Crop Nutrition

Key Points:

- Apply N fertiliser using the recommendations table (***below***) but making allowances for N applied in organic manures.
- N fertiliser applications should be timed to avoid impairing seedling germination and establishment (***see page 10***).
- P, K, Mg and Sodium should be applied using soil analysis results (***see below***).
- Application of P, K, Mg and Sodium fertilisers should be made pre-ploughing to minimise damage to soil structure.

Major Nutrient Recommendations (Kg/Ha)

	Soil Index	0	1	2	3	4	5
Nitrogen	Mineral soils	120	120	100	80	0	0
	Organic soils					40	0
	Peaty soils						0
P, K, Mg & Na	Phosphate (P_2O_5)	110	80	50	0		
	Potash (K_2O)	160	130	100	0		
	Magnesium (MgO)	150	75	0	0		
	Sodium (Na_2O) (using K Index)*	200	200	100	0		

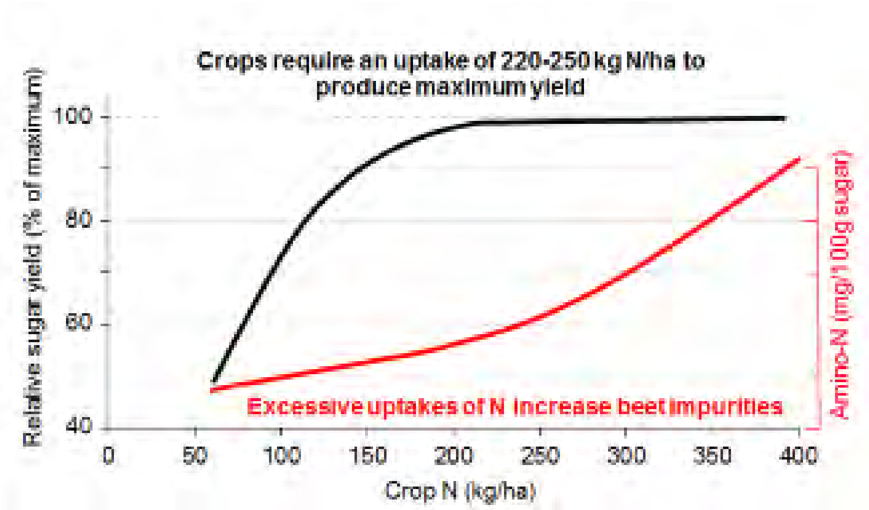
* Refer to page 12 (recommendations)

Sugar beet crops require adequate and timely supplies of nutrients to achieve maximum yields, especially during the early months of their growth.

Processes affecting the availability of nutrients in the soil and the roles and interactions between the major nutrients are shown in the Soil Management section (Page 43).

Nitrogen

Nitrogen (N) is a major component of the proteins and enzymes that drive plant growth. It is essential for the rapid development of the leaf canopy and the capture of solar radiation during the early stages of sugar beet growth.



The sugar beet crop takes up 220-250 kg N/ha to obtain maximum yield, with 30-40 kg N/ha being required by the shoot to produce each unit of leaf area index. Sufficient N is therefore required during the early stages of growth to enable shoots to acquire the 90-120 kg N/ha required to produce the three units of leaf area index needed to fully cover the soil and maximise radiation interception. Excessive or late uptakes of N do not increase yield, only beet impurities.

Apart from the applied fertiliser, three other sources of N are available to growing crops that need consideration:

1. Residual N left in the soil by the previous crop or mineralised from soil organic matter during the autumn.
2. N if applied in manures.
3. N mineralised from soil organic matter during the growth of the crop.

Recommendations
(see page 9)

The general recommendations of the RB 209 Fertiliser Manual for N fertiliser in sugar beet should be followed. A recent review of data from BBRO and earlier trials has shown no evidence to support any changes in the N recommendations. BBRO work is continuing to investigate N rates, and to identify any situations where there may be an economic response to increasing the N rate. Dr Simon Bowen represents the BBRO on the AHDB steering group, reviewing RB209 and contributing to its planned successor the AHDB Nutrient Management Guide, which is planned for release in 2017.

