Dr Simon Bowen
Head of Knowledge Exchange, BBRO

Nitrogen rates

Your questions and our thoughts, ahead of 2023

In response to the massive increase in fertiliser prices, last autumn BBRO re-evaluated the yield response curve of sugar beet to nitrogen to understand how the higher fertiliser prices effected the economic break- even point. One of the key conclusions was that due to the very shallow yield response between 90 and 120 kg N/ha, there was no cost-benefit from applying nitrogen at the higher rate.

In fact, the economic optimum was nearer 75kg N/ha where the fertiliser price was more than £500/t but this was considered too low for the crop and the advice for 2022 was to consider reducing the rate of 120 kgN/ha by 20-25%. It was suggested that on very light soils with lower soil nitrogen reserves, any reductions should be more conservative and soil mineral nitrogen testing may help decide by how much to reduce the rate. There was also a reminder of some of the key actions that can be taken to help ensure we can keep the use of inorganic nitrogen fertiliser sources to a minimum.

This article reviews this situation and answers some of the frequently asked questions we have received and, of course with the new beet prices in place, our updated advice for the 2023 crop.

Did growers reduce their nitrogen rates in 2022 and have there been any impacts on the crop to date?

Whilst we have no comprehensive data on this yet, the general consensus from growers attending various BBRO events this season is that many did reduce their nitrogen applications, typically from 120 kg N/ha to 100 kg N /ha.

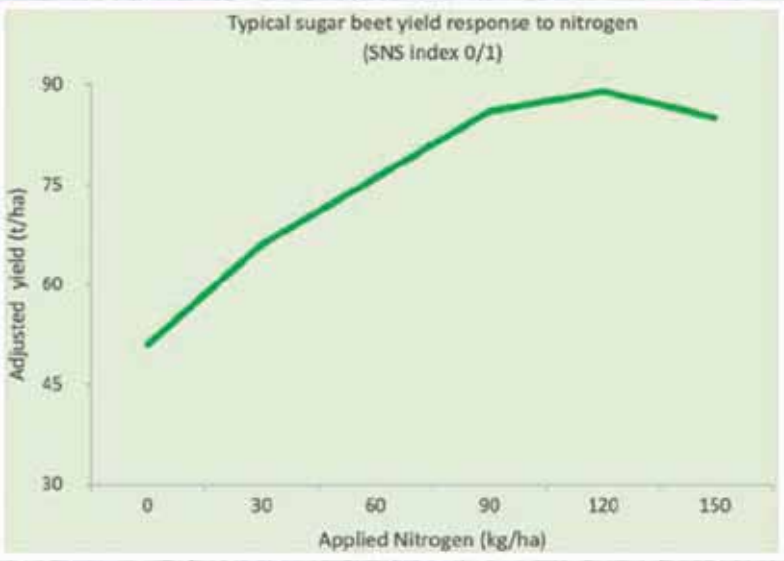
Fig. 1. Granular nitrogen

To date, we have had no reports of any detrimental impacts on canopy development. We will only be able assess any impact on yield once the harvest campaign is complete.

BBRO took the opportunity on a couple of its demo farms to do strip trial comparisons of reduced nitrogen versus the standard rate. Figure 2 was taken on our Norfolk demo farm in July and shows very similar canopy development across the two rates of nitrogen. The new National Crop Survey data will be available later in the season when yields are recorded to analyse this in more detail.

Fig. 2. In field comparison of two nitrogen rates (120 & 100 kgN/ha to left and right of cane in crop respectively). Photo taken in Norfolk in July 2022

