Effect of high fertiliser prices and scope for the reduction of fertiliser application

BBRO November 2021

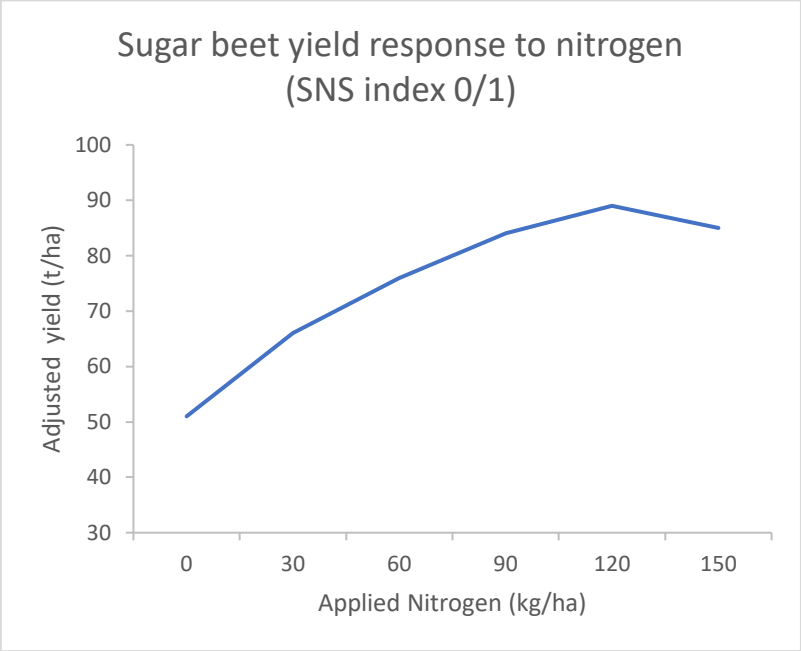
In response to the massive increase in fertiliser prices, many growers are asking BBRO how this may influence the economic optimum fertiliser rates ahead of drilling sugar beet in 2022. This note reviews the situation, looking primarily at nitrogen but also considers P & K in order to provide some information which may help you with decisions on making any reductions.

There is also a timely reminder of some of the key steps that can be taken to help ensure we can keep the use of inorganic nitrogen fertiliser sources in 2022 to a minimum.

As the amount of applied fertiliser increases, there is an increase in yield up to an economic optimum. The economic optimum depends on the shape of the response curve, the cost of the applied nitrogen and of course the value of the crop.

The sugar beet yield response curve to nitrogen is based on extensive trials work by both the former Broom's Barn Research Station and more recently by BBRO. Over 150 trials have been undertaken across a range of soil types, and seasons and provides a very reliable and consistent response to nitrogen.

Based on these data sets, a represenatative nitrogen response curve for sugar beet is presented below.



- Very typically, the yield shows a strong linear response up to 100kg N/ha followed by a much shallower response to 120 kg N/ha. Trial data shows very few consistent yield responses above 120kg N/ha.

- *This response curve is based on soils with a Soil Nitrogen Supply (SNS) Index of 0 & 1 and on land which has not regularly received organic manures or has grown a cover crop ahead of sugar beet.*

- *Note that without any nitrogen, the average yield is 51 t/ha, demonstrating how the crop can utilise both residual SMN and mineralisable nitrogen. This is very typical of N-response trials with sugar beet. Comparison of N responses in high and lower yielding crops shows that the response curve is very similar, with both high & low yielding crops having a reduced response above 120 kg N/ha.*

The reduction in yield response to high rates of nitrogen is due to a decrease in the proportion of storage root dry matter that accumulates as sugar. This is often associated with more top growth as seen on the plants on the right in the photo. Additionally, high nitrogen levels increase the nitrogen content of root which increases the levels of impurities such as amino-N. This effect is also amplified by drought as well as application of large amounts of organic manures.

- The current standard nitrogen recommendations for sugar beet are provided below for each SNS index, Recommendations are shown for potash and phosphorous which are discussed later.

