**Factsheet 08/04**

**Carrots and Parsnips**

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# Interpretation of leaf nutrient analysis results

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**Carrot and parsnip quality and marketable yield can be affected by nutrient deficiencies. If the nutritional status is below the 'critical level' visual symptoms will be present in the field. In the absence of visual symptoms, 'subclinical' deficiencies or toxicities may be present which will reduce growth and subsequently yield.**

**The foliar application of nutrients to carrot and parsnip crops can be an effective way of tackling nutrient deficiencies diagnosed either visually or by plant analysis. Yield or quality benefits from the application of essential elements are only likely when a specific deficiency has been accurately diagnosed.**

**This factsheet aims to:**

- **Assist with the diagnosis of the most common visual deficiency symptoms**
- **Provide guidance on sampling plants so that meaningful results are obtained**
- **Provide guidance on interpreting leaf tissue analysis results**
- **Provide information on managing nutrient deficiencies**

## Visual symptoms

Visual diagnosis of nutrient disorders can be made where specific symptoms of deficiency and toxicity have been accurately described and illustrated. It is the quickest method for diagnosing the cause of poor crop performance due to mineral disorders. There are, however, several difficulties in relying solely on visual symptoms:

- Severe deficiencies are rare
- Crop disorders induced by non-nutritional factors e.g. drought, low temperatures, herbicides, some pests and diseases or even air pollutants may result in symptoms that could be mistaken for nutrient disorders
- More than one nutrient may be deficient in plants causing different symptoms from those caused by a single nutrient. Under most circumstances, reliance on diagnosis by visual symptoms alone can be misleading

# Nutrient deficiency symptoms in carrots and parsnips

The diagnosis of a nutrient disorder in the field should follow clearly definable steps:

**1** Realisation that something is wrong with the crop

**2** Observation of abnormalities, noting if these are worse on older or younger leaves; chlorosis or interveinal yellowing; marginal scorch around leaf edges, necrosis of leaf tissue; pattern of distribution; deformities such as cupping, twisting and thickening

**3** Relate a particular disorder to the circumstances e.g. soil type or pH

**4** Knowledge of susceptibility of carrots or parsnips to that disorder

**5** Consider possibility of symptoms having arisen from other causes such as drought, waterlogging, etc (as mentioned under *'Similar Symptoms'* for each nutrient)

**6** Identification of possible causes by reference to photographs

**7** If doubt remains, check diagnosis by means of leaf analysis

## Photographs of nutrient deficiencies in carrots and parsnips

Note: Not all deficiencies produce clear field symptoms. Photographs are helpful in providing a visual diagnosis, but often prove slightly ambiguous. *'A colour illustrated guide to pests, diseases and disorders of vegetables'*, a CD-ROM that contains further images and information on vegetable nutrient deficiencies and *'Carrot crop walkers guide'* are both available from HDC. If in doubt, back up with leaf analysis.

**Nitrogen (N)**

*Deficiency symptoms:*
Foliage uniformly pale green and has frail appearance due to fineness of leaflets. Oldest leaves become yellow, sometimes with red tints, and shrivel. In parsnips weak spindly growth and small roots are noticeable. Plants grow slowly and can appear stunted.

*Occurrence:*
Very common whenever insufficient N available especially on sandy soils following heavy rainfall, where excessive leaching or waterlogging has occurred.

*Similar symptoms:*
Can be caused by cold weather, drought, waterlogging and root damage e.g. free living nematodes and carrot fly.

**Nitrogen – mildly deficient carrot crop showing fine, pale foliage.**

**Nitrogen – Seven week old parsnip plants showing healthy (left) and deficient**

**Phosphorus (P)**

*Deficiency symptoms:*
Reduced growth rate. Purpling of older leaves, beginning at margin can occur. In parsnips symptoms include purple tints and spindlyness to leaves and petioles or leaves have a dull green colour. No yellowing.

*Occurrence:*
On acid soils, calcareous soils or peats. Temporary deficiencies occur on cold, wet soil. Rarely occurs because most vegetable growing soils contain good levels of plant available phosphate.

*Similar symptoms:*
Low temperatures and drought can cause similar symptoms. Also, carrot fly attack – check taproots for evidence of mining - and carrot motley dwarf virus that causes older leaves to redden or purple but younger leaves are yellow.

**Phosphorus – nine week old carrot plant showing leaf purpling**

**Potassium (K)**

*Deficiency symptoms:*
Older leaves scorch and collapse beginning at margins of leaflets. More advanced symptoms; entire petioles acquire water-soaked appearance, then dry up and collapse. In parsnips; marginal and interveinal chlorosis of older leaves leading to scorch; margins of scorched leaflets roll upwards.

