# Sugar Beet Nutrition

## Introduction

Sugar beet nutrition is focused on maximising leaf growth to optimise canopy cover by mid-June and maintaining this canopy through the spring and summer. Initially the crop is focused on leaf formation and expansion which is initially driven by nitrogen and potassium uptake, with phosphorus and magnesium demand increasing as the canopy rapidly grows. Boron and manganese are also key to photosynthesis and the growth and yield of sugar beet. It is important to remember that deficiency in any one nutrient will limit yield, so all nutrients are important, not just the ones taken up in higher amounts. Always ensure soil pH is at 7 (6.5 on peat) as nutritional deficiency is highly likely where this is not the case, refer to the Soil pH and liming Fact File for more information.

This Fact File outlines the key macro and micronutrients in sugar beet agronomy and their management supported by guidance on foliar nutrient application. For detailed information on nitrogen nutrition in sugar beet see the Fact File Optimising nitrogen use in sugar beet.

### Key Points

- Remember that deficiency in any one nutrient will limit yield, so all nutrients are important, not just the ones taken up in higher amounts
- Avoid using the same assumptions each year to calculate your crop nutrient requirements, test soils regularly
- Foliar nutrition isn't a substitute for healthy soils but can aid recovery from stress
- Early growth stages of canopy development are the key target for foliar nutrient applications
- Avoid applying nutrients in high temperatures, full sun or to wilting crops

## Macronutrients

(required in greater quantities)

## Nitrogen (N)

### Needed for:

Basic component of proteins, amino acids and enzymes, cell division, chlorophyll production. Water and nitrogen are essential for leaf growth.

### Deficiency symptoms:

Pale canopy. Affects outer leaves first (wilt and die). Abnormally long petioles and erect growth habit in extreme cases. Leaf growth 2x slower (5x if also dry conditions). See photo below.

### Risk Factors:

Light soils, high rainfall, no organic inputs.

### Prevalence:

Prevalent, but often due to pests, diseases or weather.

### Crop requirements:

Sugar beet typically requires 220 kg N/ha to optimise sugar content and root yield. This doesn't all come from the bag or organic inputs – soil mineralisation makes up the N required later in the season.

For early canopy growth 50-60 kg N/ha is essential to reach 12 leaf stage.

Ideally crop should be LAI3 (Leaf Area Index) before the end of June to intercept 90% light with 120kg N/ha required at this stage.

Excess causes smaller root and larger leaves, decreasing root dry matter and less sugar will accumulate.

Calculating soil nitrogen supply (SNS) - the nitrogen provided by the soil before artificial N is applied - allows the rate of applied N to be identified and ranges from 0-120 kg N/ha.

Underestimation of SNS is common leading to costly over application of N.

See Optimising nitrogen use in sugar beet Fact File for full details on how to manage crop nitrogen requirements.

## Phosphorus (P)

### Needed for:

Structural energy transfer and nucleic acid production. Important for early root and shoot development.

### Deficiency symptoms:

Best to analyse leaf tissue or soil as hard to identify. Stunted plants sometimes darker green, poor establishment and more prevalent blackleg in severe cases. In later crops it is often driven by root damage and plants may have reddening of the leaves. See photo below.

### Risk Factors:

Low organic matter, acidic and calcareous soils, high iron levels, cold and wet soils, poorly rooted crops (even where soil levels are good).

### Prevalence:

Not common, most sugar beet soils are at index 2 or above.

### Crop requirements:

Target is Index 2 (15-20 mg P/g soil for maximum sugar yield). Often supplied by organic inputs (manure, digestate etc).

Recommendations are based on achieving and maintaining indices. Refer to RB209 as recommendations are those required to replace the offtake of the yield shown when at target and should be adjusted where yields are expected to be less or greater.

Mature sugar beet contain about 80 kg P/ha divided equally between root and shoot.

## Potassium (K)

### Needed for:

Enzyme activity, protein synthesis, $CO_2$ fixation, cell extension, osmoregulation, stomatal control, phloem transport.

### Deficiency symptoms:

Symptoms appear in older leaves first. Dull olive-green leaves, curled slightly yellow leaf edges. 'Drab disease'. Yellow areas grow and become reddish/brown. Similar to magnesium deficiency. See photo below.

### Risk Factors:

Light soils, high organic matter soils.

### Prevalence:

Not common, potassium levels are currently sufficient but future risk is high as potash applications are below levels needed to maintain indices.

### Crop requirements:

Target is Index 2- (120-180 kg K/g soil). Half the potential sugar yield lost at index 1, three quarters lost at index 0. Current phosphate, potash and magnesium recommendations are based on achieving and maintaining indices.

Refer to RB209 as recommendations are those required to replace the offtake of the yield shown when at target and should be adjusted where yields are expected to be less or greater.

Of the total arable area 65-70% receives some annual potash - insufficient to maintain soil reserves across the UK.

Mature sugar beet crops contain about 350-500 kg K/ha (two thirds in shoot and one third in root).

