Micronutrients

Unlike the major and secondary nutrients N, P, K, S and Mg, which are required by crops in kg/ha amounts, micronutrients are only required in g/ha amounts.

Crop requirements for micronutrients are usually met by supply from the soil. However, they are essential to the plant and, if a deficiency is suspected, it is important to diagnose and treat accordingly.

HGCA research has shown that the most common micronutrient deficiencies limiting productivity of UK cereals and oilseed rape are:

Cereals
Copper (Cu), Manganese (Mn) and Zinc (Zn)

Oilseed rape
Boron (B), Manganese (Mn) and Molybdenum (Mo)

Availability in UK soils

Many soils contain sufficient supplies of micronutrients to achieve potential crop yields. However, the availability of these nutrients for plant uptake can be restricted by other factors, such as:

– pH (see Figure 1)
– concentration of other nutrients in the soil
– poor soil structure, which can impede root growth and nutrient uptake

For continuous arable cropping, the maximum availability of nutrients from the soil is achieved at pH 6.5 (Figure 1). To maintain an appropriate pH, test soils every 3–5 years and treat acidic soils with a liming material. On soils where acidity is known to occur, more frequent testing may be needed. As acidity can occur in patches, spot testing with a soil pH indicator across the field is often useful.

Latest information

– HGCA research has highlighted how difficult it can be to make a definitive diagnosis of a micronutrient deficiency, however, soil and tissue analysis can help.

– This Information Sheet aims to clarify the factors that increase the risk of deficiency, the use of soil and tissue analysis and treatment options.

Action

– To help prevent deficiencies occurring, improve areas of poor soil structure and maintain appropriate soil pH.

– If you suspect a deficiency, collect and analyse soil and tissue samples and act accordingly, which might mean applying a liming material rather than a fertiliser.

Figure 1. Effect of soil pH on nutrient availability for plant uptake. The thickness of the brown bar indicates the relative availability of the nutrient.
Diagnosing a deficiency

Visual symptoms are usually the first sign of a deficiency, however, they can be short-lived, easily confused and by the time symptoms appear, it can be too late to correct the deficiency.

Drought, frost and herbicide damage can also be mistaken for visual symptoms of nutrient deficiencies.

It can be difficult to make a definitive diagnosis but if a deficiency is suspected, it is important to consider:

- which nutrient deficiencies can commonly affect the crop species being grown
- the soil type, its condition and pH
- the results of soil and tissue analysis

Visual symptoms

Cereals

Manganese
Symptoms occur in new leaves which become pale and limp. This is followed by light grey flecking and stripping which occurs at the base of the youngest fully opened leaf. In time, leaves become paler and eventually become necrotic and collapse.

Copper
Pale, twisted leaves and stunted plants. Ears are sometimes trapped in the leaf sheath and those that emerge have white tips and blind grain sites. Blackening of the ears and straw occurs in copper-deficient wheat on organic chalk soils. This symptom is not seen in wheat grown on sandy or peat soils.awns of barley become white and brittle and purpling of the stem and nodes are also possible.

Zinc
Pale stripes appear parallel to the mid-point of younger leaves. Affected tissue dies and turns pale brown.

Oilseed rape

Manganese
Yellowing and mottling between veins, which remain greener. Symptoms appear first on middle leaves and spread to older leaves.

Boron
Young leaves are smaller and puckered. Margins turn down and tissue becomes brittle and is easily torn. Stems crack and flowering is poor.

Molybdenum
Reduced leaf area, pale and limp leaves.
Factors that increase the risk of micronutrient deficiencies

Micronutrient uptake can be affected by:
- the weather
- soil type, its condition and pH
- which crop is growing

- High levels of rainfall that drain through the soil profile beyond the rooting zone can raise the risk of deficiency because many nutrients can be leached. Therefore, areas with high rainfall or shallow and/or sandy soils have a greater risk of micronutrient deficiency.
- Drought may also cause deficiencies, due to reduced nutrient uptake by roots.

<table>
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<tr>
<th>Micronutrient</th>
<th>Crop</th>
<th>Soil risk factors</th>
<th>Soil analysis</th>
<th>Tissue analysis</th>
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<tr>
<td>Boron (B)</td>
<td>Oilseed rape can be affected</td>
<td>Sandy soils High organic matter pH above 7 Deficiency can be triggered by over-liming</td>
<td>Hot water extract: deficiency is more likely below 0.8 mg B/l</td>
<td>Deficiency is more likely below 20 mg B/kg</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>Cereals can be affected</td>
<td>Shallow soils over chalk with high organic matter, sandy and peat soils</td>
<td>EDTA extract: deficiency is more likely below 1.0 mg Cu/l, unless soil organic matter is above 6%, when deficiency is more likely below 2.5 mg Cu/l</td>
<td>Not reliable</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>Cereals and oilseed rape can be affected</td>
<td>Deficiency can be triggered by over-liming Any soils with pH above 7.5 Sandy soils with pH above 6.5 Organic, peaty or marshland soils with pH above 6 Under-consolidated seedbeds, low soil temperatures and low rainfall</td>
<td>Not reliable</td>
<td>Deficiency is more likely below 20 mg Mn/kg</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>Oilseed rape can be affected</td>
<td>Soils with pH below 6.5</td>
<td>Ammonium oxalate extract: deficiency is more likely below 0.1 mg Mo/l</td>
<td>Insufficient information to be able to recommend this type of analysis</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>Cereals can be affected</td>
<td>Sandy soils with high pH and phosphate status (index 5, 6 or 7)</td>
<td>EDTA extract: deficiency is more likely below 1.5 mg Zn/l</td>
<td>Deficiency is more likely below 15 mg Zn/kg</td>
</tr>
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Soil analysis

If soil analysis is carried out early in the season, liming, seed treatments, seedbed fertilisers or autumn applications of soil and foliar fertilisers are all then possible.