These recommendations take account of the residual N left by previous crops, but provision should be made for the amounts of available nitrogen that may have been previously applied in organic manures. These can be estimated using Tables in the Manual or calculated using the DEFRA Manner program (www.planet4farmers.co.uk/manner).

The application of the fertiliser N should be timed to avoid impairing germination and seedling establishment whilst ensuring that sufficient N is available to sustain rapid leaf canopy growth. This requires 30-40 kg/ha of the fertiliser N to be applied at, or soon after, drilling and the remainder - if any - at full emergence.

Potassium

Potassium (K) is the main cellular solute that allows plant tissues to regulate their water content and osmotic balance. This maintains the cellular rigidity (turgor) needed to drive the growth and control the photosynthetic activity of the leaf canopy. It also acts as an activator of the enzymes involved in the production and transport of sugars. Under some circumstances sodium (Na) may replace potassium as an osmotic solute.

Well grown sugar beet crops contain 350-500 kg K/ha, two-thirds of which is used by the shoot and one third present in the storage root at harvest. Nitrogen fertilisers are used less efficiently when K is limiting. Sugar beet crops require a concentration of 120 to 180 mg of exchangeable K/g soil to achieve maximum sugar yield. This is equivalent to a Soil Index of 2-, and almost half of the potential sugar yield is lost on soils that are at K Index 1, and three quarters on those at K Index 0.

Sugar beet is often the crop in the rotation used to adjust P and K status of the soil for the rotation as a whole, however, applying fresh K prior to sugar beet rarely increases it yields even on low K-Index soils.

Recommendations (see page 9)

These are based on the following considerations:

- On K-index 0 and 1 soils, sufficient fertiliser K is applied to replace the K removed in the harvested beet with extra being given to raise Index to 2-. This may not always be possible on very sandy soils whose clay content is insufficient to retain the added K.
- On K-Index 2 soils only the K removed in the harvested beet is replaced.
- No fertiliser K needs to be applied to soils of K-Index 3 and above.

These recommendations require the current K status of the soil to be known from soil sampling and analysis. The amounts of K removed in the harvested beet can be estimated from the tarehouse data of loads delivered to the factory – these are now available via the British Sugar's Beet Account Online (www.bsonline.co.uk). Alternatively, approximate offtakes can be calculated by using the Potash Development Association's conversion factor of 1.8 kg K_2O/t beet, but this ratio is extremely variable.

Sodium

Sugar beet is one of the few crops that tolerate **Sodium (Na)** and can use it as an alternative osmotic solute to potassium. Large amounts of agricultural salt have, therefore, been applied to UK sugar beet as a cheap alternative or addition to a potassium fertiliser for many years.

The two nutrients are not, however, completely interchangeable. Recent research has shown that sugar beet grown on soils that are low in both exchangeable K and Na respond to applied sodium. Furthermore, it has now been shown that very little of the applied sodium fertiliser is taken up when crops are adequately supplied with K.

It is, therefore, probable that agricultural salt is currently being applied in many situations where it is unlikely to benefit the crop. Recent surveys, for instance, show that much of the UK's sugar beet is grown on soils with K Indices of 2 and above but these also receive an average of 160-170 kg Na/ha which will be of little benefit.

Recommendations
(see page 9)

Sodium can partly replace Potash in the nutrition of sugar beet when soils contain too little crop available Potash. An application of 200 kg Na_2O/ha is recommended for beet grown on soils at K Index 0 and 1. On K Index 2 soils it is only necessary to apply 100 kg NA_2O/ha when the soil contains less than 25 mg Na/kg. Fen peats, silts and clays usually contain sufficient sodium and no fertiliser sodium is recommended. Sodium at the recommended rate has no adverse effect on soil structure even on soils of low structural stability.

On K index 2 soils it is only necessary to apply 100 kg Na_2O/ha when soils contain less than 25 mg Na/kg.