*Occurrence:*
On light sandy soils with excessive leaching if K has not been applied.
*Similar symptoms:* Marginal scorch of lower leaves can be confused with chloride toxicity (see *'Toxicities'* section) and wind damage.

**Potassium – nine week old carrot plant showing complete collapse and death of old leaves**

**Magnesium (Mg)**

*Deficiency symptoms:*
Older leaves become strongly chlorotic (yellow) beginning at leaf edges. Red tints move in from the margins. Some backward curling of leaflets may occur. Bright yellowish orange colours develop at the margins of older leaves and the chlorosis extends to the main veins.

*Occurrence:*
On acid soils; on soil with very high extractable potassium/magnesium ratios, or on very sandy soils subject to leaching after heavy rainfall.

*Similar symptoms:*
Easily confused with N deficiency and carrot motley dwarf virus. Symptoms of Mg deficiency can occur as a result of restricted root growth, commonly due to soil compaction or wetness. Also frequently associated with low spring temperatures.

**Magnesium – mature healthy carrot leaf (left), ten week old leaf showing marginal chlorosis (centre) and reddening (right)**

**Magnesium – left to right: fourth, third and second leaves of 13 week old parsnip plant with chlorosis and scorched areas towards centre of leaf**

**Sulphur (S)**

*Deficiency Symptoms:*
New leaves are uniform yellow colour, and may appear frail. Parsnips leaves are also stiff and slightly concave

*Occurrence:*
S deficiency has not yet been recorded as a problem in root vegetables, but likely to occur over the next decade due to the continuing decline in sulphur dioxide emissions from industry sources and lower atmospheric sulphur deposition.

**Sulphur – nine week old carrot plant showing pale new leaves**

**Calcium (Ca)**

*Deficiency symptoms:*
Necrosis (yellowing) of growing point and new leaves. Sudden appearance of short lengths (max 15mm) of watersoaked area petioles, leading to collapse of the upper portion of leaf whilst still green. In more advanced symptoms, these leaves shrivel up.

*Occurrence:*
On acid soils following leaching rains, on soils with very high potassium levels (Index 7+), or on very dry soils. Associated with rapid growth in hot weather.

*Similar symptoms:*
Frost damage and parsnip yellow fleck virus can give similar symptoms.

**Calcium – petiole collapse in thirteen week old carrot plant**

**Manganese (Mn)**

*Deficiency symptoms:*
Whole plant, but especially young leaves, uniformly pale yellowish green and frail. Appearance in fields as patchy distribution of bright yellow areas whilst the rest of the field a reasonably normal green. For parsnips the symptom can be striking interveinal chlorosis. Symptoms are often transient and may disappear following rain.

*Occurrence:*
Frequently induced by overliming. Most severe problems occur on organic and peaty soils with a pH above 6.0. Deficiency is common but generally less severe on sands and loamy sands, particularly at pH of 6.5 and above.

*Similar symptoms:*
Differs from Mg and K deficiency in that the chlorotic areas are light green rather than yellow and in the whole plant being fairly uniformly affected.

**Manganese – mature leaves from healthy (left) and deficient carrot plants**

**Boron (B)**

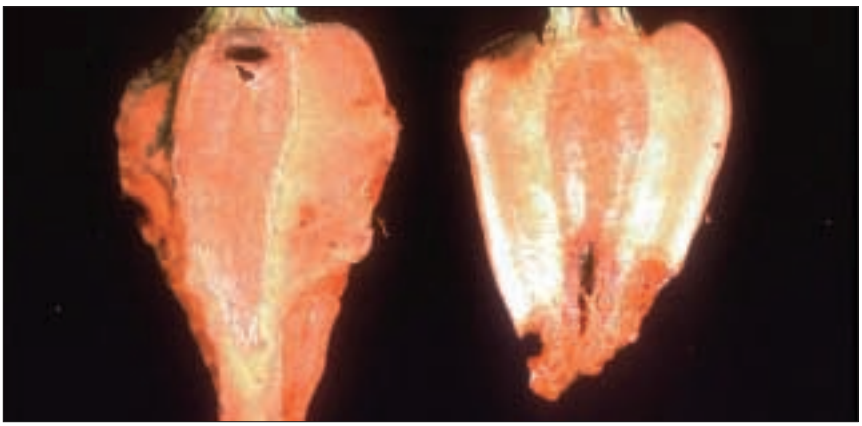
*Deficiency symptoms:*
Leaflets of young leaves are greatly reduced in size and later die back. Older leaves are chlorotic, curled backwards, giving prostrate habit, with purple edges to leaflets. Growing point may die. Corky splits may occur on leaf petioles. Roots can split, exposing central core. Dark discolouration, known as 'shadow', shown on the surface of the central carrot root as diffuse areas or tiny spots, has been demonstrated, in part at least, to be caused by boron deficiency.

