BBRO

Optimising nitrogen use in sugar beet

by Dr Georgina Barratt

This guide is designed to help you review your nitrogen applications and tailor them to ensure you are optimising nitrogen inputs for maximum profitability from your sugar beet crop. It also covers some of the basics which are often overlooked and worth revisiting.

This guide focuses on nitrogen, but all macro and micronutrients need to be sufficiently available to the sugar beet crop to ensure the crop is healthy and yields well.

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.

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, because we have some control of nitrogen availability it is a key part of sugar beet agronomy.

What does deficiency look like in beet?

- Slow canopy development
- Pale canopy which will turn yellow

Note: As shown below some varieties are inherently paler than others which shouldbe considered when deciding if beet is N deficient

- Outer leaves are affected first which will wilt and die in time
- Abnormally long petioles and erect growth habit in extreme cases, unlikely in the UK

Pests and diseases which damage roots can also lead to N deficiency as the damage prevents them from uptaking N, rather than insufficient N being available.

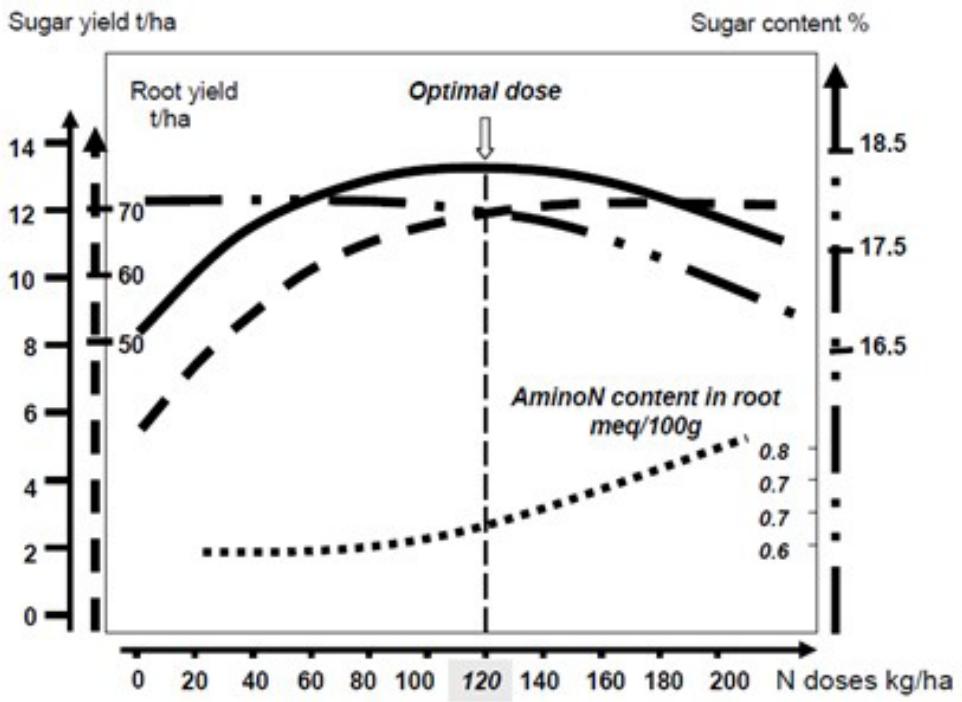
What about excess Nitrogen?

Photo:Beet on left shows impact of high nitrogen

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

- Decreases the proportion of the crop's dry matter that is partitioned to the storage root due to excessive canopy growth
- Decreases proportion of storage root dry matter that accumulates as sugar
- Increase in impurities which suppresses sugar levels

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



What is the N requirement for maximum sugar beet yields?

- 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.

Plants uptake nitrogen primarily in the forms of nitrate and ammonium ions. In the soil, microbes break down organic matter containing nitrogen into these plant available forms through mineralisation and nitrification. The level on N that is made available through the growing season is driven by the amount of organic matter, soil temperature, moisture, oxygen availability and the carbon:nitrogen ratio.

In soils with minimal organic matter inputs, and cover crop use, soil texture, rainfall and previous cropping can give a good idea of the amount on N required by the crop, this is how the RB209 field assessment method works. However, as arable rotations become more complex with the addition of different organic inputs such as digestate and cover crops the level of mineralisation in soils is harder to predict and soil sampling will give a more accurate measure to calculate applied N requirements.