The soil in each field should be routinely sampled every 3–5 years; however, if a micronutrient deficiency is suspected, ensure an analysis that includes the micronutrient in question is requested, as well as an analysis of organic matter. A routine analysis will typically only provide results for phosphate, potash, magnesium and pH.

Things to remember when collecting soil samples:
- Ideally, sample immediately after the harvest of the previous crop
- Sample as long as possible after manure or fertiliser application and avoid sampling dry soil
- If areas of fields differ significantly, sample each area separately
- Clean tools before you start and before sampling a new area
- Walk a 'W' pattern across the sampling area, stopping at least 25 times

- Avoid headlands and soil close to hedges, trees or other unusual features
- At each point, sample to 15 cm depth
- Bulk the samples and send to a laboratory
- Use appropriate packaging (normally available from the laboratory) and label samples clearly, providing as much information about the field and crop as possible
Tissue analysis

If a deficiency is suspected, tissue analysis in the spring can be a useful diagnostic tool. If tissue analysis indicates a deficiency, it is still important to take soil samples after harvest, as tissue analysis only provides an indication of the nutrient status of the crop at the time the sample was taken. The soil may contain adequate amounts of the nutrient and the deficiency may simply have been caused by reduced availability, due to adverse weather conditions or inappropriate pH.

Things to remember when collecting tissue samples:

- If possible, collect samples early in the season at stem extension rather than after problems become apparent
- Samples should not be taken from crops that have recently been sprayed with any fertiliser

Avoid collecting and sending samples immediately before the weekend or a public holiday
- If areas of fields differ significantly, sample each separately
- Ensure there is no soil contamination
- Walk a ‘W’ pattern across the sampling area, stopping at least 25 times
- At each point, collect the youngest fully expanded leaf from 2–3 plants, avoiding dusty or muddy leaves
- Dry any wet leaves and immediately send to a laboratory between sheets of paper towel
- Use appropriate packaging (normally available from the laboratory) and label samples clearly, providing as much information about the field and crop as possible

Treating deficiencies

Options largely depend on when the deficiency is diagnosed. If soil analysis confirms a deficiency early in the season, liming, seed treatments, seedbed fertilisers or autumn applications are possible. If tissue analysis confirms a deficiency later in the season, treatments will be limited to foliar-applied fertilisers.

Boron: Deficiencies can be treated using soil- or foliar-applied fertilisers.

Copper: If possible, treat deficiencies using soil-applied fertilisers in the autumn. Depending on soil application rate and soil texture, Cu treatments may be effective in raising soil Cu levels for up to 10 years; regular soil analysis, every 3–5 years, is recommended thereafter. Deficiencies can also be treated using foliar-applied fertilisers at late tillering or early stem extension.

Manganese: Deficiencies can be treated using seed treatments or foliar-applied fertilisers.

Molybdenum: Use a liming material to raise the soil pH of acidic soils to 6.5. When soil pH is more than 7 and when treatment is necessary, seed treatment, or soil- or foliar-applied fertilisers can be used.

Zinc: Deficiencies can be treated using seed treatments, or soil- or foliar-applied fertilisers.

Foliar nutrients can be applied most cost-efficiently by tank-mixing with other crop inputs such as fungicides but check product labels carefully for product compatibility.

Background

This publication is based on HGCA Project Report PR518 and HGCA Research Reviews 78 and 41. Project partners were ADAS, NIAB TAG and Rothamsted Research. HGCA are also grateful to Emerald Crop Science, Frontier Agriculture, Hill Court Farm Research, Micromix Plant Health, NRM labs, Richard Austin Agriculture, SRUC, Teagasc and Yara UK Ltd for sharing data and information.

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Fertiliser Manual (RB209)
www.defra.gov.uk/rb209

Cereal growth stages – a guide for crop treatments (HGCA, 2009)
www.hgca.com/nutrientmanagement

HGCA Project Report 518: Current status of soils and responsiveness of wheat to micronutrients (HGCA, 2013)

HGCA Research Review 78: A review of non-NPKS nutrient requirements of UK cereals and oilseed rape (HGCA, 2013)

HGCA Research Review 41: Nutrients other than NPK for cereals (HGCA, 1999)

HDC Factsheet 21/05: Interpretation of brassica leaf nutrient analysis results (2005)

HDC Factsheet 08/04: Interpretation of carrot and parsnip leaf nutrient analysis results (2004)

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