In parsnips new leaves are glossy, old ones pale, sometimes with a red margin.

*Occurrence:*
Boron deficiency is more likely to occur on sands, loamy sands and sandy loams that have been limed recently rather than those which are naturally alkaline, and particularly when the soil pH is raised above pH 6.5 and more usually over pH 7.0. Since boron is water soluble and readily leached from sandy soils, deficiency is more common following a wet winter and spring, and particularly in dry summers.

**Boron – 11 week old carrot leaves showing healthy (right) and deficient (left)**

**Boron – chlorosis of older parsnip leaf**



**Boron – hollows in centre and breakdown of carrot cortex**

**Copper (Cu)**

*Deficiency symptoms:*
Youngest leaves of carrots become very dark green and fail to unfold. Older leaves appear wilted.

*Occurrence:*
Copper deficiency has only been diagnosed in a few specific soil situations but symptomless deficiency may be more widespread. It occurs on peats and occasionally on loamy peats, mainly in the Fens. Deficiency also occurs on leached sandy soils, particularly reclaimed heathland.

**Zinc (Zn)**

*Deficiency symptoms:*
Extremely rare, but if seen, leaves become yellow.

*Occurrence:*
Associated with sandy soils, that are high in pH and phosphate status (Index 7+).

**Iron (Fe)**

*Deficiency symptoms:*
Very rare in annual crops. Yellowing of the young leaves and the veins stand out green in contrast giving a herringbone appearance. Soil and plant analysis offers little help in diagnosing deficiency, as results are difficult to interpret due to the presence of other forms of iron within the tissue. Also, sample contamination of soil by leaves growing close the ground may elevate total iron results.

*Occurrence:* Occurs on chalk soils containing free lime, especially if poorly drained.

# Why analyse leaf samples?

There are two reasons for recommending the use of leaf analysis in carrot and parsnip crops:

- To confirm a diagnosis based on the appearance of symptoms: in such cases the concentrations will usually be well below the 'critical level' and there should therefore be little doubt about the diagnosis.
- To test for 'subclinical' deficiencies or toxicities which may be already limiting growth but which are not yet resulting in visible symptoms.

## Guidance on methods of crop foliage sampling for nutrient analysis

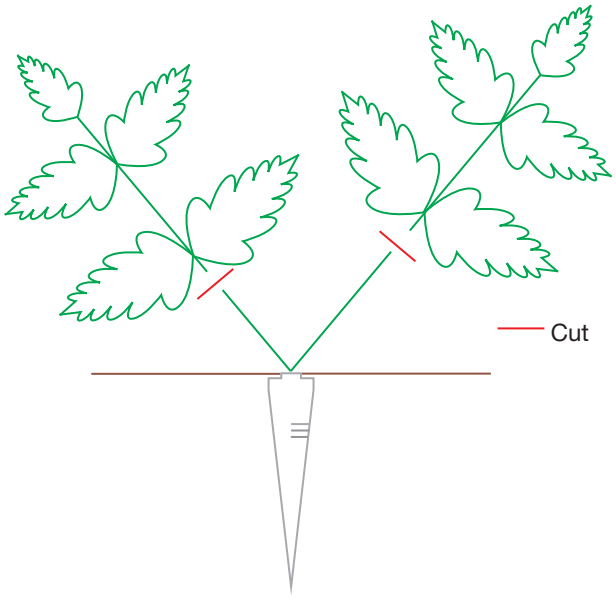
It is essential to collect leaf samples that accurately reflect the nutritional status of the crop submitted for analysis. Therefore to adequately represent any field or smaller area of crop, the following sample procedure should be followed:

- plants should be sampled at the 6 true leaf stage or when the roots are 10 + mm in diameter
- for each plant take the last fully expanded leaf
- if there is a clear differentiation between 'good' and 'poor' crop, collect a second sample of leaves from the 'good' crop
- sample at least 25 plants to provide a minimum of 250 g material
- sample the crop following a 'W' pattern, collecting leaves randomly at regular intervals
- for carrots with compound leaves discard the main petiole but include petioles of the individual leaflets in the sample
- collect leaves without any petiole for parsnips

