Beet Yield Challenge – first year report

May 2018

Foreword and top yields

The Beet Yield Challenge (BYC) was primarily designed to help improve our understanding of some of the key drivers of yield in sugar beet as opposed to just achieving the highest yield. Comparing your commercial yields to an estimate of the potential yield of your crop was considered an appropriate approach, accounting for the varying yield potential of different soil types and allowing for benchmarking against other crops. You may have noticed that the word 'challenge' has replaced the word 'competition' to reflect this. The BYC also works at a whole field level and not on estimates of yield based on test digs which can be subject to huge variances. Unlike some yield competitions, the BYC deals with the challenges of managing intra-field variation and the impact of headlands and tramlines.

There's a certain amount of irony in that 2017, the inaugural year of BYC, proved to be a very high yielding year, if not a record season for many crops! The average yield of all the fields entered was 97 t/ha, realising on average 73% of the estimated potential yield. The cold and dry start to the season made final seedbed preparation difficult and to some extent masked the effect of drilling date on yields. However, the warm temperatures and plenty of sunshine and rainfall in June drove some exceptional canopy development which continued through July, August and into September. A relatively warm autumn then allowed good growth in later harvested crops.

There was a wide range of actual yields and the range of the proportion of potential yields achieved also varied considerably. Despite the good weather, this suggested there are many other opportunities to drive yields further. Interestingly, there were few differences in the performance of crops on the various soil types represented, suggesting that the weather effectively neutralised this effect.

Our challenge has been to identify where the key focus areas are. A lot of data has been collected on the crops across the season and we have attempted to analyse and summarise some of this in this report. However, one of our key learnings is that you can never have enough data, especially at an individual farm level and it has been difficult to draw farm-specific conclusions. Looking forward we need to gather more information on soils, crop canopy development, weed, canopy foliage disease and health levels. Additionally, as more crops are entered over several seasons it will be possible to analyse data for trends which will help identify potential improvements.

Aerial photography of the fields gave us some unique insight into intra-field variation and how important this is in determining the overall performance of a crop. This is the first time this has been looked at closely, highlighting how variable sugar beet can be within a field and how reducing this variation may be a key focus for some growers.

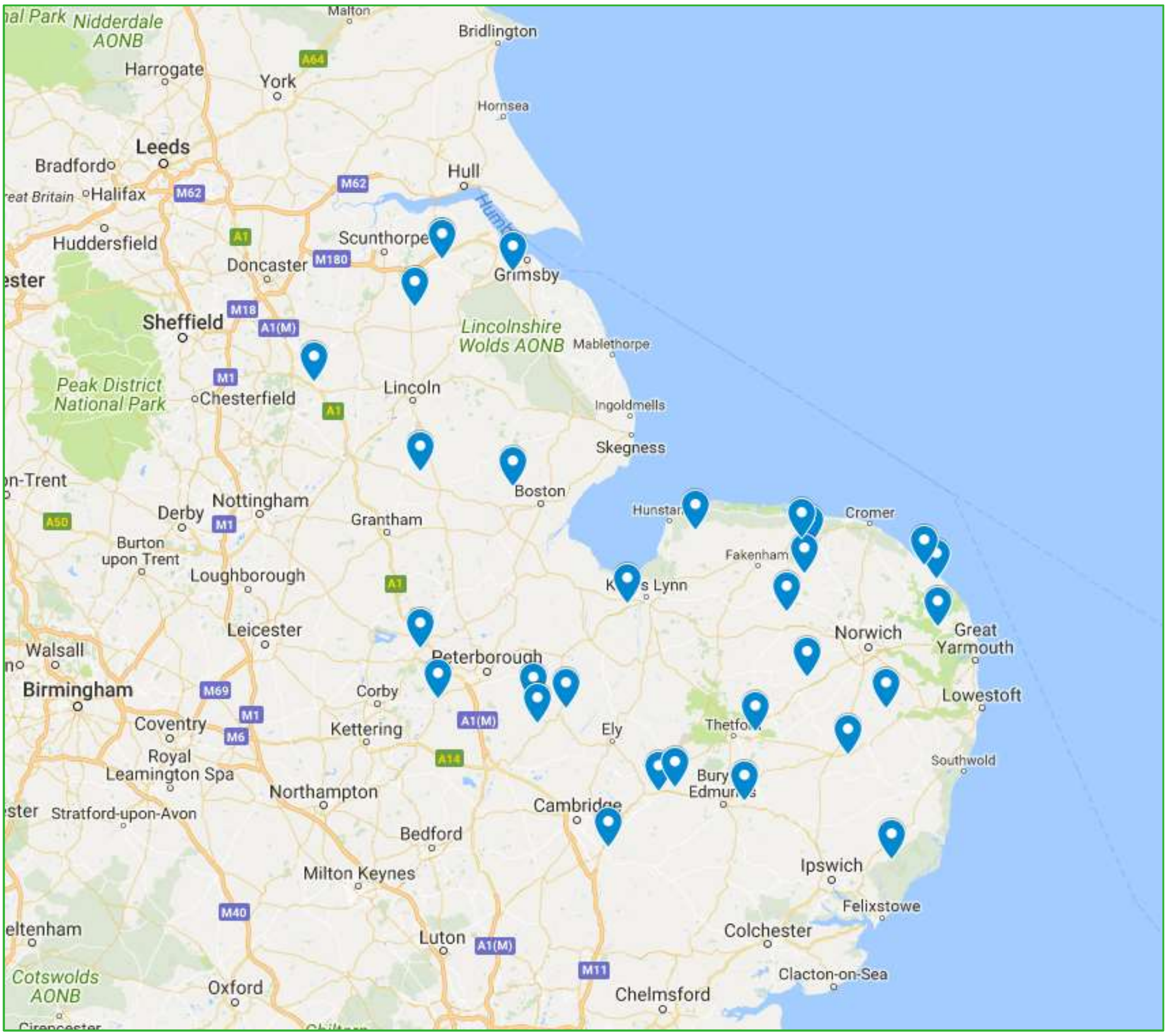
We have drawn the common trends and patterns into a 'BYC Spotlight' section identifying key focus areas. If you can take just one action away from this, your involvement is hopefully justified. We of course look forward to welcoming you back to the second year of the BYC as I'm sure you will agree; every season is different and there is always something new to learn.

