soil Science Society of America, Ch 22.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.
 Reuter, D.J. and Robinson, J.B. Plant analysis. An interpretation manual.

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Sampling

The nutritional status of this flower is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

This Guide may also be used for leucospermum and leucodendron.

Blade

Sampling Time: Mid season.

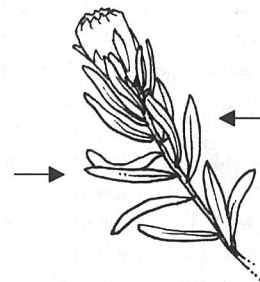
Plant Part: Youngest matured leaves.

Collect From: -

Quantity per Sample: 50.

Recommended Tests: Basic Plant (BP).

Comments: Just prior to flowering or during early flowering is considered to be the appropriate time to sample. However, regular leaf analyses should be obtained through the growing season (e.g. 6 - 8 weekly intervals) in order to monitor the effect of liquid feeding programmes being used.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: From the rooting zone of the plant.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Soluble Salts (SG).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.



Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Blade			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	0.75 - 1.50	pH	-	5.0 - 5.5
Phosphorus	(%)	0.05 - 0.14	Olsen P	(ug/ml)	5 - 20
Potassium	(%)	0.35 - 0.60	Potassium	(me/100g)	0.40 - 0.80
Sulphur	(%)	0.10 - 0.25	Calcium	(me/100g)	4.0 - 10.0
Calcium	(%)	0.50 - 1.00	Magnesium	(me/100g)	0.70 - 3.00
Magnesium	(%)	0.10 - 0.25	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.40	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	20 - 70	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	50 - 400	Sol.Salts (G/H)	(%)	0.00 - 0.20
Zinc	(ug/g)	10 - 50			
Copper	(ug/g)	3 - 8			
Boron	(ug/g)	8 - 25			

Comments:

Protea prefer light textured, free draining soils. Heavier, poorly drained soils result in rootlet death and infection from fungi such as phytophthora. Sites should also be sunny and frost free.

The soil should be acidic (pH 5.0 - 5.5). If the soil is significantly above this, then lowering of the pH is recommended.

High levels of plant available nutrients are undesirable, particularly phosphorus. Protea are known to be susceptible to phosphorus toxicity. A suggested maximum Olsen P level is 30 ug/mL, but ideally it should be less than 20 ug/mL.

Fertiliser requirements are minimal, and generally, none is applied. Soil tests are often performed to ensure the nutrient levels are low enough for this plant.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron levels cannot be reliably assessed from leaf analysis, due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Elgar, J. Proteaceae - Flower and foliage production. HortResearch HortNET, 1997.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: During fruit set.

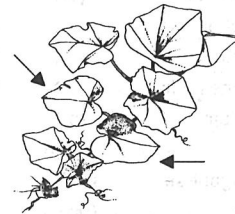
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.5 - 4.5	pH	-	5.8 - 6.7
Phosphorus	(%)	0.30 - 0.70	Olsen P	(ug/ml)	35 - 75
Potassium	(%)	2.5 - 4.0	Potassium	(me/100g)	0.70 - 1.10
Sulphur	(%)	0.30 - 1.00	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	2.50 - 5.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 1.50	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.35	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 300	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	60 - 400			
Zinc	(ug/g)	20 - 60			
Copper	(ug/g)	8 - 20			
Boron	(ug/g)	30 - 200			

Comments:

New Zealand research has shown pumpkin and squash respond to high inputs of nitrogen, phosphorus and potassium, especially early in the season.

Pumpkin and squash are members of the curcubits genus, which are susceptible to molybdenum deficiency. Leaves become small and pale coloured, and overall growth is restricted.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
 Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: When the tuber is half grown.

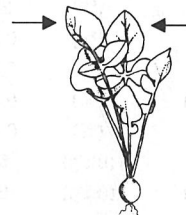
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	5.2 - 6.4	pH	-	6.0 - 7.1
Phosphorus	(%)	0.40 - 0.55	Olsen P	(ug/ml)	35 - 75
Potassium	(%)	2.0 - 5.1	Potassium	(me/100g)	0.70 - 1.40
Sulphur	(%)	0.20 - 0.50	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	2.70 - 3.70	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.20 - 0.40	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.30	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	50 - 250			
Zinc	(ug/g)	20 - 60			
Copper	(ug/g)	5 - 25			
Boron	(ug/g)	25 - 100			

Comments:

Radishes have only a low fertility requirement compared to most vegetable crops.

A nitrogen deficiency manifests itself with the older leaves going pale green, then yellow. The veins and midribs develop a red coloration.

Boron deficiencies may also occur, resulting in roots splitting or becoming very thin and misshapen.

Deficiencies of sulphur and manganese have also been observed.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Scaife, A. and Turner, M. 1983. Diagnosis of mineral disorders in plants. Volume 2, Vegetables. MAFF/ARC London.
 Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

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Sampling

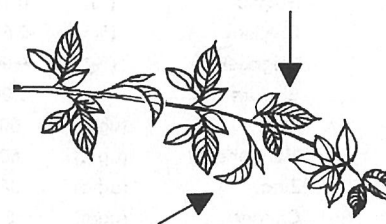
The nutritional status of raspberries is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: Two to three weeks after the final pick.

Plant Part: 5th to 12th leaves.

Collect From: Terminal 15 cm of current season's non-fruiting canes.



Quantity per Sample: 5 representative leaves from each of 10 vines.

Recommended Tests: Basic Plant (BP).

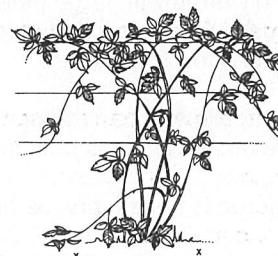
Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.

Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

Core Depth: 15 cm.

Collect From: From the rooting zone of the vines.



Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Soil samples are usually collected for analysis prior to planting the crop.

If trickle irrigation is used, the wetted zones of the soil should be sampled separately, as minerals in the water may produce abnormal test levels.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected vines. In these circumstances, a second sample taken for comparative purposes from the rooting zones of normal vines may be useful.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.4 - 4.0	pH	-	5.8 - 6.5
Phosphorus	(%)	0.30 - 0.60	Olsen P	(ug/ml)	40 - 60
Potassium	(%)	1.5 - 3.0	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.16 - 0.24	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.60 - 2.50	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	4.00 - 1.00	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.10	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	80 - 300			
Zinc	(ug/g)	34 - 80			
Copper	(ug/g)	2 - 50			
Boron	(ug/g)	25 - 80			

Comments:

Symptoms of boron deficiency include dieback and delayed bud break, or even complete bud break failure. Young leaves may become distorted with large petioles and necrotic border tissue. Leaves forming later are not affected. Less severely affected buds give rise to small, deeply indented leaflets which persist throughout the growing season. Primocanes tend not to show symptoms.

Boron in berryfruit is mobile and can translocate in young, fruiting crops. Symptoms and detection of boron toxicity may be more difficult to evaluate if this is occurring.

Caution in applying boron is necessary, as berryfruit are thought to be susceptible towards boron toxicity.

Optimum soil pH range for berryfruit is 5.8 - 6.5. Manganese and magnesium deficiencies may arise where soil pH values are in excess of 7.0.

Soil magnesium levels should be at least twice the potassium level.

All canefruit are vulnerable to salt stress. This is normally only a problem for low lying coastal areas, or where irrigation water has high dissolved solids.

Chloride toxicity is possible, and more so in irrigated or low summer rainfall areas.

References:

Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

Disclaimer:

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Sampling

The nutritional status of this flower is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Interpretive information on this Guide pertains to indoor roses.

Leaf - Glasshouse

Sampling Time: From when the buds are approximately pea size till the petals begin colouring.

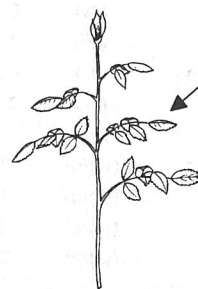
Plant Part: Five leaf leaflets, including petioles.

Collect From: Flowering shoots.

Quantity per Sample: 20 leaflets

Recommended Tests: Basic Plant (BP).

Comments: Just prior to flowering or during early flowering is considered to be the appropriate time to sample. However, regular leaf analyses should be obtained through the growing season (e.g. 6 - 8 weekly intervals) in order to monitor the effect of liquid feeding programmes being used.



Soil - Glasshouse

Sampling Time: Prior to crop establishment, and then before the spring growth.

Core Depth: 15 cm.

Collect From: From the rooting zone of the plants.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Soluble Salts (SG).

Comments: Soils should be sampled to a 15 cm depth from the rooting zone of the plants. Discard the top 1 cm, as this may contain abnormally high fertiliser levels arising from surface evaporation of water.

If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Glasshouse

Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 5.0
Phosphorus	(%)	0.25 - 0.50
Potassium	(%)	1.5 - 3.0
Sulphur	(%)	0.25 - 0.70
Calcium	(%)	1.00 - 2.00
Magnesium	(%)	0.25 - 0.50
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	60 - 200
Manganese	(ug/g)	30 - 200
Zinc	(ug/g)	17 - 100
Copper	(ug/g)	7 - 25
Boron	(ug/g)	30 - 60

Soil - Glasshouse

Element	Unit	Normal Range
pH	-	5.5 - 6.5
Olsen P	(ug/ml)	80 - 120
Potassium	(me/100g)	1.20 - 2.50
Calcium	(me/100g)	8.0 - 15.0
Magnesium	(me/100g)	2.00 - 4.00
Sodium	(me/100g)	0.20 - 0.60
CEC	(me/100g)	15.0 - 30.0
Volume Weight	(g/ml)	0.60 - 1.00
Sol.Salts (G/H)	(%)	0.00 - 0.15

Comments:

Roses are known to be very sensitive to salt stress. Soluble salts levels should be below 0.15%.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Cresswell, G.C. and Weir, R.G. 1997. Plant nutrient disorders 5. Ornamental plants and shrubs. Inkata Press.
 Bunt, A.C. 1976. Modern potting compost. George Allen and Unwin, p 129.

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Sampling

Ryegrass is often the principal component in high producing pastures, and as such, arguably New Zealand's most important crop.

From an analytical testing perspective, ryegrass is of lesser importance than the associated clover component in the pasture. This is because ryegrass is a more efficient harvester of nutrients than clover, often taking up luxury levels while adjacent clover plants may have marginal levels of the same elements. Nutritional problems therefore appear first in the clover plants, making them the preferred plant to be analysed to identify nutrient disorders.

Leaf

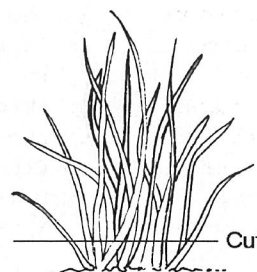
Sampling Time: At a vegetative growth stage, usually late spring or autumn flush.

Plant Part: Leaf blades.

Collect From: Cut at grazing height.

Quantity per Sample: 500g.

Recommended Tests: Basic Plant (BP).



Comments: It is not common to collect ryegrass only samples. Either a mixed herbage sample (to evaluate feed value for grazing animals), or a clover only sample (to identify nutrients limiting dry matter production) are more common. Possibly if symptoms appeared in ryegrass and a nutritional problem was suspected, then a mixed herbage analysis should be undertaken.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf

Element	Unit	Normal Range
Nitrogen	(%)	4.5 - 5.0
Phosphorus	(%)	0.35 - 0.40
Potassium	(%)	2.0 - 2.5
Sulphur	(%)	0.27 - 0.32
Calcium	(%)	0.25 - 0.30
Magnesium	(%)	0.16 - 0.20
Sodium	(%)	0.15 - 0.25
Iron	(ug/g)	50 - 60
Manganese	(ug/g)	25 - 30
Zinc	(ug/g)	14 - 20
Copper	(ug/g)	6 - 7
Boron	(ug/g)	7 - 15
Molybdenum	(ug/g)	0.30 - 0.40

Comments:

Nitrogen is the nutrient most likely to be deficient in ryegrass under normal pasture production conditions. Other deficiencies may occur, but generally they will appear in the clover plants first, and therefore analysis of clover tissue is recommended to diagnose these deficiencies.

References:

Cornforth, I.S. and Sinclair, A.G. 1984. Fertiliser recommendations for pastures and crops in New Zealand. MAF Publication, Wellington.

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Sampling

The nutritional status of this flower is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Two sampling periods for leaf analysis are proposed, depending on the growth stage of the crop.

Leaf - Early Season

Sampling Time: When the plants are between the 3-leaf stage and bud formation.

Plant Part: Youngest mature leaf.

Collect From: -

Quantity per Sample: 50 leaves.

Recommended Tests: Basic Plant (BP).

Comments: Sampling early in the growing season will mean it is possible to correct deficiencies diagnosed in the current crop.



Leaf - Mid Season

Sampling Time: After bud formation.

Plant Part: Youngest mature leaf.

Collect From: Third or fourth leaf from the top.

Quantity per Sample: 50 leaves.

Recommended Tests: Basic Plant (BP).

Comments: This is the latter of the two recommended sampling times. While it will be too late to rectify any problems in the current seasons crop, it can provide valuable data to formulate the next seasons fertiliser programme.



Soil

Sampling Time: Prior to crop establishment, and then before the spring growth.

Core Depth: 15 cm.

Collect From: From the rooting zone of the plants.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Soluble Salts (SG).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Early Season

Element	Unit	Normal Range
Nitrogen	(%)	5.0 - 6.5
Phosphorus	(%)	0.39 - 0.57
Potassium	(%)	2.0 - 3.2
Sulphur	(%)	0.25 - 0.36
Calcium	(%)	0.70 - 1.20
Magnesium	(%)	0.26 - 0.50
Sodium	(%)	0.00 - 0.28
Iron	(ug/g)	90 - 200
Manganese	(ug/g)	50 - 220
Zinc	(ug/g)	35 - 60
Copper	(ug/g)	2 - 15
Boron	(ug/g)	20 - 50

Leaf - Mid Season

Element	Unit	Normal Range
Nitrogen	(%)	4.0 - 6.0
Phosphorus	(%)	0.20 - 0.60
Potassium	(%)	1.8 - 3.5
Sulphur	(%)	0.20 - 0.50
Calcium	(%)	0.80 - 2.00
Magnesium	(%)	0.25 - 0.60
Sodium	(%)	0.00 - 0.50
Iron	(ug/g)	100 - 200
Manganese	(ug/g)	50 - 200
Zinc	(ug/g)	30 - 70
Copper	(ug/g)	4 - 15
Boron	(ug/g)	20 - 50

Soil

Element	Unit	Normal Range
pH	-	5.8 - 6.5
Olsen P	(ug/ml)	25 - 50
Potassium	(me/100g)	0.50 - 1.00
Calcium	(me/100g)	6.0 - 12.0
Magnesium	(me/100g)	1.00 - 3.00
Sodium	(me/100g)	0.00 - 0.50
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00
Sol.Salts (G/H)	(%)	0.00 - 0.20

Comments:

Sandersonia are thought to grow best in open, well drained soils.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Kerry Ryan & Ass. Ltd. Sandersonia Research Link No1/93.
Hill Laboratories data.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: When half grown and the base of the plant is 4 - 6 cm in diameter.