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		

The effect of higher nitrogen fertiliser prices.

The effect of higher fertiliser prices on the economic optimum has been based on a crop value of £25/tonne and is summarised in the table below for a range of nitrogen fertiliser prices at different nitrogen rates. This is calculated from the yield response graph. A base rate of 30 kg N/ha is used (at an adjusted crop yield of 66t/ha)

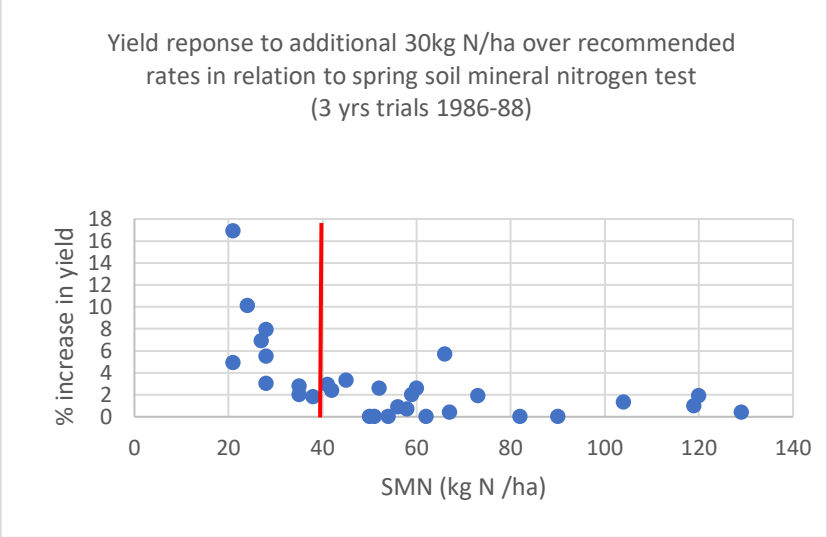
Crop return versus the total cost of AN nitrogen is calculated at increasing incremental values between 30 and 120 kg N/ha. Where the total cost of the N is more than the response to each increment, this is shown in red. Borderline scenarios may depend on the responsive nature of individual field and are shown in orange*

N rate	**Fertiliser price £/tonne**	**250**	**300**	**350**	**400**	**450**	**500**	**550**	**600**	**650**	**700**
	N/kg cost (based on AN 34.5%)	**0.72**	**0.86**	**1.01**	**1.15**	**1.30**	**1.44**	**1.59**	**1.73**	**1.88**	**2.02**
					Total £/ha						
60kg N/ha	Additional yield over 30kg N/ha = £250/ha	43	52	61	69	78	86	95	104	113	121
75kg N/ha	Additional yield over 60 kg N/ha = £100/ha	54	64	76	86	97	108	119	129	141	151
90kg N/ha	Additional yield over 75 kg N/ha = £100/ha	65	77	91	103	117	130	143	155	169	182
100kg N/ha	Additional Yield over 90 Kg N/ha = £87-100/ha*	72	86	101							
120kg N/ha	Additional yield over 100kg N/ha £87-100/ha	86	103	121	138	156	172	191	207	225	242

- The chart is a guide only, remember to use your expected beet price and the cost of fertiliser you have bought at.
- This graph shows at current nitrogen prices (Nov 2021), that the economic optimum (in green) for many crops is less than the current standard of 120kg N/ha with a breakeven fertiliser price between £350 & £450/t.
- This reduces the economic optimum nitrogen rate below the current standard recommendation. Depending on fertiliser costs, the economic optimum will be between 75 & 100 kg N/ha.
- For many crops 75 kg N/ha will be too low and overall crop profitability will be affected.
- The opportunity to reduce rates to 90-100 kg N/ha is a sensible compromise.

Remember that this response curves applies to soils with SNS Index 0 and 1. Lower economic optimums will also apply to SNS Index 2 and 3 soils. It is important that you look at your overall budgeted commercial yield level as part of the decision to reduce N and not base it solely on the N fertiliser response curve.