I'd like to acknowledge the support of the BYC Steering Group. Their support and enthusiasm has been fantastic, and we are determined to build on the success of the first year. I would also like to thank Toby Townsend for his hard work on collecting, modelling & analysing the data.

Simon Bowen, BYC Steering Group Chair

BYC participants

There were 28 fields in this year's competition. These represented all four factory areas (seven in Bury, nine in Cantley, five in Newark and seven in Wissington). They represented a range of soil types, cultivation practices, drilling dates and lifting dates.



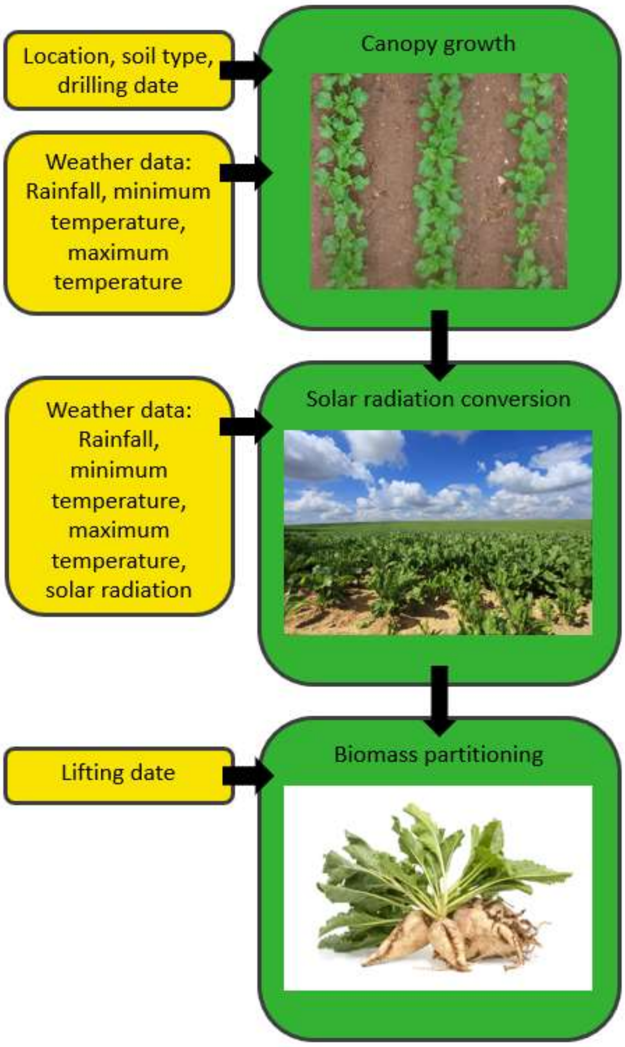
Final yields

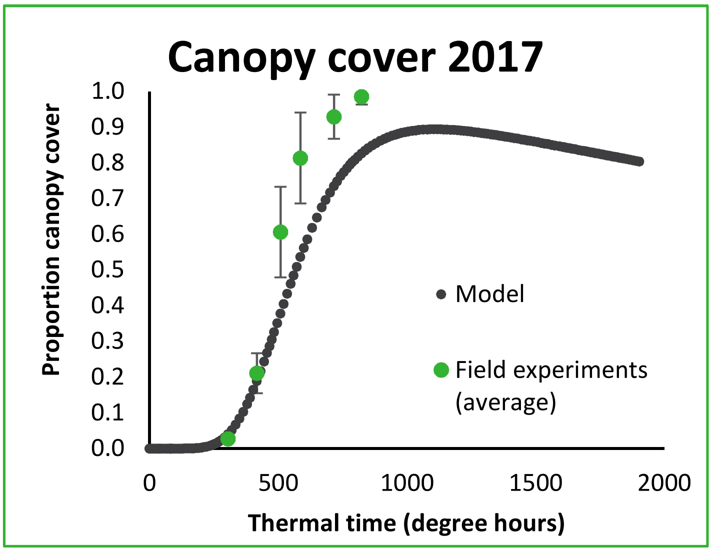
2017 was a record-breaking year for sugar beet yields and this is reflected in the yields achieved by our BYC participants. The average yield for all the BYC crops was 97.4 t/ha. Some fields had issues with crop establishment, which meant they struggled to reach their yield potential. Even so, these fields still had very good sugar beet yields.

PARTICIPANT NO.	FACTORY AREA	HARVEST PERIOD	ACTUAL ADJUSTED YIELD (T/HA)	SOIL TYPE
1	Bury	Nov-Jan	82	Loamy sand
2	Bury	Feb-Mar	116	Loamy sand
3	Cantley	Nov-Jan	99	Sandy loam
4	Cantley	Sep-Oct	71	Sandy clay loam
5	Newark	Nov-Jan	82	Loamy sand
6	Newark	Nov-Jan	98	Sandy loam
7	Newark	Sep-Oct	75	Sandy loam
9	Wissington	Nov-Jan	88	Organic silty clay
10	Wissington	Nov-Jan	84	Organic silty clay
11	Cantley	Nov-Jan	102	Sandy loam
12	Wissington	Nov-Jan	99	Sandy clay loam
13	Cantley	Feb-Mar	128	Sandy silt loam
14	Wissington	Nov-Jan	97	Sandy loam
15	Bury	Nov-Jan	110	Sandy loam
16	Bury	Feb-Mar	104	Sand
17	Cantley	Sep-Oct	121	Sandy loam
18	Cantley	Feb-Mar	100	Sandy loam
19	Cantley	Sep-Oct	104	Sandy silt loam
20	Bury	Feb-Mar	104	Clay loam
21	Bury	Nov-Jan	95	Sandy loam