Plant Part: Youngest mature leaf.

Collect From: -

Quantity per Sample: 20 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.5 - 5.0	pH	-	5.6 - 6.8
Phosphorus	(%)	0.25 - 0.40	Olsen P	(ug/ml)	35 - 90
Potassium	(%)	2.5 - 5.0	Potassium	(me/100g)	0.70 - 1.40
Sulphur	(%)	0.30 - 0.80	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.70 - 2.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 0.80	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.50 - 6.00	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 200	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	50 - 200			
Zinc	(ug/g)	20 - 80			
Copper	(ug/g)	5 - 20			
Boron	(ug/g)	25 - 80			

Comments:

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

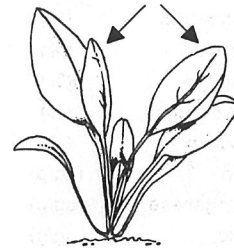
The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: 4 - 6 weeks old.

Plant Part: Youngest mature leaf (blade & petiole).

Collect From: -



Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.

Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	4.2 - 5.2	pH	-	5.6 - 6.8
Phosphorus	(%)	0.48 - 0.58	Olsen P	(ug/ml)	35 - 90
Potassium	(%)	3.5 - 5.3	Potassium	(me/100g)	0.70 - 1.40
Sulphur	(%)	0.30 - 0.80	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.60 - 1.20	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	1.60 - 1.80	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.10 - 1.00	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	220 - 245	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	50 - 85			
Zinc	(ug/g)	50 - 75			
Copper	(ug/g)	45 - 65			
Boron	(ug/g)	42 - 63			

Comments:

Spinach requires moderate levels of fertility to obtain good levels of production.

Spinach is susceptible to deficiencies of nitrogen, phosphorus, potassium, boron and molybdenum. They have a lesser susceptibility to deficiencies of sulphur, manganese, zinc and copper.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.

Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.

Scaife, A. and Turner, M. 1983. Diagnosis of mineral disorders in plants. Volume 2, Vegetables. MAFF/ARC London.

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Sampling

Two approaches are used for tissue testing of a strawberry crop: (i) analysing the petiole through the season, in particular to monitor the nitrogen status, and (ii) leaf blade analysis at fruiting, to evaluate the status of all plant essential nutrients.

Varieties differ in their ability to utilise nitrogen, primarily because of differences in growth habits, fruit production and foraging power of the roots for soil nitrogen. Consequently, different varieties should be sampled separately.

Blade

Sampling Time: During fruiting, preferably at first harvest.

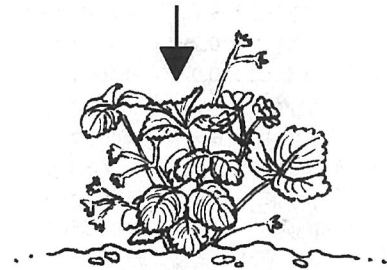
Plant Part: Leaf blades (excluding petioles).

Collect From: Youngest mature leaves.

Quantity per Sample: 30-50.

Recommended Tests: Basic Plant (BP), Molybdenum (MO), Chloride (CL).

Comments: Deficiencies are more likely to arise during fruiting, when substantial nutrient uptake is occurring. Hence the recommendation to analyse leaf blades at this time.



Petiole

Sampling Time: Through the growing season.

Plant Part: Petioles.

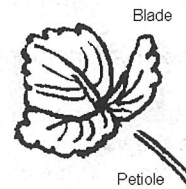
Collect From: Youngest matured leaves.

Quantity per Sample: 50.

Recommended Tests: Nitrate-N (PN).

Comments: Petiole analysis is recommended for monitoring the status of nitrogen, which is a key nutrient in strawberry production.

It can also be useful to analyse the petioles for P, K, Mg and Cl.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: From the rooting zone of the plants.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, vine performance, soil types, topography and fertiliser history.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected plants. In these circumstances, a second sample taken for comparative purposes from the rooting zones of normal plants may be useful.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation criteria given here are based on the best information available and relate specifically to the sampling instructions given.

Blade			Petiole			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	2.6 - 3.5	Nitrate-N	(ug/g)	2000 - 7000	pH	-	5.3 - 6.5
Phosphorus	(%)	0.25 - 0.35	Phosphorus	(%)	0.10 - 0.40	Olsen P	(ug/ml)	30 - 40
Potassium	(%)	1.0 - 2.0	Potassium	(%)	1.0 - 3.0	Potassium	(me/100g)	0.50 - 0.80
Sulphur	(%)	0.15 - 0.35	Magnesium	(%)	0.25 - 0.50	Calcium	(me/100g)	5.0 - 10.0
Calcium	(%)	0.70 - 1.50	Chloride	(%)	0.10 - 0.40	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.25 - 0.40				Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.02 - 0.10				CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	100 - 200				Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	200 - 500						
Zinc	(ug/g)	30 - 80						
Copper	(ug/g)	5 - 12						
Boron	(ug/g)	30 - 100						

Comments:

The most likely deficiencies to occur are nitrogen, phosphorus, potassium and magnesium.

Nitrogen deficiency symptoms starts with small chlorotic older leaf blades and develops into shortened, red and brittle petioles.

Phosphorus deficiency shows as the upper surface of the leaf blades become dark green with a black metallic sheen.

The serrated tips around the upper leaf margins of older leaf blades redden with potassium deficiency. This symptom spreads inwards between the veins.

Symptoms of magnesium deficiency are interveinal chlorosis followed by necrosis.

Petiole nitrate-N levels below 500 ug/g are considered to be too low. Rates of growth and production will decrease and leaves are likely to be a light yellowish green colour.

Petiole nitrate-N levels of over 2000 ug/g are considered adequate. Up to 10,000 ug/g can be tolerated, but above 10,000 ug/g leaf growth becomes excessive, and fruit yields are reduced.

Petiole nitrate-N levels of 5,000-10,000 ug/g will occur during rapid, vegetative growth, flowering and fruit set, followed thereafter by lower levels.

Strawberries are regarded as gross feeders, requiring relatively large amounts of fertiliser.

The optimum soil pH for fine textured clay soils is towards the lower end of the optimum range. For sandy soils it is towards the upper end of the range.

The crop is known to be sensitive to chloride. Potassium sulphate fertiliser should therefore be used in preference to potassium chloride.

References:

- Ulrich, A.; Mostafa, M.A.E. and Allen, W.W. 1980. Strawberry deficiency symptoms: A visual and plant analysis guide to fertilisation. University of California, USA.
- Blackmore, L.C.; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: When the tuber is half grown.

Plant Part: Youngest mature leaf (blade & petiole).

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.5 - 4.5	pH	-	5.9 - 6.8
Phosphorus	(%)	0.25 - 0.40	Olsen P	(ug/ml)	50 - 100
Potassium	(%)	3.0 - 4.0	Potassium	(me/100g)	0.70 - 1.40
Sulphur	(%)	0.25 - 0.60	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	0.70 - 1.10	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.25 - 0.70	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.20	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	70 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	30 - 250			
Zinc	(ug/g)	20 - 100			
Copper	(ug/g)	5 - 20			
Boron	(ug/g)	25 - 80			

Comments:

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

The nutritional status of tamarillo is monitored using soil tests and plant analysis. Annual monitoring is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

New Zealand research with tamarillos has identified visual symptoms associated with various nutrient disorders. This work, along with analyses from commercial orchard provide the basis for this Crop Guide.

Leaf

Sampling Time: January to February.

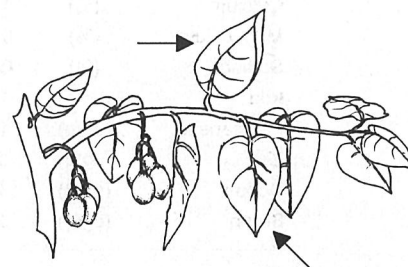
Plant Part: Youngest mature leaf (blade & petiole).

Collect From: Well developed, actively growing laterals.

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected trees for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment and annually at any time of the year, although autumn to early winter is recommended.

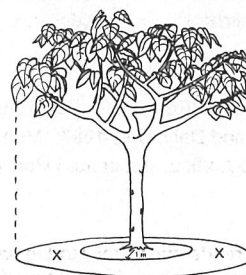
Core Depth: 15 cm.

Collect From: From the root zone of the tree.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Separate samples should be taken from blocks that differ in age, cultivar types, tree performance, soil types, topography and fertiliser history.



Where fertiliser has been broadcast, sample from the root zone of the trees. Where fertiliser has been banded, samples should only be taken from areas under the trees which have previously received fertiliser.

If the orchard has herbicide treated strips, then it is best if these are sampled separately from the grassed areas between rows. Quite different nutrient levels may exist between these two areas.

When sampling prior to orchard establishment, a 15 - 40 cm depth sample should also be taken, primarily to check the sub-soil pH.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.5 - 4.3	pH	-	5.8 - 6.5
Phosphorus	(%)	0.20 - 0.30	Olsen P	(ug/ml)	25 - 50
Potassium	(%)	4.0 - 5.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.25 - 0.35	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.20 - 2.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.32 - 0.42	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.02 - 0.06	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	100 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	100 - 150			
Zinc	(ug/g)	25 - 32			
Copper	(ug/g)	20 - 25			
Boron	(ug/g)	20 - 30			

Comments:

Tamarillos require a mild climate, and consequently, tamarillo production is limited to Northland, Auckland and the Bay of Plenty.

There is little published data on optimum soil test levels. The Normal Range levels shown above are those typically found in high producing orchards.

References:

Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR. Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.

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Sampling

Leaf analysis is the most effective means to monitor the status of a glasshouse tomato crop. Some potential problems such as unfavourable pH and excessive salts cannot be diagnosed by leaf analysis, and require a soil or media test.

Leaf and soil testing is described in this Crop Guide. However, glasshouse tomatoes are now grown in a variety of media such as bark, peat, as well as hydroponically in pumice and nutrient solutions.

Leaf - Glasshouse

Sampling Time: When first fruits mature.

Plant Part: Youngest mature compound leaf (blade plus petiole).

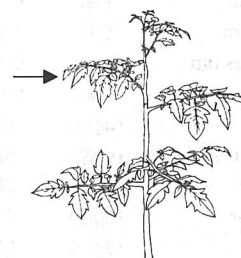
Collect From: 20 cm from the top of the plant.

Quantity per Sample: 20 leaves.

Recommended Tests: Basic Plant (BP).

Comments: The recently matured leaves are considered to be the most appropriate leaf to analyse. Being fully mature, the nutrient levels will have stabilised, allowing a reliable assessment to be made. Having only just matured means they will reflect the recent nutrient supply to the plant.

To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil - Glasshouse

Sampling Time: Prior to crop establishment and then regularly during the growing season.

Core Depth: 15 cm.

Collect From: From the rooting zone of the plants.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Soluble Salts (SG).

Comments: Routine monitoring is recommended to ensure nutrient levels in the soil are maintained at adequate levels, but not so high as to cause salt stress problems. Taking samples for analysis every 4 - 6 will allow certain problems to be identified before they adversely affect production of such a high value crop.

For NFT systems, a 500 mL sample collected from the main reservoir tank is appropriate.

For growing media systems, collect a 1 L sample from the root zone of a representative number of plants. This will be analysed as a Potting Media sample.

For plants grown in pumice (or sawdust) bags, collect a 1 L sample in the same way as for other growing media systems. The pumice is essentially an inert support media and the crop can be regarded as being hydroponically grown. In this instance, the water extraction of the pumice provides a solution for NFT analysis.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Glasshouse

Element	Unit	Normal Range
Nitrogen	(%)	4.5 - 5.5
Phosphorus	(%)	0.40 - 0.70
Potassium	(%)	4.0 - 6.0
Sulphur	(%)	0.60 - 2.00
Calcium	(%)	1.20 - 2.00
Magnesium	(%)	0.40 - 0.70
Sodium	(%)	0.08 - 0.15
Iron	(ug/g)	80 - 200
Manganese	(ug/g)	50 - 250
Zinc	(ug/g)	30 - 60
Copper	(ug/g)	15 - 50
Boron	(ug/g)	30 - 60

Soil - Glasshouse

Element	Unit	Normal Range
pH	-	6.0 - 6.5
Olsen P	(ug/ml)	70 - 150
Potassium	(me/100g)	1.50 - 3.00
Calcium	(me/100g)	10.0 - 20.0
Magnesium	(me/100g)	2.00 - 4.00
Sodium	(me/100g)	0.20 - 0.60
CEC	(me/100g)	15.0 - 30.0
Volume Weight	(g/ml)	0.60 - 1.00
Sol.Salts (G/H)	(%)	0.00 - 0.20

Comments:

Tomatoes are regarded as gross feeders and will respond to generous fertiliser programmes. However, excessive fertiliser can create problems, such as salt stress and blossom end rot.

Potassium levels are critical for growth control and for the prevention of ripening disorders. Care must be taken, however, that high potash applications do not induce magnesium deficiencies. Soil test levels of magnesium should be at least as high as those of potassium.

Excessive soluble salts can be a problem, especially where regular applications of soluble fertilisers are being applied during the growing season. There are schools of thought, however, that keeping soluble salts high can be beneficial to fruit quality. It is recommended that such management practices be planned with a consultant experienced in glasshouse tomato production.

Deficiencies observed in New Zealand tomato crops include nitrogen, potassium, calcium, magnesium, iron, manganese and boron.

References:

Brice, I. 1978. Glasshouse tomato grower short course. Dept of Horticulture and Plant Health Proceedings No. 6.
 Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
 Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

Leaf

Sampling Time: When the root is half grown.

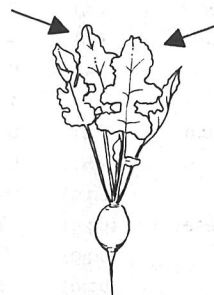
Plant Part: Youngest mature leaf.

Collect From: -

Quantity per Sample: 20 - 30 leaves.

Recommended Tests: Basic Plant (BP), Molybdenum (MO).