*There may be a concern that some crops are more responsive than average values indicate, especially above 100kg N/ha. Potentially a few soils do respond differently to N than others. As a guide, the amount of residual nitrogen in the soil in the spring could be useful. A correlation of SMN (Soil Mineral Nitrogen) and yield responses in a series of earlier trials is shown in the chart below. This shows that the yield response to additional nitrogen above an SMN level of 40kgN/ha are very flat compared to soils with lower SMN levels.



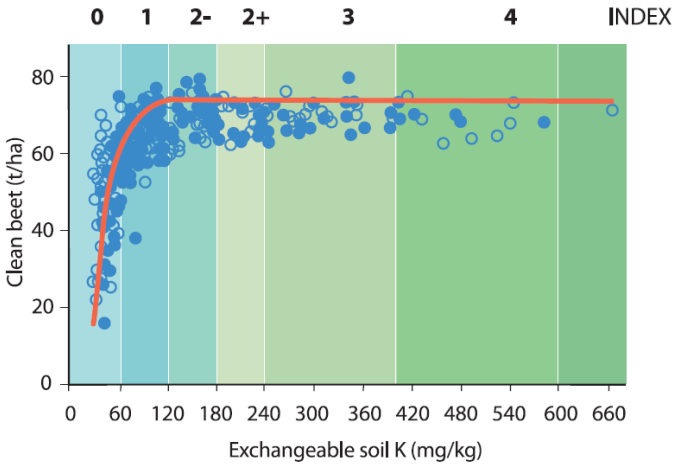
Remember that the SNS is different from Soil Mineral Nitrogen (SMN) levels as it includes elements of both available N (nitrate & ammonium- N) and also what nitrogen may be mineralised by the soil during the season.

If you are concerned about reducing the nitrogen on potentially more responsive soils, a SMN test in the spring will identify how much residual ammonium-N and nitrate-N is in the soil. If this is less than 40 kg N/ha, you may want to be more conservative about how much you reduce the nitrogen rate.

What about taking a Potash and Phosphorus holiday?

Potash

If you are thinking about reducing potash rates, trials clearly show that the yield response above Index 2 is very shallow. This is well summarised for potash by the PDA chart below. Index 2 soils account for a high proportion of sugar beet fields.



If cutting back on potash remember that on Index 0 & 1 soils, yield will be potentially lost if none is applied, especially on light sandy soils. Be wary of cutting back by more than 50% on the recommended rates in these situations. On higher index soils sufficient potash will be available to support yields but the soil reserves will be run down and will need replenishing at some point. Approximately, crop offtake of potash is 1.7 kg K_2O/t beet.

Phosphate

Well grown sugar beet crops contain about 80-120 kg P/ha distributed almost equally between the shoot and the roots with the crop removing 0.8 kg P/t in the roots. Trials across a range of soil P levels show that the concentration required for maximum sugar yield is 15-20 mg of P/g soil. This is equivalent to Soil P index 2. A high proportion of sugar beet soils are at, or above P index 2 so there is only a small yield response to applied P. Most of these soils receive an average of 60kg/P/ha which is sufficient to maintain them at this level. Reducing P on Index 1 & 0 soils will incur a relatively small yield loss. If you are considering a P holiday, having some freshly applied water soluble phosphate (30-40kg P/ha) available at drilling can assist with early root and shoot growth in young seedlings, especially when conditions are adverse to root function and nutrient uptake such as cold and wet, or dry and cobbly seed beds.

Check list on how to avoid using too much nitrogen fertiliser

1. Classify your soil accurately into the right SNS index based on previous cropping, soil type and winter rainfall. Use The Nutrient Management Guide (RB209) as your reference.
2. Account carefully for any N from organic manures. It is more reliable to analyse the manure, you plan to apply, taking a representative sample. Alternatively use a standard value from RB209 or use software to help assess nutrient availability but this will be more variable. Remember to adjust applied nitrogen rates accordingly.