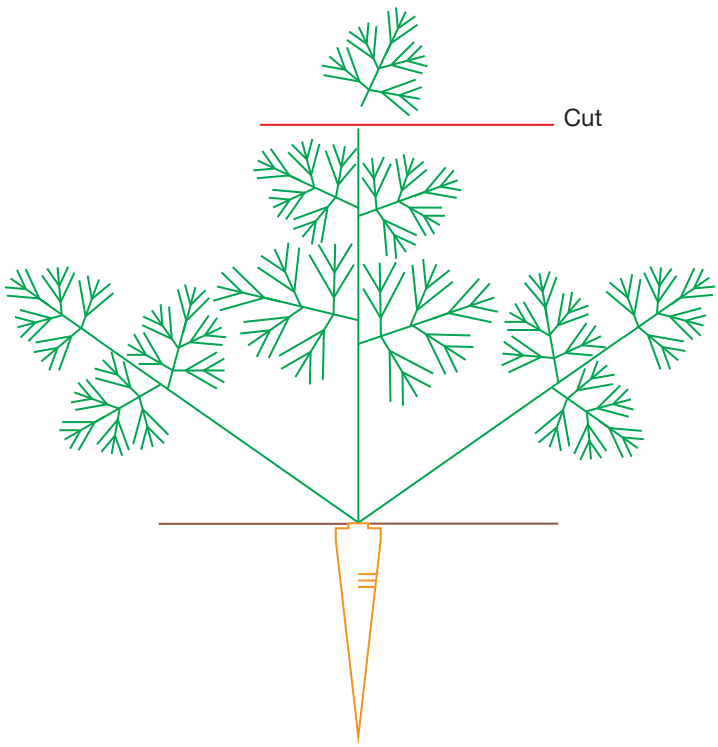
**Do not sample**

- diseased or dead plant material
- plant tissue damaged by insects and mechanical equipment
- plant tissue which has been stressed by excesses of cold, heat or moisture
- plant tissue within a week after a foliar application of nutrients or a fungicide

**Part of parsnip leaf for sampling**




**Part of carrot leaf for sampling**




**When sending samples to an analytical laboratory**

- ensure there is sufficient material (250+ g)
- avoid soil contamination
- ensure that the sample is representative of the crop/area

- include all relevant documentation and background information (sowing date, variety, field name, growers details, etc)
- pack the sample, typically in a Jiffy Bag, so it arrives in the best possible condition
- do not post fresh material in an airtight container
- label each sample clearly
- avoid sending samples before weekends and bank holidays
- send by overnight courier or deliver directly to the analytical laboratory

***Precise and meaningful analytical results are only possible when carefully selected plant material is submitted for analysis.***

## Interpretation of leaf tissue analysis results

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

## Soil nutrition

Though soil nutrition is outside the scope of this factsheet, growers are advised to consult and act upon the nutrition requirements and fertiliser management for carrot and parsnip crops in 'Fertiliser Recommendations for Agricultural and Horticultural Crops (RB208)' or the appropriate crop protocols.

Although adequate soil fertility is important, carrots and parsnips do not generally require nutrient inputs as high as for many other vegetable crops. However, carrots can be particularly susceptible to nitrogen, manganese, copper and boron deficiencies.

**Interpretation of leaf tissue analysis**

| | | Carrots | | | Parsnips |
|---|---|---|---|---|---|
| **Element** | **Unit** | **Deficient** | **Normal Range** | **Toxic** | **Normal Range** |
| Nitrogen | % | <2.0 | 2.0–4.5 | | 3.0–4.8 |
| Phosphorus | % | <0.2 | 0.2–0.5 | | 0.3–0.7 |
| Potassium | % | <2.0 | 2.5–6.0 | | 3.5–6.0 |
| Magnesium | % | <1.15 | 0.2–0.5 | | 0.4–0.8 |
| Sulphur | % | | 0.2–0.4 | | 0.4–0.5 |
| Calcium | % | <1.0 | 1.0–3.5 | | 1.2–2.0 |
| Manganese | mg/kg | <20 | 20–200 | | 30–200 |
| Boron | mg/kg | <20 | 20–60 | >150 | 25–60 |
| Copper | mg/kg | <5 | 5–25 | >20 | 6–30 |
| Zinc | mg/kg | <20 | 20–50 | >100 | 20–40 |
| Iron | mg/kg | | 50–100 | | 50–500 |
| Sodium | % | | 0.0–0.2 | | 0.0–0.2 |

# Overall strategy and specific action to rectify nutrient deficiencies identified from visual or laboratory testing

As deficiencies normally occur individually, specific treatments should be applied to the soil or crop foliage as appropriate to remedy a problem in a particular field.