Comments: To help diagnose an obvious problem, leaves showing the first signs of the distinctive symptoms should be collected as soon as abnormalities appear. If sampling outside the normal sampling time it is useful to take a second sample of similar, healthy leaves from nearby unaffected plants for analysis as a comparative standard.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf			Soil		
Element	Unit	Normal Range	Element	Unit	Normal Range
Nitrogen	(%)	3.5 - 5.0	pH	-	5.4 - 6.7
Phosphorus	(%)	0.30 - 0.70	Olsen P	(ug/ml)	30 - 80
Potassium	(%)	2.5 - 5.0	Potassium	(me/100g)	0.50 - 1.00
Sulphur	(%)	0.35 - 0.80	Calcium	(me/100g)	6.0 - 12.0
Calcium	(%)	1.80 - 4.00	Magnesium	(me/100g)	1.00 - 3.00
Magnesium	(%)	0.30 - 0.60	Sodium	(me/100g)	0.00 - 0.50
Sodium	(%)	0.00 - 0.35	CEC	(me/100g)	12.0 - 25.0
Iron	(ug/g)	50 - 150	Volume Weight	(g/ml)	0.60 - 1.00
Manganese	(ug/g)	30 - 300			
Zinc	(ug/g)	20 - 100			
Copper	(ug/g)	5 - 25			
Boron	(ug/g)	30 - 150			

Comments:

Turnips have a lower fertility requirement than other brassica crops.

They are susceptible to boron deficiency, which manifests itself as multiple crowns and brown hearts.

Nitrogen deficiency will appear as a purple pink coloration in the foliage. This symptom can also be induced by other factors such as cold weather, root damage from nematodes, drought stress and water logging.

Turnips are also prone to deficiencies of phosphorus, sulphur, potassium, copper and molybdenum.

Results for copper, zinc and manganese in leaves sprayed with fungicides will not be reliable due to adhering spray residues on the leaves.

Iron deficiency symptoms may exist even when leaf levels appear satisfactory. This may be due to the presence of physiologically inactive forms of iron within the tissue. Also, soil contamination of leaves growing near the ground may elevate total iron results.

References:

- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Scaife, A. and Turner, M. 1983. Diagnosis of mineral disorders in plants. Volume 2, Vegetables. MAFF/ARC London.
- Fertiliser recommendation for horticultural crops. HortResearch HortNET, 1997.
- Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 3. Vegetable crops. Inkata Press.

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Sampling

The nutritional status of this vegetable crop is monitored using soil tests and plant analysis. Monitoring regularly is important to help sustain optimum levels and avoid nutritional disorders. If disorders do occur, rapid diagnosis is necessary to assist correction.

This Guide is very general and covers the different growing media commonly used for vegetable production.

Soil

Sampling Time: Either prior to crop establishment or during the growing season.

Core Depth: 15 cm.

Collect From: Randomly throughout the area to be planted.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS), Soluble Salts (SG).

Comments: If a problem is suspected during the growing season, then a sample should be taken from the rooting zone immediately adjacent to the plant. Collecting a second sample from an unaffected area may help identify the cause of the problem.

Media

Sampling Time: During the growing season.

Sampling Depth: 2 - 20 cm.

Collect From: The root zone of the plants.

Quantity per Sample: 0.5 - 1 litre.

Recommended Tests: Basic Media (BM).

Comments: Samples are usually taken during the growing season. Remove the top 2 cm of media from the surface, as this often contains a build up of soluble salts as a consequence of surface evaporation of the media solution.

Pumice, which can be regarded as a totally inert media, can be handled in an alternative manner. The sample can be extracted as for the standard media test, but the resulting extract is then analysed as a nutrient solution.

NFT

Sampling Time: During the growing season.

Collect From: The feed or run off solution.

Quantity per Sample: 0.5 - 1 litre.

Recommended Tests: Basic Nutrient (BN).

Comments:

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Soil

Element	Unit	Normal Range
pH	-	5.9 - 6.8
Olsen P	(ug/ml)	50 - 100
Potassium	(me/100g)	0.70 - 1.40
Calcium	(me/100g)	6.0 - 12.0
Magnesium	(me/100g)	1.00 - 3.00
Sodium	(me/100g)	0.00 - 0.50
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00
Sol.Salts (G/H)	(%)	0.00 - 0.20

Media

Element	Unit	Normal Range
pH	-	5.2 - 6.5
Conductivity	(mS/cm)	1.0 - 2.5
Nitrate-N	(mg/l)	40 - 120
Ammonium-N	(mg/l)	1 - 30
Phosphorus	(mg/l)	10 - 30
Potassium	(mg/l)	40 - 120
Calcium	(mg/l)	30 - 100
Magnesium	(mg/l)	12 - 35
Sodium	(mg/l)	5 - 0

NFT

Element	Unit	Normal Range
pH	-	5.8 - 6.6
Conductivity	(CF)	15 - 45
Nitrate-N	(mg/l)	100 - 300
Phosphorus	(mg/l)	25 - 75
Potassium	(mg/l)	150 - 450
Sulphur	(mg/l)	40 - 120
Calcium	(mg/l)	100 - 350
Magnesium	(mg/l)	25 - 75
Sodium	(mg/l)	10 - 60
Chloride	(mg/l)	5 - 80
Iron	(mg/l)	2.00 - 10.00
Manganese	(mg/l)	0.40 - 5.00
Zinc	(mg/l)	0.10 - 3.00
Copper	(mg/l)	0.10 - 1.00
Boron	(mg/l)	0.20 - 1.50

Comments:

The levels shown are very general. The optimum level of soluble salts and conductivity will differ depending on the crop under consideration. For crops that tolerate higher levels of salts (e.g. tomatoes), the conductivity can be maintained at higher levels. For salt sensitive crops (e.g. cucumber, capsicum), the conductivity should be maintained at the lower end of the range.

References:

Prasad, M. Pers. Comm.

Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.

Cooper, A. 1979. The ABC of NFT. Grower Books, London.

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Sampling

Plant growth stage has a major influence on the nutrient levels in the tissue. Two distinct growth stages are specified for sample collection; neither preferred over the other, though each is useful for a specific purpose.

Leaf - Late Tiller

Sampling Time: When the leaves have formed, and the leaf-sheaths are lengthening and becoming erect. Just prior to stem extension.

Plant Part: Whole above portion of the plant.

Collect From: Random sites throughout the sampling area.

Quantity per Sample: 30 to 40 plants.

Recommended Tests: Basic Plant (BP).

Comments: The advantage of sampling at this early stage is that there may be time to correct nutrient disorders observed in the current crop.



Leaf - Ear Emergence

Sampling Time: When stem extension is complete and the head of the ear emerges from the boot.

Plant Part: Whole above portion of the plant.

Collect From: Random sites throughout the sampling area.

Quantity per Sample: 20 to 30 plants.

Recommended Tests: Basic Plant (BP).

Comments: Testing at this later stage will indicate more accurately that the crop has accumulated the required nutrients successfully.



Soil

Sampling Time: Prior to crop establishment.

Core Depth: 15 cm.

Collect From: Random sites throughout the sampling area.

Quantity per Sample: 12 - 20 cores.

Recommended Tests: Basic Soil (BS).

Comments: Soil samples are usually collected for analysis prior to planting the crop.

If trying to diagnose a problem with crop growth and yield, samples should be collected from the rooting zones of the worst affected areas. In these circumstances, a second sample taken for comparative purposes from the rooting zones of normal areas may be useful.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf - Late Tiller

Element	Unit	Normal Range
Nitrogen	(%)	3.0 - 5.0
Phosphorus	(%)	0.30 - 0.60
Potassium	(%)	3.5 - 5.5
Sulphur	(%)	0.30 - 0.45
Calcium	(%)	0.40 - 1.00
Magnesium	(%)	0.12 - 0.25
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	50 - 150
Manganese	(ug/g)	35 - 100
Zinc	(ug/g)	25 - 70
Copper	(ug/g)	7 - 15
Boron	(ug/g)	6 - 12

Leaf - Ear Emergence

Element	Unit	Normal Range
Nitrogen	(%)	2.0 - 3.0
Phosphorus	(%)	0.20 - 0.50
Potassium	(%)	1.5 - 3.0
Sulphur	(%)	0.15 - 0.40
Calcium	(%)	0.20 - 0.50
Magnesium	(%)	0.15 - 0.50
Sodium	(%)	0.00 - 0.10
Iron	(ug/g)	25 - 100
Manganese	(ug/g)	25 - 100
Zinc	(ug/g)	15 - 70
Copper	(ug/g)	5 - 25
Boron	(ug/g)	6 - 10

Soil

Element	Unit	Normal Range
pH	-	5.3 - 6.1
Olsen P	(ug/ml)	20 - 30
Potassium	(me/100g)	0.50 - 0.80
Calcium	(me/100g)	5.0 - 12.0
Magnesium	(me/100g)	0.80 - 3.00
Sodium	(me/100g)	0.00 - 0.50
CEC	(me/100g)	12.0 - 25.0
Volume Weight	(g/ml)	0.60 - 1.00

Comments:

Small grain production and quality are greatly influenced by fertilisation.

Nitrogen has been found to be the most important fertiliser element in New Zealand cereal crops. Significant responses to potassium, sulphur or magnesium have also been recorded.

Different cultivars have been found to have some differences in nutrient concentrations; however, these differences are relatively small, and one set of interpretation criteria can be used.

Improper growth stage identification can result in errors in interpretation. Nutrient uptake precedes dry matter accumulation occurring between tillering and head emergence. Consequently, nutrient concentrations generally decline between these stages.

Diagnosis of sulphur deficiency can be assisted by using the N:S ratio. A sulphur deficiency may exist when the N:S ratio is greater than 16:1. Severe deficiency is likely when the ratio is greater than 20:1.

References:

- Blackmore, L.C; Searle, P.L and Daly, B.K. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. NZ Soil Bureau, DSIR.
- Reuter, D. J. and Robinson, J. B. (Eds) 1997. Plant analysis. An interpretation manual. Second edition.
- Lockman, R.B. 1969. Agronomy Abstracts, American Society of Agronomy, Wisconsin, pg 97.
- Ward, R.C.; Whitney, D.A. and Westfall, D.G. 1973. Plant analysis as an aid in fertilising small grains. Soil testing and plant analysis.
- Jones Jr, J.B 1967. Soil testing and plant analysis. Part 2. SSSA Special Publication Series, p 49-58.

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Sampling

White clover is vitally important to New Zealand pastures. It is the principal source of nitrogen for all pasture species, as well as being a major pasture constituent with a high feed value.

For further information on pasture testing, including soil testing and interpretation, refer to the Crop Guides for "Ryegrass" and "Mixed Pasture". An overview is also provided in the Technical Note "Sampling Options for Pastoral Farms."

Leaf

Sampling Time: At a vegetative growth stage. Usually late spring/early summer, or in the autumn.

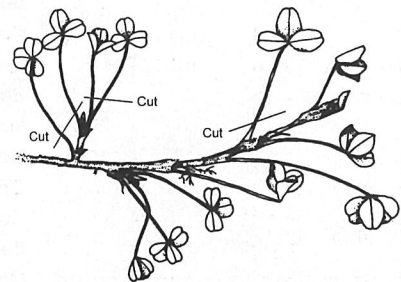
Plant Part: Leaves plus petiole.

Collect From: Areas showing poor or stunted growth.

Quantity per Sample: 50 leaves.

Recommended Tests: Basic Plant (BP), Molybdenum (MO).

Comments: Clover tissue testing is perhaps the most powerful tool available to diagnose nutrient deficiencies in pasture.



Being a legume, white clover can support nitrogen fixing bacteria in nodules on its roots. This is the principal source of nitrogen for pasture, and it is important that the clover has an adequate supply of all essential nutrients to support this function.

Clover is not as efficient at harvesting soil nutrients as grasses, and is therefore more likely to develop nutrient deficiencies (with the exception of nitrogen). Once clover is affected, nitrogen fixation is impaired and overall pasture production is reduced.

Concentrating specifically on the nutrient requirements of the clover plant thereby ensures that nitrogen fixation can occur, and that optimum pasture production is maintained.

Clover only samples are normally taken when an area is suspected not to be growing to its full potential, and a visual assessment shows poor clover vigour.

White clover should be sampled as a single species, and the sample collected specifically from the area that is performing badly. Remember that the purpose is to diagnose why the plants are performing poorly. It is pointless to sample vigorous plants from alongside dung or urine patches. Plants affected should show clearly the nutrient deficiencies from the chemical analysis.

Avoid sampling when clover is under drought stress or flowering.

Interpretation

Interpretation of the laboratory's results is possible by comparison with normal levels expected for the crop in question. The interpretation given here are based on the best information available and relate specifically to the sampling instructions given.

Leaf

<i>Element</i>	<i>Unit</i>	<i>Normal Range</i>
Nitrogen	(%)	4.8 - 5.5
Phosphorus	(%)	0.35 - 0.40
Potassium	(%)	2.0 - 2.4
Sulphur	(%)	0.27 - 0.32
Calcium	(%)	0.80 - 2.50
Magnesium	(%)	0.18 - 0.25
Sodium	(%)	0.07 - 0.40
Iron	(ug/g)	50 - 65
Manganese	(ug/g)	25 - 30
Zinc	(ug/g)	16 - 19
Copper	(ug/g)	6 - 7
Boron	(ug/g)	25 - 30
Molybdenum	(ug/g)	0.30 - 1.50
N/P Ratio	-	12 - 14
N/S Ratio	-	16 - 18

Comments:

Probable deficiencies in clover (in order of likely occurrence) are: phosphorus, sulphur, potassium, molybdenum and boron. Phosphorus deficiencies are not always readily diagnosed from a tissue analysis, as it may manifest itself as poor growth in the plant with only a small drop in the tissue phosphorus concentration.

Phosphorus is an important nutrient for the development of a vigorous root system, and a phosphorus deficiency may affect the plant's uptake of other nutrients. Consequently, a phosphorus deficient plant may show a number of other apparent deficiencies, but in correcting the principal phosphorus deficiency, the other nutrient problems may disappear.

As many nutrient levels are interdependent, nutrient ratios are very useful in diagnosing problems. The N/P and N/S ratios will indicate whether the phosphorus and sulphur levels are adequate for the nitrogen status of the plant.

An interaction also exists between potassium and sodium. High potassium levels suppress sodium uptake, whereas low potassium levels will enhance sodium uptake. Clover samples with high sodium levels (greater than 0.50%) therefore are probably deficient in potassium. Interpreting sodium in this way can assist in assessing the potassium status, as sodium is not an essential element for plant growth.