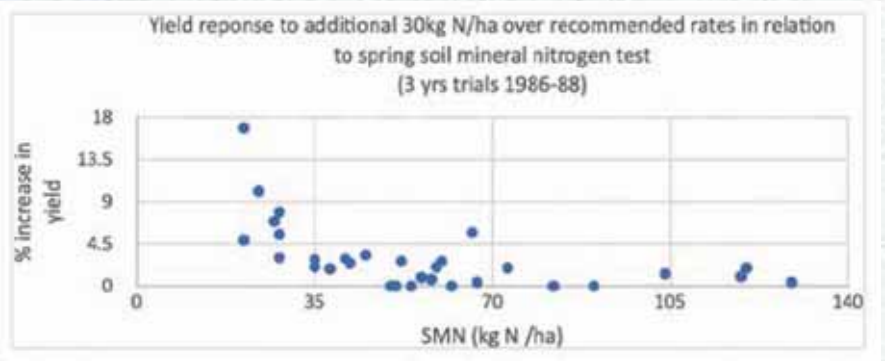
Fig. 3. Typical sugar beet yield response curve to increasing amounts of applied nitrogen and a reminder of the shallow reponse above 100 kgN/ha



Is the reduced rate recommendation too low for very light soils ?

In these situations, we recognise that some crops require more nitrogen and may be more responsive. The graph below, albeit using some old data, demonstrates that the amount of soil nitrogen (SMN) declines the likelihood of a response to an additional 30kg N/ha increase. This is clearly the case for soils with less than 40 kgN/ha which is fairly typical of light sandy loam, loamy sands and sand soil types. This is why we suggest being more conservative with reductions or perhaps using a SMN test in the spring to help you decide on how much to applied nitrogen could be cut back.

Fig. 4. Typical sugar beet yield response curve to increasing amounts of applied nitrogen and a reminder of the shallow reponse above 100 kgN/ha



Will crops destined for later harvesting 'run-out' of nitrogen where lower rates were applied?

It's important to remember that the main nitrogen requirement of the beet crop is for rapid leaf growth and to build a full canopy. Crops grown on mineral soils typically contain around 230-250 kg N/ha at harvest, most of which is taken up during early growth with less than one-fifth in the autumn. The crop is also able to take advantage of the mineralisation of nitrogen in the soil as the season progresses, especially in warm and moist soil conditions. Rates of mineralisation on average are 0.4 kg N/ha/day in mineral soils and close to 1.0 kg N/ha/day in organic soils. It is therefore unlikely that crops will be nitrogen deficient later in the season where rates have been reduced. Trials by Malnou et al. (2008) have shown that when an additional 60kg N/ha was applied in July, the late application increased foliage dry weight at harvest but failed to have a positive effect on sugar yield

Fig. 6. The effect of additional nitrogen (40 kg/ha) applied in July (three plants on the right) in BBRO demonstration plots in 2017. Note the greater top growth but little effect on root size.

	Effect on sugar yield (t/ha)	
	No late N	+ 60 kg/ha late N
N zero	12.0	12.6
N 80 kgN/ha	13.5	13.3
N 160 kgN/ha	13.9	12.8

Fig. 5. The effect of late nitrogen application (July) on sugar yield (Malnou *et al.*, 2008)

Will the lower rate of applied nitrogen and drought conditions in July result in greater nitrogen deficiency later in the season ?

If the canopy is well established at the point of the drought period, it is unlikley this would cause any future deficiency. During the drought period, plant growth and the requirement for nitrogen will be reduced and therefore N-uptake will be less. When the soil re-wets, it has been shown that mineralisation can restart and nitrogen released from the soil within 24 hours. Sufficient nitrogen should be available to the crop at this stage.

However, if there is significant leaf loss due to the drought and hot conditions, nitrogen will be key to drive any re-growth. Part of this requirement will be met from increasing uptake from the soil and part from remobilisation of nitrogen within the plant, especially in older, unproductive leaves. It is unlikely the lower rate of applied nitrogen will effect this process significantly.

How reliable and useful are soil mineral nitrogen (SMN) tests?

SMN test can give variable results. This can depend on the accuracy of sampling and of course the soil. SMN tests are not recommended on peat soils (due to high net mineralisation), established grassland or in the first year after grassland is ploughed, or within 3 months of organic manure applications.

SMN results are a reasonable guide to the amount of available nitrogen present in the soil at the time of testing, but it is widely acknowledged that mineralisation of organic matter can make a significant contribution to the SMN, and it is likely that this accounts for most of the variation in optimum applied nitrogen dose that cannot be explained by SMN status.

Current guidelines suggest that net mineralisation should be small in mineral soils of low or average organic matter content, but research has not always supported this. Various methods, including incubation, modelling, and chemical analysis, have been explored as a means of determining Potentially Available Nitrogen, but no single approach has universal support.