All trace elements except iron can be applied as simple salts, usually as foliar sprays. These are cost effective treatments. Multi-element sprays may not contain enough of a particular element to correct a specific deficiency, and where no deficiency exists, application can be wasteful. 'Insurance' treatments are not recommended where no deficiency has been identified, but where deficiencies are known to occur prophylactic sprays may be used.

**Nitrogen (N)**
Leaf analysis is valuable for the confirmation of plant N status. Treatment is usually by addition of N fertiliser to the soil and plant response to nitrate is very rapid except when the surface soil is very dry. Foliar applications of N are sometimes used as a 'fire brigade' treatment; foliar sprays of ammonium and nitrate salts can cause leaf damage except at very low concentrations. Urea may be used but there is still a slight risk of scorch.

**Phosphorus (P)**
Most soils have adequate P supplies. For severe deficiencies in a crop a foliar spray can be used but care must be taken as leaf damage can occur, particularly on hot/sunny days and at high concentrations. Where P is deficient, application to the soil is the best treatment for subsequent crops.

**Potassium (K)**
Adequate applications of potassium fertiliser mean that K deficiency should not be seen in carrots or parsnips. Foliar feeding is not recommended because there is a high risk of leaf scorch.

**Magnesium (Mg)**
It is more effective to apply Mg to the soil than to use the 'fire brigade' approach of a foliar spray. Applications of Mg can be effective if symptoms are seen very early, on soils with a low Mg content. Although visual Mg deficiency symptoms may be very marked, the deficiency generally has only a small effect on plant growth and yield is only slightly affected.

Symptoms of Mg deficiency can occur as a result of restricted root growth, commonly due to soil compaction or wetness and frequently associated with low temperatures in the spring. Foliar sprays of 20 kg/ha magnesium sulphate (Epsom salts) plus wetter in 500 l water may accelerate recovery even when the cause of the condition is poor soil physical condition limiting root growth and nutrient uptake.

**Sulphur (S)**
S deficiency has not been diagnosed in carrots or parsnips but in the longer term there is a possibility that deficiency will occur.

**Calcium (Ca)**
Ca is a major nutrient and provided soil pH is satisfactory there should be always be a good supply to carrots or parsnips. If Ca problems occur it is generally not an absolute deficiency but rather the lack of movement of the element within the plant, due to water stress, so it is the youngest tissues which will suffer. Foliar sprays of Ca have not been found to be useful.

**Boron (B)**
Plant analysis is useful in the diagnosis of boron deficiency especially when used in conjunction with soil analysis. However soil treatment prior to sowing is preferable. If foliar sprays are required apply at an early crop stage at 5-10 kg/ha Solubor in at least 250 l water.

**Copper (Cu)**
As there is often only a slight difference in the copper content of healthy and deficient plants, plant analysis has been of much less value in diagnosis than soil analysis. The disorder can be treated by application of Cu compounds to soil using copper sulphate or to leaf using copper oxychloride or cuprous oxide at 2 kg/ha.

**Manganese (Mn)**
Plant analysis provides an accurate diagnosis and response to foliar application is usually rapid, with effective control of the symptoms and for the crop to recover and make normal growth, though some irretrievable loss of yield may occur. Apply 5 kg/ha manganese sulphate plus wetter in at least 250 l water or other proprietary sources. More than one spray may be necessary.

**Zinc (Zn)**
Leaf analysis is the most useful aid to diagnosis, but commercial incidence is extremely rare.

***Always check compatibility if mixing nutrients with agrochemicals***

## Toxicities

Manganese toxicity, particular in parsnips, can occur in acid soils especially those low in organic matter. Symptoms of manganese toxicity are darkening of leaf veins, usually on older foliage with interveinal chlorosis, leaf cupping or necrotic blotching.

Boron toxicity occasionally found as a result of application of too much B. Symptoms are marginal chlorotic band on old leaves.

Copper should not be applied to soils without a demonstrated need through soil and plant analysis. Toxic effects from over-application can last many years.

Chloride toxicity causes marginal leaf scorch, abscission and chlorosis. Usually associated with irrigating with saline water

***Foliar treatments should only be applied when an identified problem has been confirmed and when a foliage application is the preferred method. Over-application can last for years and in extreme cases lead to toxicities.***

It is not possible within this factsheet to list all the laboratories that offer leaf nutrient analysis. Growers should discuss with their agronomist or crop protection consultant.

**Acknowledgement**
Photographs courtesy of and copyright of Warwick HRI.

**Further information available from the HDC office (01732 848383).**

**August 2004**



**Design and production: HDR Visual Communication**