Molybdenum and nitrogen levels together provide the best indication of molybdenum deficiency. If the molybdenum and nitrogen levels are both low, this would indicate the low molybdenum status is adversely affecting nitrogen fixation. A low molybdenum but adequate nitrogen level would suggest there is sufficient molybdenum available.

As for all plant analyses, a very low level of a particular nutrient may not necessarily mean that this nutrient is deficient in the soil. Other non-nutritional factors may be the cause of the plant ill-thrift, e.g. low soil temperature. Soil tests should therefore be performed in conjunction with the plant analyses to help elucidate the cause of the problem.

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- McNaught, K.J. 1970. Proceedings of the XI international grassland conference. p334.
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Weir, R.G. and Cresswell, G.C. 1995. Plant nutrient disorders 4. Pastures and field crops. Inkata Press.
Cornforth, I.S. and Sinclair, A.G. 1984. Fertiliser recommendations for pastures and crops in New Zealand. MAF Publication, Wellington.

Disclaimer:

Normal Range levels quotes relate specifically to the sampling procedure given. The Normal Range levels and Comments provided are the most up to date levels available but may be altered without notification. Such alterations are implemented immediately in the laboratory histogram reports. It is recommended that a consultant or crop specialist be involved with interpretations and recommendations.

Technical Notes

Listed below are the Technical Notes currently (July, 1998) available from Hill Laboratories.

- TN003 **Sampling Options for Pastoral Farms**
- TN004 **Cation Exchange Capacity and Base Saturation**
- TN012 **The Resin P Soil Test**
- TN001 **New Calibration Data for Soil Trace Element Tests in New Zealand**
- TN013 **Animal Dietary Mineral Balance Report**
- TN002 **Mineral Ratios and Grass Staggers**
- TN007 **Potting Media Analysis**
- TN014 **Compost Analysis**
- TN006 **Apple Leaf Analysis**
- TN011 **Apple Fruitlet Analysis**
- TN009 **Summary of Methods Used**

Contact the laboratory for other Technical Notes relating to Environmental or Industrial & Food testing.

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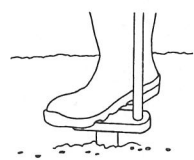
Sampling Options for Pastoral Farms

Soil and herbage analyses help pastoral farmers and their advisors choose the best fertiliser programme. They also highlight mineral imbalances that might be affecting the health of pasture or animals.



Available Nutrients in the Soil

Plants require an adequate supply of a wide range of nutrients if they are to grow vigorously. Some of the major nutrients required for healthy growth are nitrogen, phosphorus, potassium, sulphur, calcium, and magnesium. Most of these nutrients are extracted by the plants' root system, from the solution of water and chemicals that surrounds the roots. Nutrients that have dissolved into this 'soil solution' represent only a small fraction (about 1%) of the total amount of chemical nutrients in the soil. Most of the remaining nutrients are either potentially available, but not yet dissolved (about 10%); or will never be available because they are too closely bound to various minerals and chemical compounds in the soil (about 90%).



saturation).

Soil Testing

Soil analysis, or 'soil testing', measures the levels of nutrients that are potentially available to the plants. As well, other soil characteristics are measured (e.g. the soil's acidity or alkalinity (pH), bulk density, cation exchange capacity, and base

Unlike some other laboratories, we include these as part of our standard soil test because of their important role in the processes by which plant roots absorb nutrients, and their value in helping pastoral farmers and their advisors to appraise the soil's fertility.

Herbage Analysis

Herbage analysis provides a more accurate method of measuring the nutrient status of pasture plants, and important trace elements such as molybdenum, cobalt, and selenium can be reliably assessed using this technique. (Soil analysis can only provide an approximate indication of how well pasture plants are utilising the nutrients in the soil. Other factors may be affecting the pastures' ability to take advantage of these nutrients.)



Soil Testing versus Herbage Analysis

Often we are asked which of these techniques is the more appropriate to use. The answer is that they are complementary to one another. The two techniques - when used in conjunction - will provide a better overall picture of a farm's nutrient status than either used alone. For this reason we recommend that you provide yourself with the maximum information by submitting both soil and herbage samples for analysis.

Mixed Herbage Samples - Animal Health

Most herbage samples submitted to this laboratory for analysis are a mixture of all plant species present in the pasture. This 'mixed' herbage sample is essentially an animal feed sample, and as such is most valuable in assessing the nutrients that are important for animal health (e.g. sodium, cobalt, selenium, magnesium, iodine, and copper).



Clover Only Samples - Plant Health



If the principal reason for the analysis is to determine why pasture is not growing well, then collecting a sample of clover only is preferable to mixed herbage sampling.

Clover is important to the other plant species in the pasture, since it is the principal source of the key nutrient, nitrogen. Other species need healthy clover to avoid nitrogen deficiencies.

Clover is also likely to develop mineral deficiencies well before the problems appear in the other grass species, signalling potential problems for all pasture plants.

By collecting a sample specifically of poorly growing clover plants, the laboratory results will highlight deficiencies that might be affecting, or about to affect, the whole pasture.

Fertiliser Recommendations

Soil and herbage test results are only one of a number of considerations to be considered, when formulating the best fertiliser programme for a farm.



For this reason we do not make fertiliser recommendations ourselves, believing that such advice is more properly provided by competent advisors who know the farm, and the farmer's objectives.

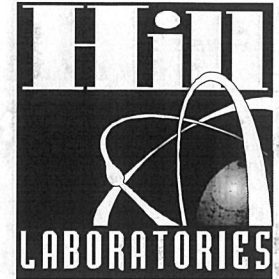
As an independent consulting laboratory, we aim to serve you best by providing the most reliable and accurate analysis of your soil and herbage samples; and presenting the test results in an easily readable manner.

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Cation Exchange Capacity and Base Saturation

This note explains how Cation Exchange Capacity (CEC) and Base Saturation can help assess soil fertility.

R J Hill Laboratories Ltd. differs from some other testing laboratories in N.Z., in that we include analysis of a soil's Cation Exchange Capacity and Base Saturation as part of our Basic Soil Analysis. We do this because we believe that it provides important additional information for assessing soil fertility.

Cations and Anions

Before explaining CEC, it is first necessary to provide a general explanation of the behaviour of nutrients in the soil. Plant nutrients usually exist as ions - that is, they carry an electrostatic charge. The positively charged nutrients are known as **cations**, and those with negative charges are known as **anions**.

The most important of these nutrients are:-

Cations (+)		Anions (-)	
Calcium	Ca ²⁺	Nitrate	NO ₃ ⁻
Magnesium	Mg ²⁺	Phosphate	H ₂ PO ₄ ⁻ , HPO ₄ ²⁻
Potassium	K ⁺	Sulphate	SO ₄ ²⁻
Sodium	Na ⁺	Chloride	Cl ⁻
Hydrogen	H ⁺	<i>(Not surprisingly, the interaction of anions with soil is markedly different to that of cations. This note is only concerned with cations, and does not discuss the behaviour of anions.)</i>	
Aluminium	Al ³⁺		

Exchangeable Cations – The Fraction Available to Plants

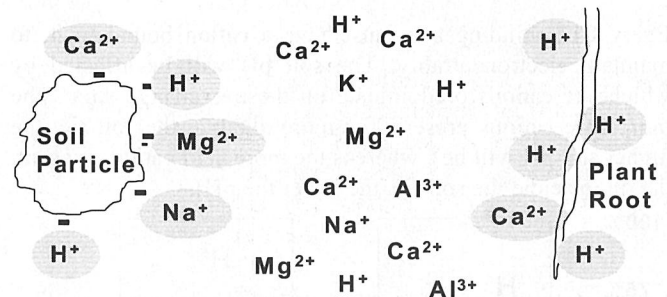
Cations can be bound to the soil to varying degrees. At one extreme, they may be an integral part of the soil, strongly bound to silica and essentially unavailable to growing plants. At the other extreme, they may be fully soluble – not interacting with the soil to any significant extent.

Between these two extremes are the **exchangeable cations**, which are weakly bound to soil particles. Soil particles carry net negative electrostatic charges as a result of the processes of soil weathering, and organic decomposition. These sites of negative charge are most predominant in the humus fraction of the soil, and on the edges of clay particles. They are 'neutralised' by the weak bonds that they form with the positively charged exchangeable cations. The bonds between

soil particles and exchangeable cations are not permanent, and are continually broken and reformed, as the cations move within the water surrounding soil particles. The bonding of these cations largely prevents their loss by leaching, but is not so strong that plants cannot extract them from the soil. In fact, plant roots absorb exchangeable cations by 'swapping' them for hydrogen cations (H⁺)

What Is Cation Exchange Capacity?

The **cation exchange capacity** of a soil is a measurement of its ability to bind or hold exchangeable cations. In other words, it is a measure of the number of negatively-charged binding sites in the soil.



Cation Exchange Capacity Helps to Characterise Soils

The cation exchange capacity helps characterise the soil type under consideration. For example, because organic matter in the soil is a major source of negative electrostatic sites there is a strong correlation between CEC values, and the amount of organic matter present in the soil.

Typical CEC values for different soils are as follows:-

Rating	CEC (me/100g)	Comment
Low	5 – 12	Soil very low in organic matter. Typical of sandy soils.
Medium	12 – 25	Pumice soils often in the range 13 – 18; lower fertility mineral soils in the range 15 – 25
High	25 – 40	High fertility soils may be in the range 25 – 35. Also may have high clay content.
Very High	40 +	Values typically found in peat soils. Consolidated peats typically in range 40 – 65; raw peat may be as high as 100.

The CEC results provide advisers with an insight into the type of soil they are dealing with, as well as providing secondary information for use in formulating a fertiliser programme. **This can be especially important if they did not collect the samples themselves, and they are making their recommendation without seeing the property.**

Example

Consider the CEC values for these four soil samples:-

Sample Name	CEC (me/100 g)
Wet Gullies	54
Contoured Block	12
Back Hills	17
Front Flats	27

The CEC results indicate that the sample "Wet Gullies" contains a substantial amount of organic matter, and is very possibly a consolidated peat.

The "Contoured Block" has very little organic matter, suggesting that the top soil was not fully replaced (with implications for nutrient supply and the water holding properties of the soil.)

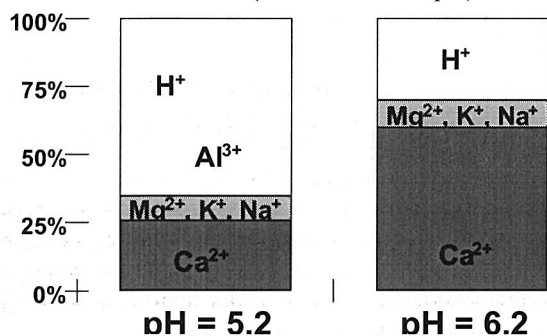
The remaining two samples have more normal CEC values, with the "Front Flats" being likely to be the more fertile soil of the two.

What Is Total Base Saturation?

The exchangeable cations can be divided into two groups:

Bases	Cations which are alkaline and therefore raise the soil pH	Ca ²⁺ , Mg ²⁺ , K ⁺ , Na ⁺
Acids	Cations which increase soil acidity and therefore lower pH	H ⁺ , Al ³⁺

Every CEC binding site must have a cation bound to it, to maintain electroneutrality. The soil pH will be affected by whichever cations predominate on these exchange sites. The more base cations present, the more alkaline the soil (ie. the higher soil pH will be), whereas the more acid cations present, the more acidic the soil (ie. the lower the pH).



The **Total Base Saturation** is the fraction of the negative binding sites occupied by bases. For example, a base saturation level of 75% means that three out of every four sites is occupied by basic cations. (The remaining 25% of the sites must therefore be occupied by acid cations). Total Base Saturation is simply calculated by summing together the levels of calcium, magnesium, potassium, and sodium found in the soil; then expressing this sum as a percentage of the CEC value.

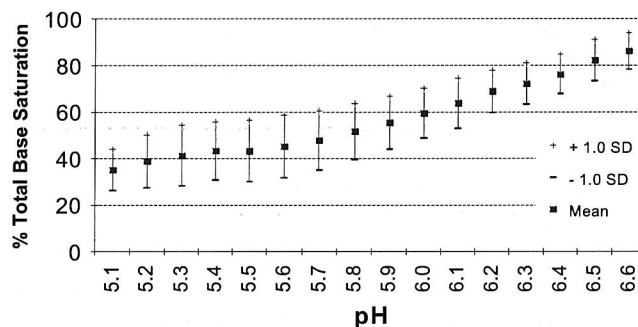
$$\text{Total Base Saturation} = \frac{\text{Ca} + \text{Mg} + \text{K} + \text{Na}}{\text{CEC}}$$

Is Lime Required?

Most pastoral and horticultural crops prefer neutral to slightly acid soil conditions; and it is often necessary to raise soil pH levels (when they are too acidic), by applying lime.

There is a strong correlation between total base saturation and soil pH. The next graph shows the mean values and standard deviation of total base saturation versus pH for a sample of 7,500 pasture soils processed by this lab.

Total base saturation therefore gives a **second perspective** on



the soil's acidity or alkalinity, and on the need for liming.

Note: Usually the base saturation level and the pH value will indicate a very similar soil acidity level. Sometimes, there will be a discrepancy between the two. Because the Base Saturation result involves a more rigorous and complete extraction of the soil than the pH test, it is the more reliable test of the two to consider when making liming decisions.

Knowing the CEC and total base saturation will also yield a lime requirement, by calculating the amount of calcium necessary to achieve a target total base saturation (usually 75%). The calcium is expressed as Kg/Ha Calcium Carbonate, assuming 90% purity.

As the pH tends to show more seasonal variation than total base saturation, this calculation is regarded as being a more reliable lime requirement test than one based on pH alone.

Individual Base Saturation Levels

Individual base saturations can also be used to gauge the balance of cations within the soil. For a soil where the pH should be in the range 5.8 – 6.5, the following base saturation levels can be regarded as being 'ideal'.

Potassium	2% – 5%
Calcium	50% – 75%
Magnesium	5% – 15%
Sodium	1% – 2%

As with all soil test interpretations, however, attempting to achieve the ideal level may not be economic or practical. For different crops, on varying soil types, these 'ideal' levels may differ. (For example, 30% – 50% Ca for a peat soil is more appropriate than the range 50% – 75%).

For high value crops, where the cost of fertiliser is not a major concern, then working towards the optimum individual base saturation levels does have some merit.