22	Bury	Feb-Mar	95	Sandy loam
24	Wissington	Feb-Mar	85	Clay loam
26	Cantley	Feb-Mar	124	Sandy silt loam
27	Newark	Sep-Oct	87	Sandy loam
28	Newark	Feb-Mar	92	Sandy loam
30	Cantley	Nov-Jan	91	Loamy sand
31	Wissington	Sep-Oct	114	Clay loam
33	Wissington	Sep-Oct	80	Clay loam
Factory area	Bury		101	
averages	Cantley		104	
	Newark		87	
	Wissington		93	

What is yield potential?

- This competition is being judged on the proportion of yield potential that is achieved. The potential yield is calculated by assessing the maximum that could be achieved given the limitations placed on it by location, soil type and weather conditions. We wanted to make the challenge fair by removing the yield-affecting factors that growers cannot control.
- Yield potential takes account of the drilling and lifting dates.
- Yield potential is calculated using a crop growth model, originally developed at Broom's Barn and subsequently updated by AB Sugar.
- This model assumes that high-quality crop management is maintained throughout with 100,000 plants per hectare evenly distributed across the field, and all pests, diseases and weeds controlled.
- Due to the high temperatures and soil moisture in June, canopy growth in the field was quicker than the model predicted (see the graph and note the green dots depicting measured canopy at the experimental site at Sutton Bonington, Nottinghamshire, compared to the model predictions). We hoped to get canopy estimates from participants in order to update the model but did not receive enough information to do this.
- Weather data is taken from NASA (https://power.larc.nasa.gov/data-access-viewer/). Although rainfall data was supplied by some participants; as we did not have coverage for all farms, we used the same data source for all competition fields to be consistent.