The Farm Crap App is a free app that enables you to visually assess manures and slurry applications (rates) and calculate what is being provided in terms of total and crop-available nutrients. You can select different seasons, types of manure(s) and crops growing to see what the manure will provide in terms of fertiliser value. The app is available on Apple and Android devices, through the iTunes or Google Play stores.

MANNER-*NPK* is a free practical software tool that provides farmers and advisers with a quick estimate of crop-available nitrogen, phosphate and potash supply from applications of organic materials. MANNER-*NPK* is applicable in England, Wales, Scotland and Northern Ireland
planet4farmers.co.uk/manner

3. Consider N contribution from cover crops. Cover crops can help to reduce nitrogen leaching overwinter and add nitrogen to the soil. Inclusion of legumes will add more nitrogen. Typically, 30-80kg N /ha can be fixed in the autumn by a good legume-based cover crop. A SMN test will help identify nitrogen levels and potential savings. Nitrogen lock-up is not usually an issue where a five-to-six-week gap is maintained between cover destruction and drilling of sugar beet. High C:N ratio cover crops such as woody brassica species may need longer.
4. Avoid extremes of pH to avoid N losses and poor availability and inefficient use of N
5. Check spreading equipment are carefully calibrated
6. Placement of 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 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.
7. Avoid any N leaching losses. On leaching-prone soils, aim to apply at 30-50kg/ha at drilling to support early growth and to help avoid any leaching losses. Apply the remaining nitrogen at crop emergence.

Key reference material

1) *A meta-analysis of sugar beet yield responses to nitrogen measured in England since 1980 (Jaggard et al, 2009)*
2) *An analysis of the agronomic, economic, and environmental effects of applying N fertiliser to sugar beet (Beta vulgaris) (Allison et al, 1996)*
3) *Nitrogen Prediction Response Evaluation (NPRE) 2016 (Bowen 2016, BBRO Report)*
4) *Uptake and utilisation of nitrogen by sugar beet (Milford 2016, BBRO Report)*
5) *The Nutrient Management Guide (RB209) Sections 2 & 4* https://ahdb.org.uk/RB209
6) *PDA Leaflet 12 Potash for sugar beet*

Soil Mineral Nitrogen (SMN) testing

Most companies offering routine soil analysis are also able to provide SMN testing. However, it is important to contact the service provider (laboratory) or agronomist to ensure you collect samples in line with any relevant protocols.

Some laboratories offer a soil sampling service. Soil sampling must be done well to avoid misleading results and expensive mistakes. Some general guidelines on how to sample for Soil Mineral Nitrogen (SMN) are provided below:

- In most situations, sampling in late winter or early spring before nitrogen fertiliser is applied gives slightly better predictions of SNS than sampling in the autumn, because overwinter leaching is accounted for, especially in high rainfall areas or on shallow or light sand soils. On soils less prone to leaching, sampling in autumn or early spring is equally effective
- Avoid sampling within two to three months after application of nitrogen fertiliser or organic manures, or within a month after sowing
- Areas of land known to differ in some important respects (e.g. soil type, previous cropping, manure or nitrogen fertiliser application) should be sampled separately
- Do not sample unrepresentative areas, such as ex-manure heaps or headlands
- Avoid collecting and sending samples immediately before the weekend or a public holiday
- Samples must be taken to be representative of the area sampled. 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, unless the soil type is not uniform, in which case more than one sample should be taken. This can be done by dividing the field into smaller blocks from each of which 10–15 soil cores are taken
- 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
- Samples from each depth should be bulked to form a representative sample of that depth. If the bulk sample is too big, take a representative subsample to send to the laboratory; do not stir the sample excessively
- Use appropriate packaging (normally available from the laboratory) and label samples clearly, providing as much information about the field and crop as possible
- Samples should be analysed within three days of sampling. Samples must be kept cool (2–4˚C) but not frozen during storage or transport.