Crop Nutrition

Phosphorus (Phosphate)

Phosphorus (P) is essential in plants for:

- Plant cell membranes.
- Genetic material (DNA).
- Compounds involved in the capture and transfer of energy during photosynthesis.
- Enzymes involved in protein synthesis.
- Involved in the formation and transport of sugars.

Well grown sugar beet crops contain about 80 kg P/ha, distributed almost equally between the shoot and the storage root. Trials with long established differences in soil P show that the concentration required for maximum sugar yield is 15-20 mg of P/g soil (i.e. Soil P Index 2).

Recommendations
(see page 9)

Surveys suggest that over 90% of the national sugar beet area is currently at, or above, P Index 2. Most of these soils continue to receive and average of around 60 kg P/ha which is sufficient to maintain them at this level.

Magnesium

Magnesium (Mg) is the central metallic ion of chlorophyll and an essential co-factor for energy transfer, and so essential for photosynthesis and respiration.

Well grown sugar beet crops contain around 23 kg Mg/ha, almost three quarters of which is in the shoot. Trials show that crops require a minimum of 50 mg of exchangeable Mg/kg soil (Mg Index 2) to produce maximum yield.

Recommendations (see page 9)

Surveys suggest that three quarters of the current national sugar beet area is currently at, or above, Mg index 2.

Sulphur

Sulphur (S) is a structural component of enzyme proteins, the sulpholipids of cell membranes, and plant polysaccharides.

The uptake of S by well grown crops is around 50 to 70kg S/ha and those of a high yielding crop closer to 100 kg S/ha. Crops may suffer from sulphur deficiency especially higher yielding crops grown on sensitive soils (sands, sandy loams and shallow soils) and where there is no routine use of organic manures in the rotation. Where deficiency is possible, previous trials of 10kg S/ha (25kg SO_3) was as effective as higher rates. Higher rates of sulphur (40-50 kg SO_3) are likely to be needed where the yield is expected be greater than 80-90t/ha. A new programme of BBRO trials is currently assessing this.

Recommendations

Sulphate-containing fertilisers only need be applied if deficiency symptoms consistently appear in other, more sensitive crops within the rotation, such as oilseed rape and barley.

Crop Nutrition

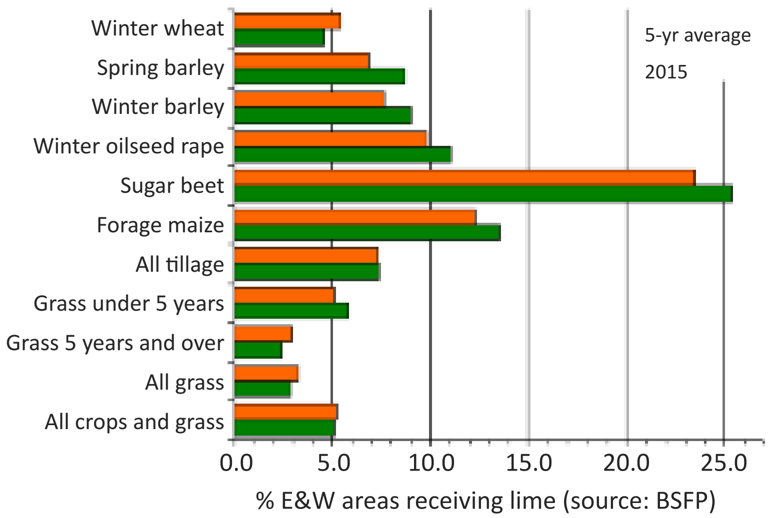
Lime and pH

Key Points:

- Lime is required to correct soil pH to maximise yield of sugar beet (and many other crops).
- Mild yield effects can be seen on mineral soils below pH 6.5.
- Serious effects of soil acidity occur on the soils below pH 6.0.
- It is risky to rely on a composite soil sample pH result as few soils are truly uniform for pH.
- Calcium is a major nutrient - a 70t/ha crop contains over 100kg of calcium.
- Liming on many soils is an essential rotational investment.
- Low pH limits the availability of essential nutrients (depressing yield).
- Select a liming product that is both reactive and long lasting.
- Apply in good time to allow thorough mixing into the top 20cm.