The accuracy level for SMN tests has been reported to be within 10-20% of the total, on 70-80% of occasions.

This said, using a SMN test gives a broad guide as to how much available soil N is present and can be useful in the context of deciding how much to cut your nitrogen rate in 2023. On our demo farms in 2022, SMN testing showed levels of more than 60 kg N/ha, and this gave us the confidence to cut rates by 20-25%. Had fields tested at <40 kg N/ha, we would have reduced by only 10-15%.

Does the new beet price for 2023 change the economic break-even price of nitrogen fertiliser for 2023?

The higher beet price is expected to increase the economic break-even point for different nitrogen rates. Remember, in 2022 the economic break-even price of the incremental increase in crop value at a beet price of £25/t versus nitrogen cost was as follows:

£300-400 /t nitrogen at 90 kg N/ha

£300-350/t nitrogen at 120 kg N/ha

For many crops therefore where fertiliser cost more than £300, the optimum rate would have been 75 kg/ha. However, applying at this rate was considered too low for overall crop profitability, as yield could be adversely affected, therefore reducing rates to 90-100 kg N/ha would be an acceptable compromise.

The simplified table (Fig. 7.) shows the effect of re-calculating values using a beet price of £40/t for the 2023 crop. Crop return versus the total cost of AN nitrogen is calculated at increasing incremental values. Where the total cost of the N is more than the response to each increment, this is shown in red. Not unexpectedly, this increases the economic fertiliser rate higher. In fact, there is only one relevant economic breakeven price:

£400/t nitrogen at 120 kg N/ha

So, at the time of writing (July) nitrogen (AM) prices are being reported at around £750/t. This means that for 2023 crops, 90 kg N/ha is the optimum rate. If fertliser has been bought at £200/t, then 120kg N/ha can be justified.

Fig. 6. The economic break-even price of fertiliser cost and increase in yield.

		Fertiliser price £/tonne	200	400	500	600	700	800	1000
Nitrogen rate	Value of yield response (£40/tonne)*	N/kg cost (based on AN 34.5%)	0.57	1.15	1.44	1.73	2.02	2.31	2.80
60kg N/ha	£400		34	69	86	104	121	138	173
90kg N/ha	£400		51	103	130	156	182	208	254
120kg N/ha	£120		68	138	172	207	242	277	338

*The value of the incremental uplift in yield with the increasing nitrogen rate (60-120kg).

Remember that when deciding on your nitrogen strategy for 2023 it is important to consider other sources of nitrogen available to the crop and actions you may want to consider that will increase availability of nitrogen-use efficiency. Follow our checklist below.

How to avoid using too much fertiliser in 2023

1. Make sure you classify your soils accurately into the right SNS index based on previous cropping, soil type and winter rainfall. Use The Nutrient Management Guide (RB209) which provides a step-by-step reference guide on how do to this.
2. Account carefully for any N from organic manures and adjust applied nitrogen rates accordingly. It is more reliable to analyse the manure you apply, but make sure you take a representative sample if you are doing this. Alternatively use a standard value from RB209 or use software such as 'Manner NPK' or 'The Farm Crap App' to help assess nutrient availability.
3. Remember to consider and adjust for any N contribution from overwinter cover crops (see the article in this edition of Beet Review)
4. Consider doing a SMN test in the spring (before spring nitrogen is applied of course!)
5. Avoid extremes of pH to avoid N losses and poor availability/ inefficient use of N. Ensure you have tested for pH and applied any lime where required.
6. Check fertiliser spreading equipment is carefully calibrated before applying.
7. Placement of some of the nitrogen N has shown that crops use N more efficiently and reduction in rates of 10-20% have been achieved where placing nitrogen in a band to the side and below the seed. Commercial BBRO strip trials have reduced rates from 120 to 90 kg N/ha with placement. There is limited data on reducing rates more than this with placement.
8. Avoid any N leaching losses. On leaching-prone soils, aim to apply at 30-50kg/ha at drilling to support early growth and avoid leaching. Apply the remaining nitrogen at crop emergence.