## Magnesium (Mg)

### Needed for:

Chlorophyll synthesis, cellular pH control, enzyme activity. Not required in large quantities.

### Deficiency symptoms:

Pale yellowing of the leaf veins towards the edge of the leaf which spreads towards the centre of the leaf. Leaf edge blackens and disintegrates (can be confused with virus yellows but leaves aren't as yellow and don't thicken and crunch). See photo below.

### Risk Factors:

Sandy and acidic soils, high potassium levels, high applied phosphorus and zinc, cold and wet conditions, moisture stress.

### Prevalence:

Prevalent, but often driven by dry conditions as three quarters of growing area is at index 2.

### Crop requirements:

Sugar beet (and potatoes) are susceptible to deficiency on soils at index 1 but other arable crops at index 0. Monitor changes in Mg and apply fertiliser when soil declines to Mg index 2 (50 mg Mg/kg soil).

Mature sugar beet crops contain 23 kg Mg/ha (three quarters of this in the shoot). Three quarters of the UK sugar beet crop is at index 2 or above.

## Calcium (Ca)

### Needed for:

Cell wall Formation/structure (pectins), osmoregulation, cell extension, membrane activity.

### Deficiency symptoms:

Inner leaves stunted. Necrotic leaf tips which curl ('tip burn'). Severe cases resemble heart rot. Vascular rings turn brown. See photo below.

### Risk Factors:

Light sandy soils, high organic matter soils, dry cold springs, cloddy seedbeds and acidic soils.

### Prevalence:

Not common, unlikely in UK.

## Sodium (Na)

### Needed for:

Cell expansion, water balance.

### Deficiency symptoms:

Same as potassium, similar to magnesium. See photo below.

### Risk Factors:

Low organic matter, acidic and calcareous soils, high iron levels, cold and wet soils, poorly rooted crops (even where soil levels are good).

### Prevalence:

Little sodium is taken up when crops have adequate potassium supply. Fen peats, silts and clays usually contain sufficient sodium and no sodium fertiliser is needed.

### Crop requirements:

Most UK sugar beet is grown on soils with potassium indices of 2 and above but also receive likely unneeded rates of Na (160-170 kg Na/ha). 200 kg $Na_2O$/ha is recommended for beet grown on soil at a potassium index 0 and 1. On potassium index 2 soils only apply 100 kg Na/ha when the soil contains less that 25 mg Na/kg.

Sugar beet is one of the few crops which can tolerate sodium and use it as an alternative osmotic solute to potassium. But the two aren't completely interchangeable.

Sodium at recommended rate has no effect on soil structure on soil of low structural stability.

## Sulphur (S)

### Needed for:

Amino acid synthesis, structural components.

### Deficiency symptoms:

Symptoms start out the same as nitrogen deficiency. Eventually heart leaves also turn yellow unlike with nitrogen deficiency. Brown spots on leaves and petioles appear in extreme cases. See photo below.

### Risk Factors:

More sensitive soils - sands, loams and shallow soils, particularly where there is no use of organic crops, are more likely to need sulphate containing fertilisers. Acid or light soils, low organic matter, poorly aerated soil, waterlogged soils.

### Prevalence:

Not common, but should be closely monitored on light soils with high yielding crops and no organic matter inputs.

### Crop requirements:

Higher rates of Sulphur (40-50 kg $SO_4$) are likely to be needed where the yield is expected to be greater than 80-90 t/ha. Consider applying 25-50 kg $SO_4$/ha depending on the likelihood of deficiency. This can be estimated by appearance/history of deficiency symptoms appearing in more sensitive crops eg oilseed rape and barley.

In well grown crops uptake is around 50-70 kg S/ha. Higher yielding crops closer to 100 kg S/ha.

## Micronutrients
(required in smaller quantities)

## Manganese (Mn)

### Needed for:

Cell division/elongation, chlorophyll production.

### Deficiency symptoms:

Typically appear in spring to August. Interveinal yellowing. Patches of very pale leaf tissue 'speckled yellows'. Develops into necrotic spots which coalesce with time. See photo below.

### Risk Factors:

High organic matter, sandy soils, high pH, after liming, fluffy seedbeds, cold and wet conditions

### Prevalence:

Prevalent, particularly in fast growing crops.

### Crop requirements:

See foliar nutrient application table on next page. Sugar beet is more sensitive than other crops.

## Copper (Cu), Iron (Fe), Molybdenum(Mo) and Zinc (Zn)

Copper deficiency is not common in sugar beet. Copper can only be used as a foliar nutrient when the crop is deficient – fungicidal use not approved.

Iron, molybdenum and zinc deficiencies are not common in UK sugar beet crops.

## Boron (B)

### Needed for:

Cell wall structure, growing points.

### Deficiency symptoms:

Brown corky patches on leaves which then turn yellow and die. Heart rot (heart leaves turn black and die). Can spread to the crown. Brown streaks in vascular tissue of the root. See photo below.