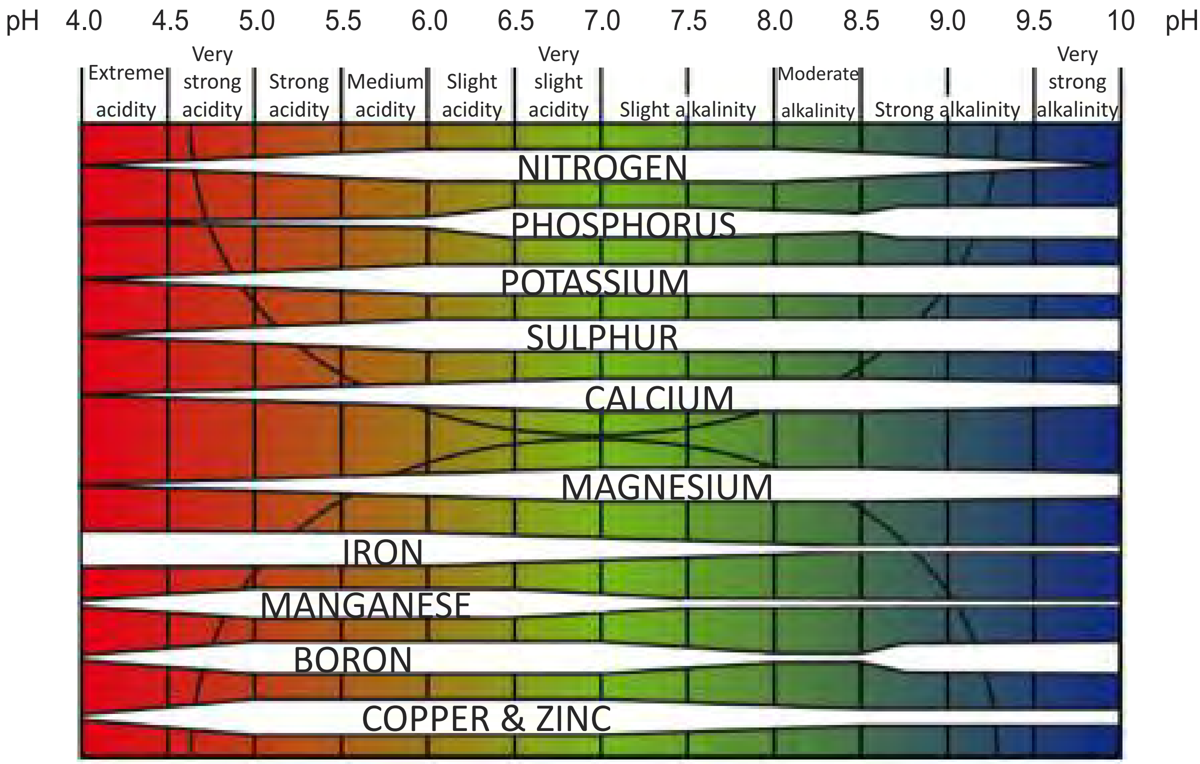
Current crop situation

The British Survey of Fertiliser Practice illustrates that c.25% sugar beet land is limed ahead of cropping. This will provide rotational liming benefit to other pH sensitive crops, such as barley, brassicas and maize – however, all crops will benefit.



