Sugar Beet Nutrition

Optimising nitrogen use

Introduction

Optimising nitrogen inputs plays a key role in improving sugar beet resilience and maximising crop profitability. By understanding the crop's fundamental nitrogen requirements and how different forms of nitrogen influence growth and yield, growers can develop a more precise and effective nutrient management strategy.

What does nitrogen do?

Nitrogen is a key nutrient in plant growth as it is a major component of chlorophyll driving photosynthesis and growth. It is also a major component of amino acids which are the building blocks of proteins and enzymes, giving the plant structure and driving chemical processes. It is an essential component for leaf growth.

Why is nitrogen important in sugar beet?

Sugar beet needs to reach a leaf area index of 3 (3m^2 of leaf over a 1m^2 area) by mid-June to optimise light interception to drive maximum growth and ultimately yield. Canopy expansion is driven by temperature and nitrogen availability, making the control of nitrogen a key part of sugar beet agronomy.

Key Points

Early application of nitrogen is essential for sugar beet growth

Later applied nitrogen will lead to increased canopy but will likely reduce the root size

Assess potential levels of nitrogen before drilling, taking into consideration applied manures, cover crops and previous cropping.

High levels of Amino nitrogen impurities and low sugars can be an indications of excessive N application

Deficiency symptoms:

The canopy can appear pale, with the outer leaves being the first to wilt and die, in extreme cases you will also see abnormally long petioles and erect growth habit. Leaf growth will 2x slower (5x if also dry conditions). See photo below.

Risk Factors:

Nitrogen deficiency is not always caused by low nitrogen in the soil. It can also result from leaching and high rainfall, light soils and poor retention, limited organic inputs or damaged roots due to pests and diseases.

Optimum N requirement:

Sugar beet typically requires 220kg 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 for later in the season.

Plants take up nitrogen mainly as nitrate and ammonium. Soil microbes convert organic nitrogen into these available forms through mineralisation and nitrification, with supply influenced by organic matter levels, temperature, moisture, oxygen, and the carbon:nitrogen ratio.

In soils with few organic inputs crop nitrogen requirements can be estimated from soil type, rainfall, and previous cropping, as used in the RB209 field assessment method. However, more complex rotations with inputs such as digestate and cover crops make nitrogen supply harder to predict.

What are the key factors to consider?

Table 1 (below) outlines the key factors to consider when looking at nitrogen applications in an arable rotation.

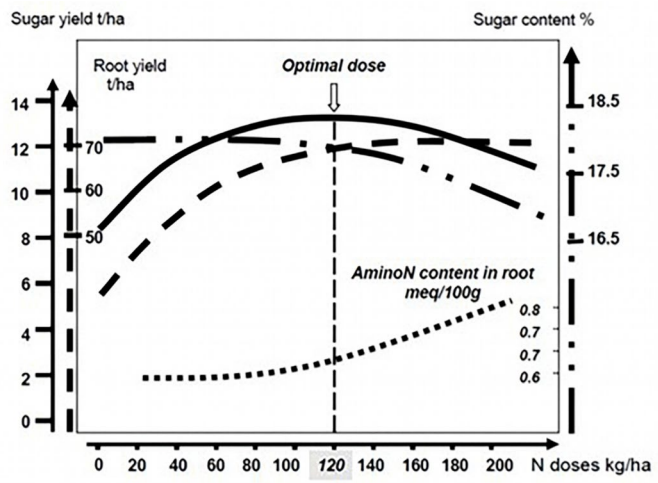
Factor	Relevance
pH	Sugar beet is pH sensitive, preferring soils of circa pH7. Because soil pH can very widely within a field, targeted sampling problem areas will provide more accurate results.
Soil type/ texture	Lighter soils retain fewer nutrients and will have lower levels of available and potentially mineralisable nitrogen.
Soil organic matter	Higher organic matter levels will equate to higher nutrient levels, as well as more potential N mineralisation.
Organic inputs	Organic inputs are highly variable in nutrient content and C:N ratio, so need to be carefully considered. They can also build soil organic matter leading to increased nitrogen levels in the soil.
Rainfall	High rainfall can cause nitrogen to be leached from the soil. Dry conditions can also reduce the amount of nitrogen available for uptake in the forms plants need.
Cover crops	Cover crops can contribute available nitrogen to the following crop, but research shows this can be 35kg/ha (NiCCs, ADAS 2024) depending on mix, type of destruction and the weather. They should be considered when looking at N application rates.

What about excess nitrogen?

Excessive nitrogen has a negative effect on sugar beet yield because it:

- Reduces the proportion of the crop's dry matter partitioned to the storage root due to excessive canopy growth
- Decreases the proportion of storage root dry matter that accumulates as sugar
- Increases impurities which suppress sugar levels.

The figure below shows this relationship (Sugar Beet, Draycott 2006). Above the optimal N dose level, in this example 120 kg/N applied, the root yield and sugar content decrease whilst the amino nitrogen impurities increase.



Testing across field or manure heaps before application can be very beneficial as nutrient content can vary widely.

N rate calculations: RB209 field assessment method

Step 1. Identify the soil category for the field

Step 2. Identify the previous crop

Step 3. Select the rainfall range for the field

Step 4. Identify the provisional SNS Index using the appropriate table (example of low rainfall table shown opposite)

Step 5. Make any necessary adjustments to the SNS Index – manures, cover crops, vegetables

This last step is when it becomes more open to interpretation. Although standard values can be found it is more accurate to measure any other inputs. Send manures for testing to get an accurate nutrient value. Cover crop biomass can be sampled for N content but this doesn't always correlate with the N which will be available to the following crop so previous experience may be the best steer. You can also consider the RB209 field measurement method which is outlined right.