### Risk Factors:

Dry growing conditions, high pH, sandy and calcareous soils, low organic matter.

### Prevalence:

Prevalent, most often in dry years and on light soils.

### Crop requirements:

See foliar nutrient application table on next page. Sugar beet are particularly sensitive to boron deficiency as they require more than other crops.

### Quick Guide to Identifying Deficiencies

**Uniform Yellowing**: Nitrogen, Sulphur
**Stunted Greening:** Phosphorus
**Leaf Scorch:** Potassium, Sodium, Magnesium
**Growing Point Damage**: Boron, Calcium
**Yellowing with Green Veining**: Manganese, Iron, Copper, Zinc

## Foliar nutrition for sugar beet

Foliar nutrition is not a substitute for healthy soils but can aid recovery from stress. Early growth stages of canopy development (BBCH12-18) are the key target for foliar applications, and their use can be split into three key strategies based on crop risk shown in the table below.

| | |
|---|---|
| **1) Most sugar beet crops** | |
| **Manganese** | Minimum of 1-2 applications during early canopy growth from BBCH 14 repeating at 7-14 days<br><br>Target 1kg Mn/ha in normal growing conditions, 2kg Mn/ha where there is a higher likelihood of deficiency<br><br>Symptoms can be transient depending on growing conditions |
| **Magnesium** | May not be required where it has been soil applied but where there is a history of deficiency foliar application can help canopy growth<br><br>Target light sandy, more acidic soils or where crops are sitting in cold wet soils<br><br>Target 1-2 kg Mg/ha repeating at 7-10 days |
| **2) Crops on light and thin soils (especially in dry conditions)** | |
| **Manganese and Magnesium** | Apply as above (using higher rates) |
| **Boron** | Deficiency can reduce shoot growth<br><br>Target 1-2 kg B/ha especially in early growth stages BBCH14-18 |
| **Sulphur** | Target crops in dry conditions on light sandy soils with no history of organic manure application<br><br>Deficiency can result in slow pale canopy development<br><br>Target 2-3 kg S/ha from BBCH 14 onwards repeating 1-14 days |
| **Calcium** | Application of calcium at 0.5 kg Ca/ ha at BBCH14-18 in droughted conditions |
| **3) Crops with compromised canopy development due to poor seedbed conditions, herbicides, frost damage, soil pests, early disease infection etc.** | |
| **Manganese, Magnesium, Sulphur and Boron** | As above |
| **Phosphorus** | Higher risk soils are those with low organic matter, acid or calcareous soils<br><br>Phosphorous is essential for early rooting and leaf growth.<br><br>Target an application of 2 kg P/ha |
| **Nitrogen** | Where rooting is severely compromised a little and often approach of foliar nitrogen of 3-6 kg/N ha can be beneficial to support leaf growth but consider scorching risk. |

### Application of foliar nutrients on early canopies:

- Target application to actively growing crops
- Avoid high temperature and full sun where possible, higher humidity encourages leaf uptake
- Do not apply to crops wilting/prone to wilting. Target when crops are recovering and start actively growing again
- Check label compatibilities before applying as a tank mix

### Application of foliar nutrients on established canopies:

- Limited trials on use of foliar nutrients in sugar beet applied later than BBCH 35 (50% crop cover)
- Treatment of, or recovery from a specific problem may be aided but each case is specific

## Biostimulants

A Biostimulant is anything that can be added to plants or soil to stimulate natural processes to benefit the crop beyond fertilisation or pesticidal action alone. They are often be included in seed treatments.

There are numerous biostimulants available, and more research is needed to identify which are of use in sugar beet agronomy. Typical questions to ask when looking at using biostimulants are:

- Which types (the table below gives an overview of the most common)?
- When and number of applications?
- What conditions to apply?
- Pre or post stress?
- In tank mixes with herbicides/fungicides?

| Biostimulant types | Source | Claimed mode of action |
|---|---|---|
| Seaweeds | Natural extracts and manufactured | Elicitors of PGR activity (auxins, ABA, Cytokinins)<br>Rooting and stress resilience |
| Humic acids | Products of decomposition, high OM content, humic acid, fulvic acid | Growth promotion (auxins) |
| Phosphites | Manufactured with one less oxygen molecule compared to phosphate | Growth stimulation<br>Enhanced nutrient uptake (disease suppression) |
| Chitin/Chitosan | Crustacean shell by-product | Anti-microbial<br>Elicits plant defences<br>Tolerance to stress<br>Stomatal closing via ABA |
| Amino-acids | Either as free amino-acids or more complex compounds | Promotes nitrogen assimilation<br>Enzyme activity<br>Stress tolerance |
| Rhizobacteria<br>Mycorrhizal fungi | Beneficial bacterial in rhizosphere<br>Symbiotic fungal associations (beet tends to not form associations) | Improved nutrient uptake<br>PGR production to elicit response<br>Reduced pathogen infection<br>Stress tolerance |