The table below outlines key factors to consider when looking at nitrogen applications in an arrble rotation.

Factor	Relevance
pH	Sugar beet is a pH sensitive crop, a pH of 7 is optimal pH can be highly variable across a field so sampling areas with previous suspected issues can be beneficial rather than one mixed sample for the whole field
Soil type/texture	Lighter soils hold less nutrients and will have lower available and potentially mineralizable nitrogen levels
Soil organic matter	Higher organic matter levels will equate to higher nutrient levels, as well as more potential N mineralisation
Organic inputs (manures, digestate, sewage sludge etc.)	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 which can lead 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.

Testing manure heaps can be very beneficial as nutrient content can vary widely

N rate calculations

A FACTS qualified advisor will be able to calculate N application rates, but it is valuable to understand the basics and when a more detailed assessment may be beneficial.

How do I undertake the 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 (shown below for a low rainfall area)
- 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 follow crop so previous experience may be the best steer. You can also consider the RB209 measurement method which is outlined overleaf (Table 1)
- Step 6. Identify N application rate from crop relevant table, the sugar beet table is shown overleaf (Table 2)

Table 1 SNS Indices for low rainfall (500-600 mm annual rainfall, up to 150 mm excess winter rainfall) based on the last crop grown.

Previous crop	Soil category					
	Light sand soils or shallow soils over sandstone	Medium soils 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 Qualiifed Adviser	All crops in SNS Index 4,5,or 6. Consult a FACTS Qualiifed Adviser
Cereals	0	1	2	2		
Forage crops (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 (medium N)[a]	0	1	2	2		
Vegetables (high N)[a]	2	4[b]	4[b]	4[b]		

a. Refer to Step 2
b. Index may need to be increased by up to 1 where signigicantly larger amounts of leafy residues are incorporated (Step 5). Where there is uncertainty, soil sampling for soil mineral nitrogen (SMN) may be appropriate.

Table 2 Nitrogen for sugar beet

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

How do I undertake the RB209 field measurement method?

This method is more 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 – excess lodging or crop failure
- Significant variation in soil texture and/or history of lots of crop residues
- Following outdoor pigs

- 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. The last page in this guide has a detailed description of how to sample for SMN accurately. Step 3. Select the rainfall range for the field

- 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)

- Step 5. Identify N application rate from crop relevant table as shown in the field assessment section previously.

Table 3 SNS Index

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

Measuring N content in cover crop biomass can be useful to decide on whether to reduce applied N in the spring

What should I consider when applying N?

Product choice

You will likely already be set up to use liquid and/or solid fertiliser. Either work well for beet and correct nitrogen rates are more important. You may choose a product with other nutrients in it depending on your requirements.

Legal considerations

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

Broadcast fertilizer being applied, ensure machinery is calibrated

Liquid placement fertiliser kit being used ahead of sugar beet, this is often beneficial to the crop

What about placement fertiliser, are there any benefits?

- Typically, placement of 40-60 kg N/ha is placed at drilling, the remainder being applied at emergence
- Yield responses tend to be greater in dry springs/seedbeds when soil mineralisation is lower
- Strip trials have shown that rates can be reduced by 10-15% with no adverse effects on yield (BBRO, 2017)
- Placing Phosphate with Nitrogen (DAP) can aid growth but more research needed to quantify this

How do I know if I have optimised my nitrogen fertiliser application?

Yield will be the ultimate measure of whether you got you nitrogen application rates correct, also consider your margins. Amino nitrogen impurities and low sugars can be a good indicator of excessive N application. Under application of N will be evident from low root yields. However, for both of these observations it may be other factors having an effect such as the weather, drought or poor light levels, and/or pests and diseases. Ensure all factors are considered before concluding if you got it right.

Guidance on how to collect and prepare a soil sample for SMN analysis and calculate SNS:

Considerations

- Sample in late winter or early spring, especially in high rainfall areas or on 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 ex-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: 0–30 cm, 30–60 cm and 60–90 cm. Sampling to 60 cm 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˚C) but not frozen during storage or transport
- Avoid collecting and sending samples immediately before the weekend or a public holiday

Using an auger to soil sample will ensure the right depths are sampled

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 15 cm layer of soil)

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

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

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

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