Role of liming

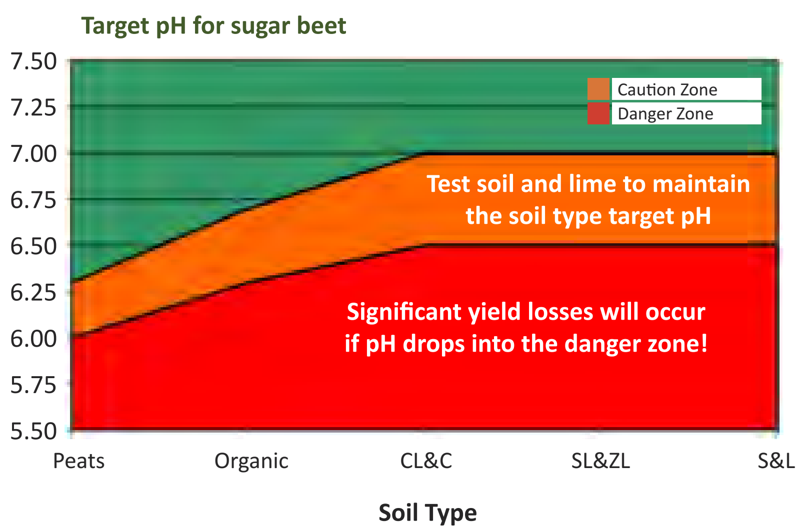
The correct soil pH is a fundamental requirement for the availability of macro and micro nutrients, and will significantly influence the efficient utilisation of nutrients applied from fertilisers and organic manures/materials:



Soil type and optimum pH range

A managed soil pH programme should ensure the most pH sensitive crops are protected from risk of yield loss due to i) low pH and ii) compromised nutrient availability; and, therefore, the following guide identifies the green and amber pH ranges by soil type. Lower optimum pHs are required on the organic and peat soils in response to their unique Cation Exchange Capacity (CEC).

Neglecting soil pH will only lead to consequential yield loss across the rotation.



Product selection

Choose a fine product that will be reactive and correct pH more rapidly.

Finely ground products (>40% passing 0.15mm) are preferable.

Most good limestone and chalk products (calcium carbonate) should offer this level of fineness (or reactivity) in combination with c.50% neutralising value (NV) compared to pure CaO equivalent (calcium oxide).

LimeX is an extremely fine precipitate of calcium carbonate with >85% passing 0.15mm and a minimum NV of 25% CaO. This offers very rapid and lasting pH correction as a direct function of surface area. This also contains P_2O_5, MgO and SO_3 to support least cost crop production when applied overall for pH management and calcium supply.

Avoid coarse, hard materials as particles >1.3mm may offer no liming value in practice.

Therefore, request a product specification, and have confidence in what you are buying:

- Neutralising value
- Percent passing through 0.15mm

Timing of application

Ideally lime products should be applied 12-18 months before pH sensitive crops to ensure thorough incorporation of the liming product with the soil. However, finer, more reactive products such as LimeX or ground chalk and limestone products with >40% passing 0.15mm can be applied successfully in the autumn before cropping with sugar beet.

Rate of application

If primary cultivations are deeper than 20cm, application rates should be increased pro-rata to avoid dilution and hence a reduced efficiency of the pH increase.

Generic application rate tables can be found at aglime.org.uk assuming a 54%NV product with 40% passing 0.15mm.

For LimeX70, please use the following guide:

Soil Type	Arable 20cm depth t/ha (t/ac)	Grassland 15cm depth t/ha (t/ac)
Sands	6.0(2.5)	5.0(2.0)
Light	7.0(3.0)	5.0(2.0)
Medium and Clay	8.0(3.3)	6.0(2.5)
Organic	10.0(4.0)	7.0(3.0)
Peat and Peaty	16.0(6.5)	7.0(3.0)

Information on LimeX45 can be found at **limex.co.uk**

Additional benefits

LimeX products also contain valuable nutrients and when applied overall can be taken into account within the nutrient management plan (NMP):

Minimum nutrient content kg/t

Element	LimeX70	LimeX45
P_2O_5	10	7
MgO	7	5
SO_3	6	4

Soil Testing

Soil pH testing and mapping

Ideally fields should be grid sampled to show the range of ‘as found’ soil pH. Sampling on a 60m x 60m grid will provide 2.5 samples/ha (1/ac) from which an objective decision to lime, or not, can be determined.