Step 6. Identify N application rate from crop relevant table (Sugar Beet Table 2 below)

Soil category	N recommendation (kg N/ha)				
	SNS Index				
	0 and 1	2	3	4	5
All mineral soils	120	100	80	0	0
Organic soils	-	-	-	40	0
Peaty soils	-	-	-	-	0

N rate calculations: RB209 field measurement method

Step 1. Measure soil mineral nitrogen (SMN)
When sampling for SMN it is best to take the time to do it properly or the results you get are not accurate enough to be useful.

Step 2. Estimate nitrogen already in the crop
In beet the estimate for N already in the crop is 0 as plants will not have yet emerged or will be very small.

Step 3. Make an adjustment for net mineralisable nitrogen
As a crude guide, around 10 kg/ha more SNS may be expected for each 1% increase in soil organic matter above 4% in England and Wales or above 10% in Scotland and Northern Ireland. Where soil organic matter is less than this, mineralisation has generally been ignored until now. There are N-min tests available that can measure this more accurately.

Step 4. Identify soil nitrogen supply (SNS) Index from the RB209 table (Table 3 below)

Step 5. Identify N application rate from crop relevant, (Table 2 - left).

SNS	
Less than 60	0
61-80	1
81-100	2
101-120	3
121-160	4
161-240	5
More than 240	6

Previous crop	Soil category					
	Light sand soils or shallow soils over sandstone	Medium or shallow soils not over sandstone	Deep clayey soils	Deep silty soils	Organic soils	Peat soils
Beans	1	2	3	3	All crops in SNS Index 3,4,5 or 6. Consult a FACTS Qualified Adviser	All crops in SNS Index 4,5 or 6. Consult a FACTS Qualified Adviser
Cereals	0	1	2	2		
Forage (cut)	0	1	2	2		
Oilseed rape	1	2	3	3		
Peas	1	2	3	3		
Potatoes	1	2	3	3		
Sugar beet	1	1	2	2		
Uncropped land	1	2	3	3		
Vegetables (med N)	0	1	2	2		
Vegetables (high N)	2	4	4	4		

Table 4 SNS Indices for low rainfall (500-600mm annual rainfall, up to 150mm excess winter rainfall) based on the last crop grown. (See ssessment method step 2. Index may need to be increased by up to 1 where significantly larger amounts of leafy residues are incorporated (Step 5). Where there is uncertainty, soil sampling for soil mineral nitrogen (SMN) may be appropriate.

Why are there 2 methods?

The field assessment method provides more of an overview of likely N rates. The field measurement method is more accurate but also time intensive and costly as it requires sampling SMN, however this will ensure money is not wasted on excessive N application. To be used when field have a history of:

- Cover crops
- Organic manure or vegetable crops
- Long leys or pasture (not 1st year after)
- Previous crop issues
- Significant variation in soil texture and/or history of lots of crop residues
- Following outdoor pigs

Product choice

Most growers will already be equipped to apply either liquid or granular fertiliser, both of which are suitable for sugar beet production. The primary consideration should be achieving the correct nitrogen application rate, as accuracy of nitrogen supply is more critical than fertiliser form. Product selection may also incorporate additional nutrients where soil analysis or crop requirement indicate a need.

When broadcasting granular nitrogen ensure the machinery and rate has been properly calculated.

Placement fertiliser benefits

Typically, around 40-60 kg N/ha is applied at drilling, with the remaining nitrogen applied at crop emergence. Yield responses are generally greater in dry springs or dry seedbed conditions, when soil mineralisation is lower. Strip trials have shown that nitrogen application rates can be reduced by 10-15% without any adverse effects on yield (BBRO 2017). In addition, placing phosphate with nitrogen, such as using DAP, can aid early crop growth, although further research is needed to fully quantify this effect.

Cover crops

Cover crops can play an important role in overall N availability. Measuring N content biomass can be useful to decide on whether to reduce applied N in the spring.

Please see Cover Crop Fact File for guidance on the use of cover crops.

Legal considerations

Ensure you are abiding by all the relevant legislation when applying fertiliser or organic inputs and are not applying more than the legal maximum.

Soil sampling for SMN analysis

Considerations

- Sample in late winter or early spring, especially in high rainfall areas or in shallow or light soils
- Avoid sampling within two to three months after the application of nitrogen fertiliser or organic manures
- Don't sample unrepresentative areas, such as past manure heaps or headlands
- Samples must be taken to be representative of the area sampled, consider different management history, soil types, previous crop issues etc.

Sampling protocol

- A minimum of 10-15 soil cores should be taken following a 'W' pattern across each field/area to be sampled
- In larger fields (10-20 ha), increase the number of cores to 15-20
- Each position should be sampled at three depths in the spring: 0-30cm and 60-90cm. Sampling to 60cm is adequate in the autumn
- In stoney soils sampling to 90cm may not be possible, go as deep as possible
- Samples from each depth should be bulked to form a representative sample of that depth
- Use appropriately labelled plastic sample bags
- Samples must be kept cool (2-4^{O}C) but not frozen during storage or transport.

Calculating SNS from the lab results

- Samples should be analysed for nitrate-N and ammonium-N
- Analytical results in mg N/kg should be converted to kg/ha, taking into account the dry bulk density of the soil and then summed to give a value for the whole soil profile
- For the majority of mineral soils, a 'standard' bulk density of 1.33 g/ml can be used, and the calculation can be simplified to:

SMN (kg N/ha) = mg N/kg x 2 (for each 15cm layer of soil)

SMN (kg N/ha) = mg N/kg x 4 (for each 30cm layer of soil)

SMN (kg N/ha) = mg N/kg x 8 (for each 60cm layer of soil)

} Add these 3 sums together to get the SNS in kg N/ha

Using an auger (image right) to soil sample will ensure the right depths are sampled.