Conclusions

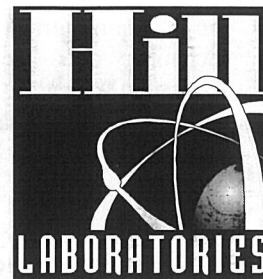
CEC and base saturation data is particularly useful in highlighting differences in soil fertility between samples from the same farm; and in determining lime requirements. We believe that the inclusion of CEC and base saturation data in our soil test reports is a major advantage, compared to the reports of some of our competitors.

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The Resin P Soil Test

Hill Laboratories has offered the Resin P test since 1993. It is based on a sound scientific model and is gaining in credibility among users as a complement to the Olsen P test. This Technical Note outlines some of the background issues and results of observations made in the laboratory.

Phosphorus is arguably the most important element in New Zealand agriculture, as nearly all New Zealand soils are naturally low in plant available P. It is present in both inorganic and organic forms, with most of the total soil P being unavailable to plants.

Much research has been focused on the development of suitable soil tests for the inorganic form of P, and in the early 1970s the National Series¹ of trials conducted by MAF compared a range of these tests. This work revealed only small differences in reliability between the tests, but the Olsen was slightly better. (Note: The Resin P test was not available at that time). In 1976 the Olsen P test was adopted as the standard in New Zealand soil testing². It specifically minimises the measurement of P from acid soluble sources such as soil apatite and slow release P fertilisers, by using an extraction procedure buffered at pH 8.5.

A summary of the more common tests used here and overseas is shown in Table 1. It shows the chemical composition and the pH of the extractant.

Test	Extractant	pH
Olsen	Sodium Bicarbonate	8.5
Bray	Ammonium fluoride & hydrochloric acid	2.6
Truog	Sulphuric acid & ammonium sulphate	3.0
Resin	Water & anion/cation exchange membranes	Soil pH

Table 1: Common Soil P Tests

In more recent times, research at Massey University has demonstrated the use of ion exchange technology in the measurement of P in a range of soils with different fertiliser treatments³. This research has built on soil fertility research in USA, Brazil and Canada, and has shown favourable results as a P test under New Zealand conditions. This is now known as the Resin P test^{4,5}.

How It Works

Nutrients in the soil are in equilibrium with those in the soil solution, and plant roots, using an ion exchange mechanism, take up nutrients from the soil solution as required.

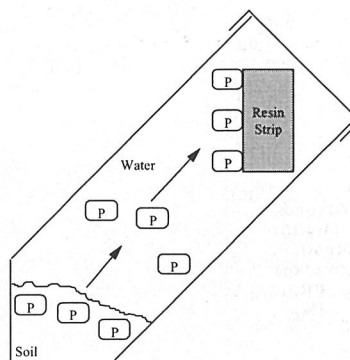


Figure 1: Resin P Extraction in the Laboratory

In the laboratory the Resin P test uses a mechanism that closely mimics the soil/soil solution/plant root model. Soil, water and ion exchange membranes are shaken overnight. During this process, phosphate in the soil moves into the water phase where it is efficiently taken up by the ion exchange membranes. The

amount of P adsorbed onto the membrane is proportional to the soils ability to replenish P into the water phase.

Benefits

We believe the Resin P test overcomes some of the anomalies observed with the Olsen P test. For example:

- Under conditions of low soil pH, free aluminium and iron may immobilise P in the field⁶. Because the Olsen extraction is performed at a high pH, some of this bound P will be released during the extraction, thus overestimating the plant available P. As the Resin P extraction is performed at soil pH, this effect will not arise.
- Soils with high pH, or recently limed soils⁷, tend to have higher levels of calcium. When the Olsen extraction is performed at pH 8.5, some calcium phosphate precipitates during the extraction process⁸ and does not get measured. Other sources of calcium phosphate, such as RPR, are also insoluble. Consequently the Olsen test underestimates plant available P.
- Target Olsen P levels vary with the P retention of the soil⁹. We surmise that, as the Resin P test is primarily a simple water extraction, the P Retention will directly affect the amount of P being extracted. The need to consider the P Retention when interpreting the extractable P result should not be as critical for the Resin P test.
- The yield response curves for Resin P are similar for different soils types, unlike those for Olsen P³. This simplifies the interpretation of the soil test, as it is not so dependent on soil type.

- As a multi-nutrient extraction technique. The resin technology has been successfully used for sulphur¹⁰, potassium, calcium, magnesium and sodium¹¹, and it is suspected it may also have application for some trace elements.

Limitations

Being a relatively new test, there is only a limited amount of interpretation data available. The tendency has been to relate the Resin P result to the Olsen P and interpret it using established Olsen P experience. Investigation have shown a good correlation with the Olsen P results, with a constant

average Resin P:Olsen P ratio of 2.5. However, on an *individual* test basis, the relationship varies according to many factors. This emphasises that the Resin P has unique properties that differentiate it from the Olsen P test.

Laboratory Observations

A thorough survey of our database was conducted in an attempt to find possible relationships between available soils test results and the Resin:Olsen P ratio.

These tests included Olsen P, Resin P, pH, Base Saturation and Phosphate Retention (PR). The most interesting findings are represented in Figure 2.

The graph shows that soils where the Resin P:Olsen P ratio is significantly less than the overall *average* of 2.5 have a:

- **Low pH**
The relatively low Resin P levels found in soils of low pH suggests that that this test does not overestimate the available P like the Olsen P test does. We suspect that at the pH of the Resin P extraction, aluminium and iron do not release bound P.
- **High Phosphate Retention**
Soils with high PR also show a relatively low Resin P, confirming that less P is available from these soils. This means that target P levels do not have to be adjusted for soils of different P retentions.

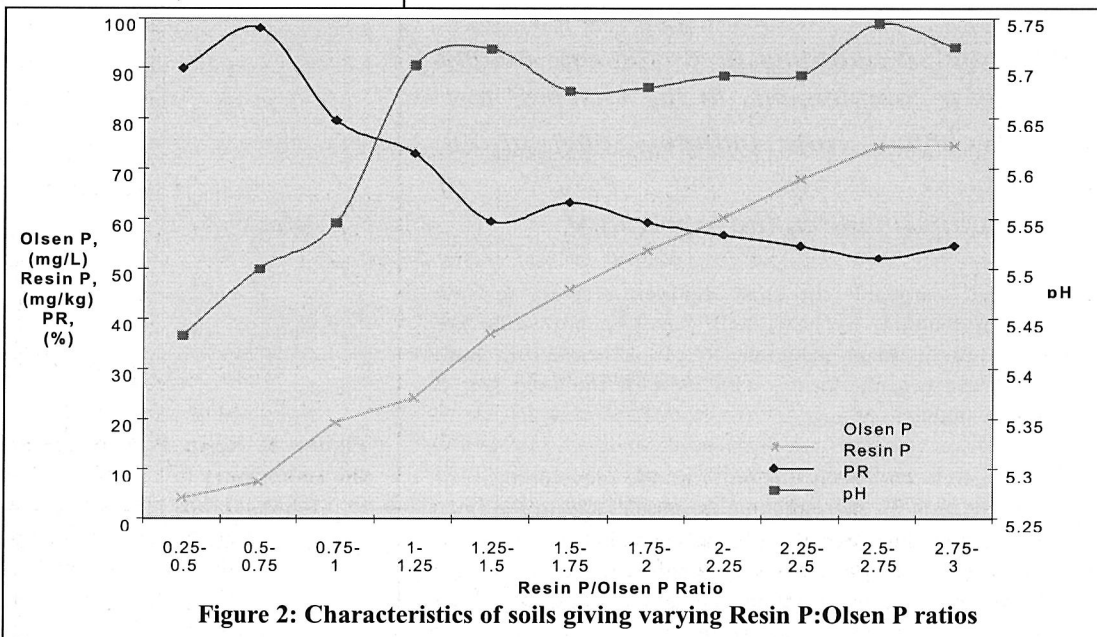


Figure 2: Characteristics of soils giving varying Resin P:Olsen P ratios

- **Low P Status**
The lower the amount of P in the soil, the more dramatic is the affect of the different soil properties on the plant availability of P. The Resin P test appears more sensitive to these affects, particularly those of pH and PR.

Conclusions

The model on which the Resin P test is based is one that seems intuitively and scientifically sound. While the initial research and investigations are very promising, we also realise that this is still a new test, with limited field trial data at this time. Consequently, the Resin P should not be regarded as a replacement for the Olsen P. Despite the identified limitations of the Olsen P test, the experience invested in it by scientists and consultants justifies its continued use. We regard the Resin P as an important new development in soil testing which complements the Olsen P test.

We are also interested in further expansion of ion exchange technology as a multi-nutrient extraction technique.

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² Change in Soil Test for Phosphorus Status, N. A. Cullen, Director, Soil and Field Research Organisation, DSFR 45, June 3, 1976.

³ Sagger, S. (1992): *Field evaluation of Olsen, Colwell and Resin P tests for New Zealand pasture soils. Final report.* MAF-Technology/Massey Soil P Test Project.

⁴ Sagger, S.; Hedley, M.J.; White, R.E. (1992): Development and evaluation of an improved soil test for phosphorus: 1. The influence of phosphorus solubility and soil properties on the extractability of soil P. *Fert. Res.* 33:81-91.

⁵ Sagger, S.; Hedley, M.J.; White, R.E.; Greg, P.E.H.; Perrott, K.W.; Cornforth, I.S. (1992): *Development and evaluation of an improved soil test for phosphorus: 2. Comparison of the Olsen and mixed cation-anion exchange resin tests for predicting the yield of ryegrass grown in pots.* *Fert. Res.* 33:135-144.

⁶ *Soil testing and plant analysis.* Ed. L. M. Walsh; J. D. Beaton. Revised Edition. Soil Science Society of America, Inc., (1974).

⁷ Haynes, R.J. (1982): *Effects of liming on phosphate availability in acid soils.* *Plant and Soil*, 68:289-308.

⁸ Puntipa Som-srivichai; Tillman, R.W.; Cornforth, I.S. (1984): *The effect of soil pH on Olsen bicarbonate phosphorus values.* *J.Sci.Food Agric.* 35:257-264.

⁹ *Fertiliser recommendations for horticultural crops.* Compiled by C. J. Clark; G. S. Smith; M. Prasad; I. S. Cornforth. 1st Ed. Wellington, New Zealand: Ministry of Agriculture and Fisheries, (1986).

¹⁰ Searle, P.L (1988): *The determination of phosphate-extractable sulphate in soil with an anion-exchange membrane.* *Commun. in Soil Sci. Plant Anal.* 19(13),1477-1493.

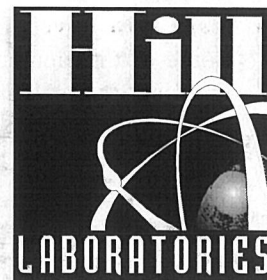
¹¹ van Raij, B.; Quaggio, J.A.;de Silva, N.M. (1986): *Extraction of phosphorus, potassium, calcium and magnesium from soils by an ion exchange resin procedure.* *Commun. in Soil Sci. Plant Anal.* 17(5), 547-566.

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New Calibration Data for Soil Trace Element Tests in NZ

Recent calibrations of soil trace element levels for New Zealand conditions have prompted a re-evaluation of these tests.

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.

Until recently, 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, Analytical Services Laboratory and R J Hill Laboratories (the parent company) have not actively promoted trace element soil testing.

Two papers presented recently to a conference at Massey University, however, report 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 paperⁱ 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 than soil manganese levels were high.

Copper and Zinc in Canterbury Cropping Soils

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

Dr. Dick Haynes of NZ Institute for Crop and Food Research, Lincoln, reportedⁱⁱ 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."

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 offer either of these extraction methods, but recommend the EDTA extraction because this is the method for which we have the most useful calibration data. This procedure has been recommendedⁱⁱⁱ as the most appropriate for NZ conditions.

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/perchloric 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.

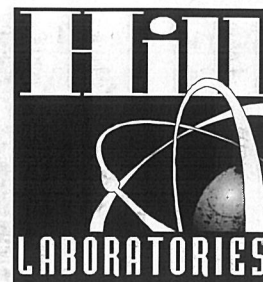
ⁱⁱⁱ **An Evaluation of the Use of DTPA and EDTA as Extractants for Micro Nutrients in Moderately Acid Soils** RJ Haynes and RS Swift, *Plant and Soil*, 74, 112, (1983).

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The Animal Dietary Mineral Balance Report

Announcing a New Service...

*Hill Laboratories has developed a new report format for pasture and feed samples. This is called the **Animal Dietary Mineral Balance** report. It has been designed to assist Veterinarians and Consultants in their assessment of the mineral content of herbage, and how well it supplies the animal's daily requirements.*

A main feature is that this report considers the **animal requirements only**. This is in contrast to our standard Analysis Results histogram report, where the levels found are compared to optimum levels that are based on **both plant and animal requirements**, whichever is the greater. For example, an element such as potassium is graphed according to the plants requirements only, as the plant requires typically 2.5-3.5%, and the animal only 1.0%. Other elements, such as sodium and selenium, are assessed according to animal requirements, since they are not regarded as being essential for pasture growth.

A special **Request Form** has also been prepared, as this report requires some additional data from the farmer, namely animal liveweight, calving date and the daily dry matter intake of the feed submitted. If not provided, then the calculations assume a 400 kg animal, calving in mid-July. Daily dry matter intake is varied according to the time of year (See Table 1).

Another new feature of this report is that the minerals are shown as **Daily Intake** in grams and milligrams. If the daily dry matter intake is not provided by the client, then the following assumptions are made:

Lactation Stage	Time of Year	Daily DM Intake
Peak Lactation	July - November	16 kg
Mid Lactation	December - April	12 kg
Dry	May - June	8 kg

Table 1: Default values for New Zealand conditions.

The **Daily Requirement** is also calculated, based on the animal's liveweight and the Lactation Period^{1,2}. The

difference between the actual daily intake and requirement is shown, and a bar graph provides a quick,

visual guide as to the severity of any deficiency or surplus.

This is preferable to the more commonly used approach of presenting results as **concentrations** in the dry tissue, either in % or ug/g (ppm). This is the format used in our standard Analysis Results histogram report.

Presenting the results as Daily Intakes (g or mg) has three main advantages:

1. This is the best way to assess the animal's needs. Variable feed intakes makes the concentration in the feed approach less reliable. For example, the cow's daily selenium requirement is reasonably constant, irrespective of whether it consumes 8 kg or 12 kg of DM.
2. If supplementary feeding is occurring (e.g. maize silage), then this approach can accommodate this. The mineral contributions from both the herbage and the supplement can be derived (provided the daily quantities consumed of each per cow is supplied). This reporting option will simply add them together to yield the animal's total daily intake.
3. These units are "meaningful", in that the farmer or his advisor can readily calculate quantities of minerals required to further supplement the animal's diet. For example, if the report shows a deficit of 8 mg of copper per animal per day, it is simple arithmetic to convert this into quantities to incorporate into feeds, etc.

Nutrient Interactions

The bar graph shows the difference between the animal's daily intake and requirement of minerals, each considered individually. However, mineral availability is often influenced by interactions between minerals. Magnesium and/or calcium deficiencies often exist where there are adequate levels in the diet, but the potassium level is excessive.

Nutrient indices are calculated to indicate whether unfavourable interactions that are associated with metabolic disorders are likely.

Certain Feed Types are Naturally Low in Minerals

Some feeds are inherently low in minerals, and will therefore rate poorly in this new reporting format. Examples would be grain-based feed concentrates, and some of the high yielding bulk feeds being grown today (for example, maize silage, Sudax grass).

We would urge the farmer not to take this to mean these are inferior feeds. They are grown primarily as an energy supplement, being rich in carbohydrate, and as such, have an important role in achieving an overall balanced nutrition. This report will simply highlight they are feedstuffs low in minerals, and if they comprise a significant part of the animals intake, then careful attention needs to be paid to the other feed components, to ensure an adequate supply of minerals.

The "Model" behind the Report

This new report is comprised of three separate calculations:

1. Calculation of the Daily Mineral Intake.

This involves taking the results of the feed analysis (as concentrations in the feed), and multiplying them by the quantity of D.M. consumed daily. This gives the actual quantities (in g and mg) of nutrient being consumed. If D.M. Intake is not supplied, then quantities as shown in Table 1 are assumed.

2. Calculation of the Daily Requirement.

This required establishing the mineral requirements by referencing a number of publications. These requirements are defined for three lactation stages (as shown in Table 1), and for a 400 kg cow. If the calving month is not July, then the requirements are adjusted, according to the calving date supplied. If an average cow liveweight is provided, then the requirements are again scaled proportionately to the default 400kg.

3. Deriving the deficit/surplus.

This is very straight-forward, simply being the difference between the daily intake and daily requirement. Slightly more complex is the construction of the bar graph, showing the severity of the imbalance. Differences of opinion abound in the literature, and Hill Laboratories have used their resources and experience to set these critical levels to the best of their ability.

Some Issues of Interest

The Composite Feed Report

A further reporting feature developed at Hill Laboratories is the ability to **combine results from more than one feed sample** to give an overall assessment of the animal's mineral intake. The quantities of each mineral (in g and mg) from each sample are simply summed together, to allow an overall composite feed evaluation.

To take advantage of this feature, ensure that the Daily D.M. Intake for each feed type is supplied, and record that you would like a composite report as well. There is no charge for this additional service.

- **Selenium.** There is one school of thought that high producing dairy cows require higher levels of selenium than has been used in the past (ie. 0.30 ug/g rather than 0.05 ug/g in the feed.) Recently published NZ work³ indicates the lower levels are quite adequate.

Our interpretive scale is based on a feed content of 0.05 - 0.30 ug/g being adequate.

- **Nutrient Ratios.** While there is no dispute that nutrient interactions have a very real effect on the availability of many nutrients, there has been some debate about the validity/reliability of some of the ratios to predict clinical metabolic disorders. Hill Laboratories acknowledge this, and have only calculated ratios that, in their opinion, have some validity and usefulness **as risk indicators**.

- **Copper.** Perhaps the element of most interest with respect to nutrient interactions is copper, and it is unfortunate that there is no reliable calculation available to quantify the effects of interferences on this nutrient. It is well known that high levels of molybdenum, sulphur, iron and zinc can all reduce the dietary availability of this element.

References

¹ Nutrient Requirements of Domestic Animals - Nutrient Requirements of Dairy Cattle. Sixth Revised Edition (1989 Update), National Research Council. National Academy of Sciences, Washington D.C. 1988.

² The Mineral Requirements of Grazing Ruminants. Ed. N.D. Grace. Occasional Publication No. 9, New Zealand Society of Animal Production 1983.

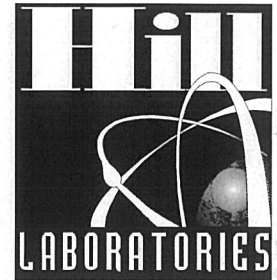
³ Managing Trace Element Deficiencies. Grace, N. New Zealand Pastoral Agriculture Research Institute Ltd 1994.

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Mineral Ratios and Grass Staggers

Dairy and beef cattle are prone to metabolic disorders such as 'grass staggers' at certain times of the year. Various mineral imbalances have been implicated as contributing factors.

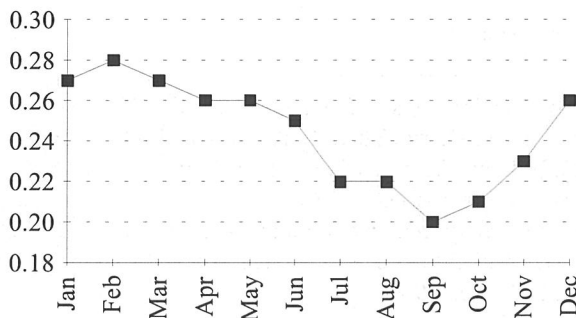
Hypomagnesaemic tetany, or 'grass staggers', occurs when ruminant animals have abnormally low levels of magnesium in their blood.

There are many theories about the causes of these low magnesium blood-levels: some focus on the age, genetic make-up, and metabolic requirements of the animal; and others focus on the chemical composition of pastures. A variety of animal stress factors (such as pregnancy, lactation, the weather) have also been studied.

Magnesium Concentrations in Pasture

The concentration of magnesium in pasture follows a clear seasonal pattern, reaching a maximum in summer and a minimum in winter. Data from pasture samples processed through R J Hill Laboratories Ltd. illustrates this seasonal pattern.

Mean Values: Magnesium in Pastures



Research suggests that a **magnesium** concentration in pasture of **0.20%** is generally adequate.

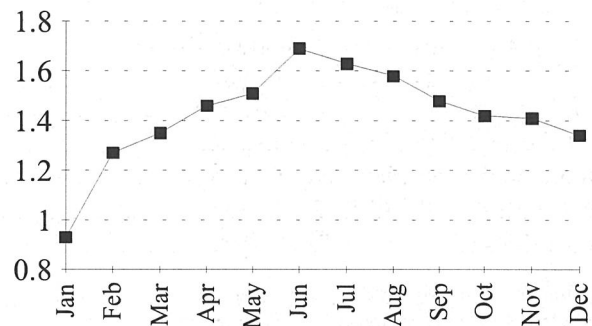
The 'Grass Staggers' Ratio

Grass staggers can occur even when pasture magnesium concentrations are in excess of 0.20%. The ratio* of potassium to calcium and magnesium has been found to be a better indicator of grass staggers than magnesium concentrations alone.

$$* \frac{(K/39)}{((Ca/20)+(Mg/1213))} \text{ i.e. } \frac{K}{Ca+Mg} \text{ expressed in milliequivalents}$$

This ratio also follows a seasonal pattern, peaking in mid-winter and reaching a minimum in summer.

Mean Values: 'Grass Staggers' Ratio



It has been suggested that the 'critical' value for the 'Grass Staggers Ratio' is 2.2, with a sharp rise in grass staggers incidence being reported for pastures with a ratio **higher** than 2.2.

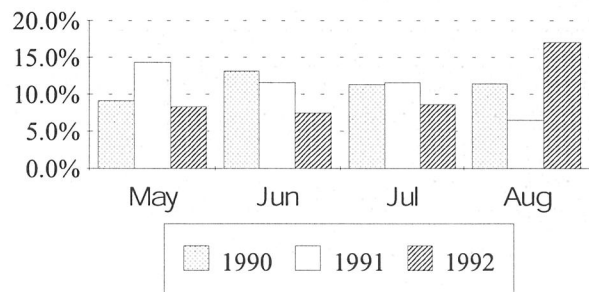
Grass Staggers Ratio in Winter 1992

Grass staggers can be more of a problem in some years than others. For example, some farmers experienced a higher incidence of grass staggers in the spring of 1992.

Analysis of samples processed by R J Hill Laboratories for the winter of 1992, compared to the 2 previous winters, shows that the proportion of pastures in which the Grass Staggers Ratio exceeded the 'critical' value of 2.2 **increased sharply** in August 1992, to 17%.

In contrast, the proportion during May to July 1992 was about 8%, much lower - and therefore more favourable - than the 2 previous years.

% Pastures with Grass Staggers Index > 2.2



The higher incidence of grass staggers reported in Aug. 1992 could well have been caused by a rapid decline in pasture quality due to the adverse climatic conditions with this decline reflected in the graph above.

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Potting Media Analysis

Potting Media have been analysed by R J Hill Laboratories and Analytical Services Laboratory for many years. Although there are similarities with conventional soil testing, there are also significant differences. By their nature, Potting Media present some special challenges.

This Technical Note provides background information on the Potting Media tests offered by this laboratory.

Background

Sonneveldⁱ developed the 1:1.5 media to water extraction in Holland in the early 1970's. Subsequent to this Munoo Prasadⁱⁱ and Mike Spiers at the Levin Horticultural Research Centre (LHRC) undertook a considerable amount of Potting Media research during the late 1970's and early 1980's. This work provided the basis for routine Potting Media analysis in New Zealand, and made a significant contribution to the development of the Australian Standard for Potting Media Analysis by Kevin Handreck. This Standard also provided additional test procedures not previously offered in New Zealand.

This laboratory has adopted the Australian Standard with the exception of the Basic Media test. The water extraction procedure as used at the LHRC has been retained, rather than the DTPA extraction of the Australian Standard.

Basic Media (BM)

Almost all the media received at this laboratory are analysed for the Basic Media Test. This includes pH and Electrical Conductivity, and the immediately available nutrients ammonium-nitrogen, nitrate-nitrogen, phosphorus, potassium, calcium, magnesium and sodium.

The pH and EC tests are most important. The pH will affect the availability of many nutrients and should be maintained in the optimum range. The EC provides an overall measurement of the dissolved salts, and is important in diagnosing problems such as salt stress in crops.

It is important to realise that this test measures the nutrients that are immediately plant available. It does not include nutrients that may become available over time (e.g. from slow release fertiliser prills). This would be the major limitation of this test. Consequently it is possible that a Potting Media analysis shows only low levels of nutrients present, even though the crop is apparently growing well. When this is the case, the crop takes up these nutrients at the same rate as they are being released by slow release fertilisers, and there is no need for concern.

Heavy watering of the media just prior to testing will also result in low nutrient levels. Nutrients do not always bind strongly to the media so watering can easily flush out much of what was present.

Because of these factors, the levels reported should be regarded as a snap-shot of the media at the time of analysis. The treatment given to the media before or after analysis must be taken into account when interpreting the analysis results.

Trace Elements (TE)

The trace elements iron, manganese, zinc, copper and boron are analysed from the DTPA extraction. As with soil trace element testing, there are limitations to the reliability of the test, and in most instances suspected trace element problems should be confirmed with plant tissue analysis.

Physical Analysis (PA)

This test measures the Water Holding Capacity (WHC) and Air Filled Porosity (AFP) of the Potting Media by the method specified in the Australian Standard. It has been difficult to provide consistent results using this method. From time to time the

laboratory has attempted to get these difficulties under control and improve the test without deviating from the Australian Standard. However, the test appears inherently imprecise. Alternatives, such as measuring pore space at various water tensions using a tension table are currently being considered.

Nitrogen Drawdown Index (NDI)

This test measures the degree to which Potting Media have 'stabilised' by composting, and is especially relevant for media such as pine bark. Uncomposted media are often a rich energy source for the proliferation of microbes. This process requires nitrogen, and if such material is used in Potting Media then microbes will compete with the plant for the available nitrogen. Consequently, nitrogen deficiency symptoms usually appear in the crop.

The NDI test can show if this process has slowed down from its initial high rate to the point where the media has stabilised and the nitrogen drawdown by the microbes has reduced to the point where the supply of nitrogen to the crop is relatively unaffected.

It should be remembered that two factors can slow down the composting process. Either the Potting Media becomes truly stabilised, or the microbes run out of nitrogen. Some confusion has arisen from Potting Media that have been composted and appeared stable, but when tested have given a low NDI. Possible explanations for this are that the material has either run out of nitrogen before stabilisation or a 'nitrogen hunger' has developed due to further breakdown during storage.

The NDI test should be performed on media before the addition of slow release fertilisers as these additional nitrogen sources will interfere with the test.

Interpretation

The end use for analytical results is to interpret them in a meaningful way to enable sound decisions to be made about the media and fertiliser use. To do this, a comparison needs to be made between the analytical results and the desired or target levels. Where possible, the laboratory provides these critical levels on the report with the analytical results. For this to work effectively, the sample, or its intended use, must be identified correctly. Until recently, the critical levels used for the Basic Media tests have been very general. Some specialist categories are

now available that reflect the varied requirements of the media. The complete list of available categories are as follows:

<i>Category</i>	<i>Code</i>	<i>Nutrient Levels</i>
General	M1	Broad range
Seedlings	M2	Very low
Slow Growing Ornamentals	M3	Low
Fast Growing Ornamentals	M4	High
Vegetables	M5	High

Clients submitting samples for analysis should specify which of these categories apply, giving either the category or the code. If this is not done, then the default will be General (M1).

Other Tests

Other tests available are the Cation Exchange Capacity and Toxicity tests. Please contact the laboratory for further information.

Sampling Requirements

For nutrient monitoring, collect material from at least 10 pots at random to get a representative sample. If diagnosing a specific problem, select the sample from the pots showing the most prominent symptoms. Mix the material well and submit 0.5 - 1 litre for the Basic Media and Trace Element tests.

The Physical Analysis and Nitrogen Drawdown Index tests both require large samples. Please supply at least two litres of sample.

References

ⁱ Sonneveld, C.; van den Ende, J.; van Dijk, P.A. (1974): Analysis of Growing Media by Means of a 1:1.5 Volume Extract. Comm. in Soil Science and Plant Analysis, 5(3), 183-202.

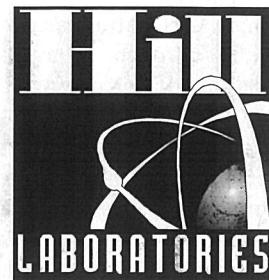
ⁱⁱ Prasad, M.; Spiers, M.; Ravenwood, I.C. (1981): Soil Testing of Horticultural Substrates (I) Evaluation of 1:1.5 Water Extract for Nitrogen. Comm. in Soil Science and Plant Analysis, 12(9), 811-824.

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Compost Analysis

Hill Laboratories tests composts, sludges, manures and other similar organic materials for their nutrient concentration. In the past, they have been processed through our routine potting media or plant tissue tests, and other times treated as fertilisers through our Non-Routine section.

A new testing programme specifically devised for these materials is now available. As well as assessing the materials for their fertiliser value, additional tests relevant to their usage in organic growing are also offered.

What Is Compost?

There is some confusion regarding exactly what is a compost. Soil-less growing media are sometimes referred to as composts, as are organic fertilisers and soil conditioners.

Table 1 lists some common descriptive terms, components and usages of composts and related materials likely to be encountered.

When describing a material, it is important to establish (i) whether the sample will be used directly as a complete growing media for the plants to grow in or (ii) whether it is to be added to a soil as a mulch or soil amendment.

In the first case, the sample is a growing media and the plant available nutrients are of most interest. The material is considered to be a potting mix for which the Basic Media test profile is already available.

At Hill Laboratories, materials other than growing media will be regarded as composts, and if the material is low in organic

matter then it will be treated as fertiliser (the Australian Standard defines composts to have an organic matter of greater than 75% on a dry matter basis).

Summary of Tests

The most commonly asked questions about composts are 'What's in it?', or, 'Can I use it as an organic fertiliser?' We have established a series of test profiles that are useful to evaluate compost quality.

The tests most appropriate for your sample will depend on knowing the origin of the material and how the compost is to be used.

Table 2 lists the recommended profiles and their prices.

Basic Compost Profile

The Basic compost profile consists of the following tests:

Moisture

Composts can vary greatly in their moisture content. The moisture effectively dilutes the nutrients in the sample. For this reason, we believe the moisture content of the sample should be reported. The nutrient levels can be converted from a dry matter basis to an 'as received' basis using the moisture result.

Major Nutrients

The levels of plant essential nutrients are important to assess the compost's value. The major nutrients N, P, K, S, Ca, Mg and Na are included in the Basic Compost test.

Organic Matter

The organic matter in the compost may improve soil condition and structure. It will also act as an indicator to distinguish between composts and inorganic fertilisers. The degree to which the material is definitely organic in nature is also important to some clients.

C/N Ratio

This ratio can be useful to assess the nitrogen supplying potential of the compost. In undecomposed organic matter the amount of carbon is relatively high, and as it decomposes much of this is lost to the atmosphere as carbon dioxide. In this process, nitrogen is consumed by microbes breaking down the organic carbon. A

Common Terms	Likely Components	Final Purpose
Growing Media	Bark, sawdust, peat, pumice	Growing of plants
Compost Mulch Soil Amendment Soil Conditioner Manure Organic Fertiliser	Plant material, bark, sawdust, animal manure, animal paunch, vermicast, fish waste	Adding nutrients to soil, conditioning the soil, covering the soil
Biosolids	Treated urban sewage	Adding nutrients to soil
Mushroom Compost	Straw and chicken manure	Growing mushrooms

Table 1: Common Terms Relating To Compost

high C/N ratio usually means that very little nitrogen is available to the crop, because of this microbial competition.

For growers relying on their nitrogen source being provided from the recycling of organic materials, this ratio can be used to judge whether the compost is likely to supply nitrogen, or in extreme cases, consume it in the breakdown of the material.

Profile Name	Tests	Price
Basic Compost	Moisture, N, P, K, S, Ca, Mg, Na, OM, C/N Ratio	\$100
Full Nutrient	N, P, K, S, Ca, Mg, Na, Fe, Mn, Zn, Cu, B, Moisture, OM, C/N Ratio	\$120
Heavy Metals	Cd, Cr, As, Pb, Ni, Hg, Zn, Cu	\$105
Pesticide Screen	Multi-residue (>140 compounds)	\$230
Water Extractables A	pH, Soluble Salts	\$40
Water Extractables B	pH, Soluble Salts, NH ₄ -N, NO ₃ -N	\$80

Table 2: Profile Options and Prices (ex GST, valid till 1 May, 1999)

Full Nutrient Profile

This profile is an extension of the Basic Compost Profile and includes the trace elements Fe, Mn, Zn, Cu and B.

Heavy Metals Profile

Some composts and soil amendments may contain elevated levels of heavy metals, due to the source of some of their constituents. These metals may subsequently accumulate in the crop being grown. The levels of various heavy metals can be determined if required.

Water Extractable Nutrients

Two water extractable nutrients profiles are offered. The pH will indicate whether the material is acidic, neutral or alkaline. The presence of soluble salts, particularly inorganic nitrogen ions, is relevant in assessing whether or not the material complies with organic farming requirements.

Pesticide Screen

The material can be analysed for the presence of a wide range of pesticides. Over 80 organo-nitrogen, organo-phosphorus and organo-chlorine compound are included in the standard test.

Mushroom Profile

This profile is a special profile established for the requirements of the mushroom growing industry.

Sampling Instructions

Your composts have been processed from a mixture of biomass and/or other components and are not totally uniform in composition. We suggest that you collect several small 'grab samples' from your bulk compost and combine these to give a composite sample of approximately one kilogram and store it in a stout, sealed plastic bag or container. Bags will be provided by us on request.

Reporting Method

Test results for all nutrients and pesticides will be expressed on a dry matter basis, and can be recalculated to a fresh weight basis by the client using the moisture result using the following formula:

$$\text{result (as received)} = \text{result (dry matter basis)} \times \left(\frac{100 - \text{moisture (\%)}}{100} \right)$$

Note that reporting results on a dry matter basis is in contrast to the convention applying to fertilisers in general, where results are reported on an 'as received' basis.

Result Interpretation

Where possible, results reported will be interpreted using currently available local and international standards.

Special Considerations

Please provide additional information about the sample, particularly the constituents used and whether they may constitute a health hazard. This will ensure our staff can take appropriate precautions when handling these samples. Some particularly difficult samples may require additional sample handling and consequently incur additional costs.

Conclusion

Hill Laboratories is pleased to now offer a testing programme specifically for composts. By having established these routinely offered profiles we can provide a more relevant and effective service to our clients.

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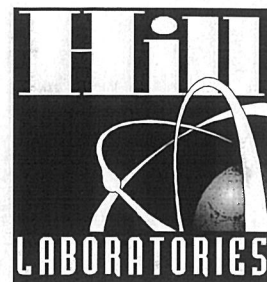
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Apple Leaf Analysis

Interpretation of apple leaf analysis results for samples collected earlier or later in the season should take into account within-season changes in normal ranges.... as well as possible varietal differences.

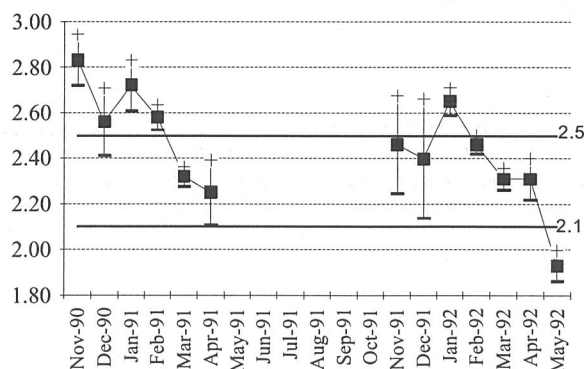
Analysis of apple leaves in mid-summer is now a well-established part of monitoring an orchard's nutritional status, particularly to assist detect major imbalances; and monitor the effects of subsequent corrective actions

Seasonal Changes in Nutrient Levels

Interpretative guidelines for leaf tissue analyses usually assume that the sample leaves have been collected during January and February, as this is considered to be the optimum collection time. However, there can be considerable differences in the nutrient levels found in leaves at different times in the growing season, and between seasons.

The following graphs show the mean values of nitrogen and calcium for all apple leaf samples processed by R J Hill Laboratories during the 1990/91 and 1991/92 seasons. (Similar graphs for other elements are provided over the page.) The vertical bars indicate the range within which these mean figures have a 95% probability of falling; and the two solid horizontal lines represent the 'normal' range used in R J Hill Laboratory reports.

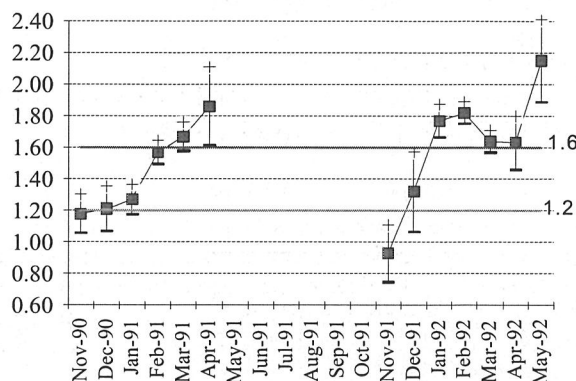
Mean Values of Nitrogen



For most elements, early season values tend to be higher than those in mid-season (zinc levels in early leaf samples tend to be particularly high). Late-season values tend to be lower than 'normal'. Calcium samples are an exception to this tendency -

its value usually rises

Mean Values of Calcium

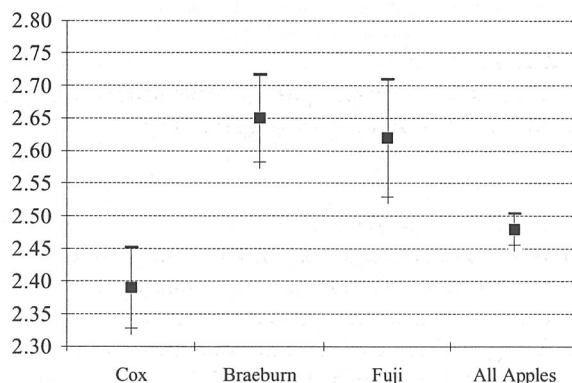


Varietal Differences?

It has been suggested that the 'normal' nutrient levels in apple leaves differ between particular varieties; and that varietal differences should be considered along with other factors such as tree age, management techniques, fertiliser history, water supply, and climatic conditions.

We have found clear differences in the mean values of leaves from different apple varieties processed at R J Hill Laboratories, for some nutrients. For example, the graph below shows that Braeburn and Fuji apples have tended to have higher nitrogen levels than Coxes apples.

Mean Nitrogen Values, by variety



Conclusion

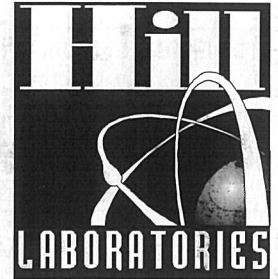
When apple leaf samples are taken outside of the January/February period, consultants and orchardists should be aware that nutrient levels in these leaves are likely to differ from 'normal' simply by virtue of the time of sampling. The potential for varietal differences should also be considered, prior to taking action to correct what might appear to be a nutrient imbalance in the trees sampled.

Technical Note

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Apple Fruitlet Analysis

Mineral analyses of fruitlets, and fruit, from a sample of New Zealand orchards during the 1992/93 and 1993/94 seasons suggests that early season fruitlet analysis can help growers to assess the degree of risk of mature fruit having unacceptably low concentrations of calcium.

Some varieties of apple are particularly susceptible to post-harvest disorders, such as bitter pit, when their mineral composition is out of balance. Considerable scientific research in New Zealand has been - and continues to be - undertaken into ways of preventing these disorders, and of predicting the risk of their development.¹

Limitations of Soil or Leaf Tests

Although soil and leaf tests are valuable management tools for maintaining the health and vigour of the trees themselves, such tests have proved of limited value for assessing the risk of post-harvest disorders in mature fruit, because "soil, leaf and fruit nutrient contents [are] generally not well correlated with one another...[This is] attributed to the empirical nature of soil tests, the presence of large nutrient reserves within the tree framework, and the effects of cultural and environmental factors in nutrient uptake and translocation by the trees."²

Mineral Analysis of Mature Fruit

Mineral analysis of mature fruit is generally held to be a reasonable predictor of storage disorders. For example low concentrations of calcium in the fruit at harvest have been associated with "the storage disorders bitter pit and senescent breakdown in Cox's Orange Pippin and lenticel blotch pit in Braeburn"; and abnormal levels of other nutrients (e.g. potassium) can also contribute to storage disorders.

However there are only limited remedies available to growers who discover that their fruit has these mineral imbalances at harvest.

Early Season Fruitlet Analysis

The concept of early season fruitlet analysis has been investigated, in an effort to find out whether post-harvest storage disorders can be predicted earlier in the growing season. The results of this research have shown that the earlier in the season the analysis is performed, the more difficult it is to predict post-harvest disorders. For example, Belgium researchers³ found between 18% and 41% of the variance in long-term keeping qualities of the apple variety Jonagold could

be predicted by early season mineral analysis of fruitlets. They concluded that it would be difficult to predict "very precisely the storage potential of an individual fruit sample" from such early season analysis since "mineral fruit composition is only one of numerous factors playing a role in storage."

Predicting Potential Grading Problems

This laboratory has a long and close relationship with individual apple growers, and their merchant suppliers; and we know that growers would welcome prior warning of mineral imbalances in their harvested fruit, especially as these imbalances might adversely effect their crop's calcium status at harvest. With prior warning, growers might be able to take a range of corrective actions such as pruning, spraying, or tree nutrition measures.

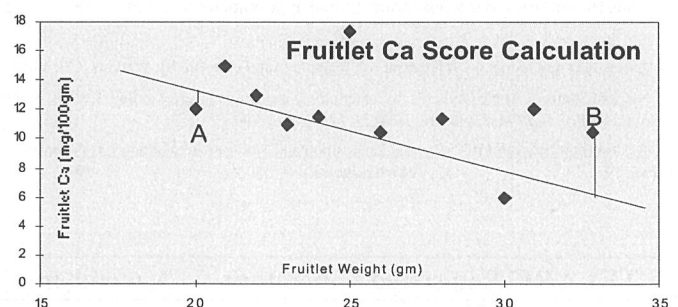
During the 1992/93 and 1993/94 seasons, Analytical Services Laboratory - with the support of Phosyn plc - analysed^{note 1} more than 300 samples of Braeburn and Cox's Orange fruitlets selected early in the growing season. The fruitlet test results were then correlated with corresponding mineral analyses of mature fruit taken from the same orchard blocks at the end of each season.

The objective of our research was to compare the apples mineral levels early in the season with those at harvest, to see whether growers could use early season mineral analyses of fruitlets to predict potential fruit grading problems at maturity.

The study focused on the relationship between levels of calcium in the fruitlets (expressed as a Fruitlet Calcium Score, as explained below), and calcium in mature fruit. The relationship between mature fruit mineral levels, and storage disorders is already well covered by New Zealand's scientific community and the NZ Apple & Pear Marketing Board; and was outside the scope of our study.

The Fruitlet Calcium Score

The concentration of calcium declines markedly as fruitlets increase in size. Therefore any interpretation of fruitlet mineral analysis needs to take the fruitlet weight into account. To simplify the interpretation, a Fruitlet Calcium Score was developed to allow for this weight variation.



The Fruitlet Calcium Score is simply the difference between the level of Ca in the fruitlet, and the expected level of fruitlets of that variety and weight. The expected level is based on data from this study of New Zealand fruitlets, and fruitlet research done in the UK. For example, fruitlet **A** might have a calcium level of 12mg/ 100gm, and a weight of 21 gm. If the expected Ca value for fruitlets of this weight is 13 mg/100gm, then fruitlet A has a Calcium Score of **-1**. In contrast, fruitlet **B** might have a calcium level of 11mg/ 100gm but a calcium score of **4** because the expected value for a fruitlet of its weight is only 7 gm/100gm.

Calcium in Braeburn

We found a statistically significant relationship between calcium levels in Braeburn fruitlets, and calcium levels in mature Braeburn fruit when applying the Analysis of Variance technique at the 5% significance level. Mature Braeburn fruit were grouped into three categories, corresponding **low** Fruitlet Calcium Scores (less than 2.0), **medium** Fruitlet Calcium Scores (2.0 - 4.0), and **high** Fruitlet Calcium Scores (above 4.0).

The calcium values in corresponding mature fruit from these three groups are graphed above. The difference between the mature fruit Calcium levels for these three groups is clear:

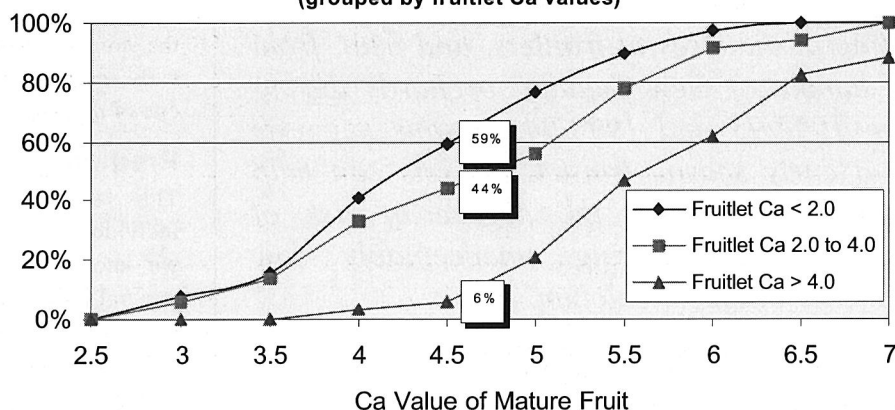
- **59%** of those with **low** Fruitlet Calcium Scores, and
- **44 %** of those with **medium** Fruitlet Calcium Scores had calcium levels at maturity **below** the critical 4.5 level^{note 2}.
- Only **6%** with **high** Fruitlet Calcium Scores subsequently had fruit calcium levels below this critical point.

Calcium in Cox's Orange Pippin

We did not find a statistically significant relationship between calcium levels in Cox's Orange Pippin fruitlets, and calcium levels in mature Cox fruit when applying the Analysis of Variance (ANOVA) technique at the 5% significance level.

Since all growers were told their fruitlet scores early in the season, those with low fruitlet calcium levels might have decided to try remedial action during the growing season. Therefore the fact that we did not find the same statistical relationship between Cox's fruitlets and fruits as we did for

Calcium in Braeburn Apples (grouped by fruitlet Ca values)



Braeburn might reflect a difference in the responsiveness of the two varieties (between early fruit development and maturity) to remedial action such as pruning or spraying, or external environmental factors like the weather.

Other Mineral Elements

Although calcium was the focus of our study, fruitlets and fruit were analysed for other mineral elements too. In situations where absolute calcium levels are low, it is often useful to consider the level of calcium relative to other minerals such as the ratios of nitrogen to calcium, and (potassium + magnesium) to calcium. In addition to reporting actual mineral levels for their samples, growers who submit apple fruitlets to Hill Laboratory now receive information about 'normal' levels of these other minerals, and mineral ratios, based on our analysis fruitlets of the same variety and similar weight.

note1 Method Used

Growers participating in the study selected apple fruitlets up to 35gms in weight. Analysis during the first season showed that the ideal weight range was between 20 gms and 35 gms, corresponding to fruitlets 100cm in circumference - about the size of 50c piece. Fruitlets less than 20gms were too immature to provide reliable correlation. Mineral analyses for a wide range of nutrients, together with key nutrient ratios, were undertaken on the whole fruitlet, and (later) the whole fruit, including core material but excluding pips. This approach follows that of some European researchers, but differs from the procedure used in the industry for grading purposes (where a mid-flesh sample is taken for mature fruit analysis.)

note2

4.5 mg/100gm using our whole-fruit method approximates to 2.5 mg/100gm using the mid-flesh core sampling method of the NZ Apple & Pear Marketing Board.

¹ Assessment and reduction of bitter pit risk in apple fruit. Ferguson, IB; Watkins, CB; Volz, RK.; Hort. & Food Res Inst. of NZ; *Acta-Horticulturae* 1993, No.326, 157-164.

² Nutrient Status of Apple Orchards in Canterbury, New Zealand. Level in Soil, Leaves, and Fruit and the Prevalence of Storage Disorders. Haynes, RJ, MAF Technology, Lincoln, *Communications in Soil Science and Plant Analysis* 1990,21:11-12, 903-920.

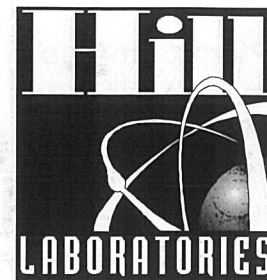
³ Relationship between Fruit Mineral Composition and Storage Life of Apples, CV. Jonagold. Marcelle, RD; Porreye, W; Deckers, T; Simon, P; Research Station of Gorseme Brede Akker, Belgium; *Acta Horticulturae* 1989, No. 258, 373-377

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Summary of Methods Used

This Technical Note is intended as a quick reference for those interested in the methods being used to analyse their soil, plant, media, NFT and feed samples. It includes the method of extraction/digestion, the measurement technique and an indication of the precision of the test. Tests that are Telarc Registered are in bold italics.

Soil Samples

SAMPLE PREPARATION			
Drying & Grinding	Air dried at 35°C for two days (residual moisture typically 4%) and crushed to pass through a 2 mm screen. Tests performed and reported on this basis.		
TEST	EXTRACTION/DIGESTION	DETERMINATION	COV
Volume Weight	None	The weight/volume ratio of dried, ground soil	2
pH	1:2 (v/v) soil:water slurry	Potentiometrically using a pH electrode	1
Phosphorus	Olsen extraction	Molybdenum Blue colorimetry	6
Extractable Cations	1M Neutral ammonium acetate extraction	Atomic absorption (Mg Ca) and atomic emission (K, Na).	4
Cation Exchange Capacity	None	Summation of extractable cations (K, Ca, Mg, Na) and the acidity determined from the change in pH of the cation extraction solution	4
Total Base Saturation	None	Calculated from Extractable Cations and Cation Exchange Capacity	4
Organic Matter	Walkley-Black oxidation	Colorimetrically. Converted from readily oxidisable C using a factor of 1.72. No correction for incomplete oxidation (approx 90%) has been applied	5
Available Nitrogen	Anaerobic incubation followed by ammonium-N extraction using 2M KCl	Berthelot colorimetry	18
Total Nitrogen	Kjeldahl digestion	Berthelot colorimetry	10
Soluble Salts (Glasshouse)	2:5 soil:saturated calcium sulphate solution extraction	Potentiometrically using a conductivity electrode	2
Soluble Salts (Field)	1:5 soil:water extraction	Potentiometrically using a conductivity electrode	2
Phosphate Retention	Equilibration with 1000 mg/L P solution	Molybdo-vanadate colorimetry	2
Reserve Magnesium	1M Hydrochloric acid extraction	Magnesium is determined by atomic absorption spectroscopy, from which the exchangeable Mg result from the Basic Test is subtracted	6
Reserve Potassium	1M Nitric acid extraction	Atomic emission spectroscopy	9
Exchangeable Aluminium	1M Potassium chloride extraction	Atomic absorption spectroscopy	8
Sulphate Sulphur	Water/anion exchange membrane extraction	ICP-OES	15
Extractable Organic Sulphur	0.02M Potassium phosphate extraction	Total extractable S is determined by ICP-OES from which the sulphate-S is subtracted	3
Resin P	Water/anion exchange membrane extraction	Molybdenum Blue colorimetry	6
Hot Water Soluble Boron	0.01M Calcium chloride extraction	Azomethine-H colorimetry	11
Trace Metals (Mn, Zn, Cu, Co)	0.05M EDTA extraction	ICP-OES	6
Trace Metals (Fe, Mn, Zn, Cu)	0.005M DTPA extraction	ICP-OES	6
Total Phosphorus	Nitric/perchloric acids digestion	Molybdenum Blue colorimetry	-
Total Selenium	Nitric/perchloric acids digestion	Hydride generation atomic absorption spectroscopy	-
Cadmium	0.1M Hydrochloric acid extraction	Atomic absorption spectroscopy	-
Ammonium-N	2M KCl extraction	Berthelot colorimetry	-
Nitrate-N	Calcium sulphate extraction	Salicylate colorimetry	-

Nutrient Solution Samples

TEST	EXTRACTION/DIGESTION	DETERMINATION	COV
pH	As received	Potentiometrically using a pH electrode	2
Conductivity Factor (CF)	As received	Potentiometrically using a conductivity electrode (25°C)	2
Nitrate-N	As received	Salicylate colorimetry	4
Phosphorus, Potassium, Sulphur, Calcium, Magnesium, Sodium, Iron, Manganese, Zinc, Copper, Boron Chloride	As received	ICP-OES	3
Ammonium-N	As received	Potentiometric titration	1
Molybdenum	As received	Berthelot colorimetry	-
Silicon	As received	ICP-MS	-
		Molybdenum Blue colorimetry	-

Plant Samples

SAMPLE PREPARATION			
Drying & Grinding	Oven dried at 65°C overnight (residual moisture typically 5%) and ground to pass through a 0.5 mm screen. Tests performed and reported on this basis.		
TEST	EXTRACTION/DIGESTION	DETERMINATION	COV
Nitrogen	Kjeldahl digestion	Berthelot colorimetry	5
Phosphorus, Potassium, Sulphur, Calcium, Magnesium, Sodium, Iron, Manganese, Zinc, Copper, Boron	Nitric/perchloric acids digestion	ICP-OES	3
Molybdenum, Cobalt	Nitric/perchloric acids digestion	ICP-MS	7
Selenium	Nitric/perchloric acids digestion	Hydride generation atomic absorption spectroscopy	8
Iodine	Double alkali dry ashing	Kinetic colorimetrically	15
Chloride	2% nitric acid extraction	Potentiometric titration	1
Nitrate-N	2% acetic acid extraction	Salicylate colorimetry or Cd reduction followed by NED colorimetry	10
Dry Matter	Weight loss on drying	Gravimetric	-
Sulphate-S	2% acetic acid extraction and carbon cleanup	ICP-OES	4
Aluminium	Nitric/perchloric acids digestion	ICP-OES	13
Fluoride	0.1M perchloric acid extraction	Potentiometrically using a Fluoride Electrode	-

Potting Media Samples

TEST	EXTRACTION/DIGESTION	DETERMINATION	COV
pH	1:1.5 (v/v) Water extraction	Potentiometrically using a pH electrode	4
Electrical Conductivity (EC)	1:1.5 (v/v) Water extraction	Potentiometrically using a conductivity electrode (25°C)	1
Nitrate-N	1:1.5 (v/v) Water extraction	Salicylate colorimetry	-
Ammonium-N	1:1.5 (v/v) Water extraction	Berthelot colorimetry	15
Phosphorus	1:1.5 (v/v) Water extraction	Molybdenum Blue colorimetry	4
Potassium, Calcium, Magnesium, Sodium	1:1.5 (v/v) Water extraction	Atomic absorption (Mg Ca) and atomic emission (K, Na)	6
Iron, Manganese, Zinc, Copper	2 mM DTPA extraction (Australian Standard 3743-1989)	Atomic absorption spectroscopy	10
Boron	2 mM DTPA extraction (Australian Standard 3743-1989)	Azomethine-H colorimetry	20
Air Filled Porosity & Water Holding Capacity	Australian Standard 3743-1989	Gravimetrically	8 & 2
Nitrogen Drawdown Index	Australian Standard 3743-1989	Salicylate colorimetry (for nitrate-N)	-

Feed Samples

SAMPLE PREPARATION			
Drying & Grinding	Oven dried at 65°C overnight (residual moisture typically 5%) and ground to pass through a 0.5 mm screen		
TEST	EXTRACTION/DIGESTION	DETERMINATION	COV
Dry Matter	Weight loss on drying overnight at 103°C	Gravimetric	-
Protein	Kjeldahl digestion	Berthelot colorimetry	5
Fibre	Modified acid detergent extraction	Gravimetrically	2
Ash	Ashing at 600°C	Gravimetrically	2
Digestibility	None	Calculation using feed table digestion coefficients	-
Metabolisable Energy	None	Calculation using feed table digestion coefficients	-
pH	Water slurry	Potentiometrically using a pH electrode	-
Ammonium-N/Total-N Ratio	Water extraction	Berthelot colorimetry. Ratio calculated using protein result	-

Fruitlet Samples

SAMPLE PREPARATION			
Drying & Grinding	Oven dried at 65°C over 3 nights (residual moisture typically 5%) and ground to pass through a 0.5 mm screen. Tests performed on a dry matter basis but reported on a fresh weight basis.		
TEST	EXTRACTION/DIGESTION	DETERMINATION	COV
Nitrogen	Kjeldahl digestion	Berthelot colorimetry	5
Phosphorus, Potassium, Sulphur, Calcium, Magnesium, Sodium, Iron, Manganese, Zinc, Copper, Boron	Nitric/perchloric acids digestion	ICP-OES	3
Dry Matter	Weight loss on drying at Sample Preparation	Gravimetric	-

Notes

- Tests in bold italics are Telarc Registered.
- The Coefficient of Variance (COV, sometimes referred to as Relative Standard Deviation) listed are typical variations and derived from the standard deviation of 20 analyses.
- For further details and explanations, please contact the laboratory.