Actual yields as a proportion of potential yields in 2017

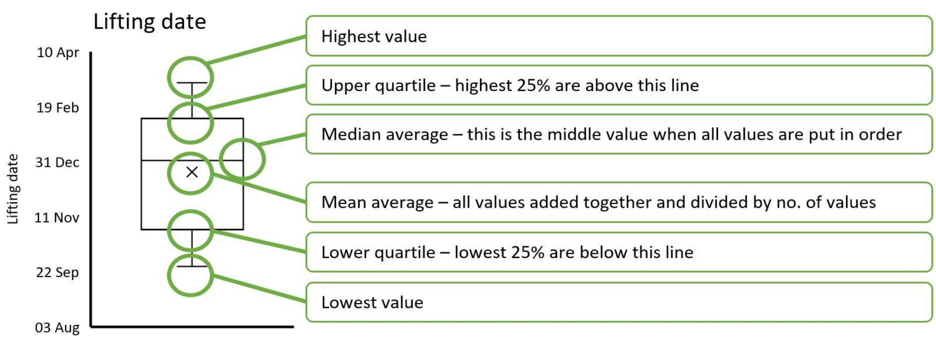
- There was a wide range of potential yields realised in 2017 (see chart below).
- The average of the proportion of potential yield achieved was 73.5%. Our highest performing competition field was very close to its yield potential.
- However, some of the highest yields did not always equate to the highest % of yield potential achieved, in many cases the later harvested crops lost out on potential yield.
- As this is the first year, there are no comparable information on % of yield potential achieved for sugar beet available. Interestingly, the three highest fields in the 2017 winter wheat YEN competition realised between 76-83% of their potential yield. As 60% of the BYC sugar beet crops realised over 70% of their potential yield, the results are a favourable comparison!

% of potential yield achieved	% of crops
<60	7
60-70	32
70-80	39
>80	21

Data analysis in this report

Data was collected for each of the competition fields and this data is presented together in this report. Data for each individual BYC field will be given to participants separately. Data coverage is not complete as some data was not returned by participants and we were also unable to collect a full set of data for some of the competition fields. This means that not all competition fields will necessarily be included in each graph or analysis in this report.

We have presented some of the data as *box and whisker charts*. We have highlighted how this works here:

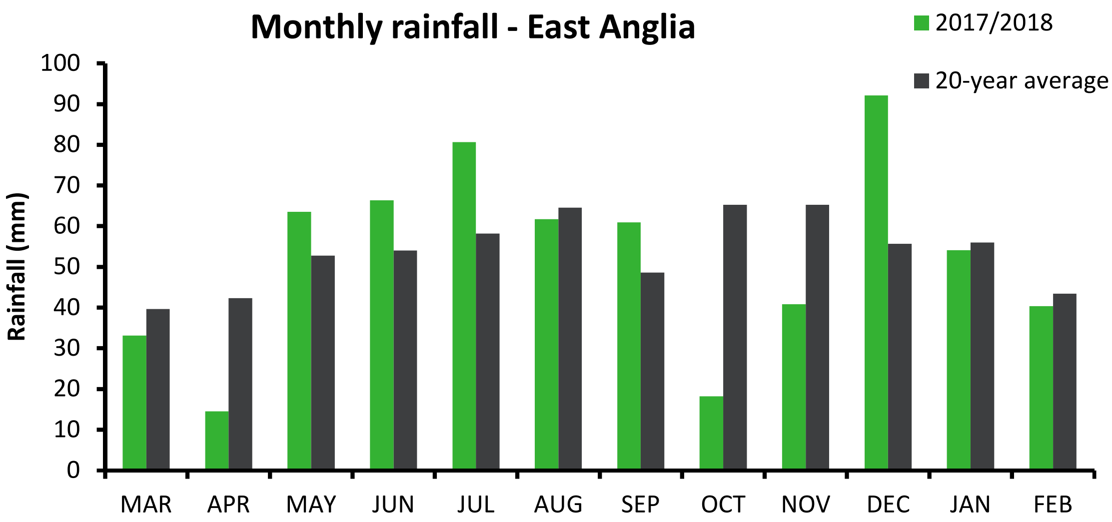


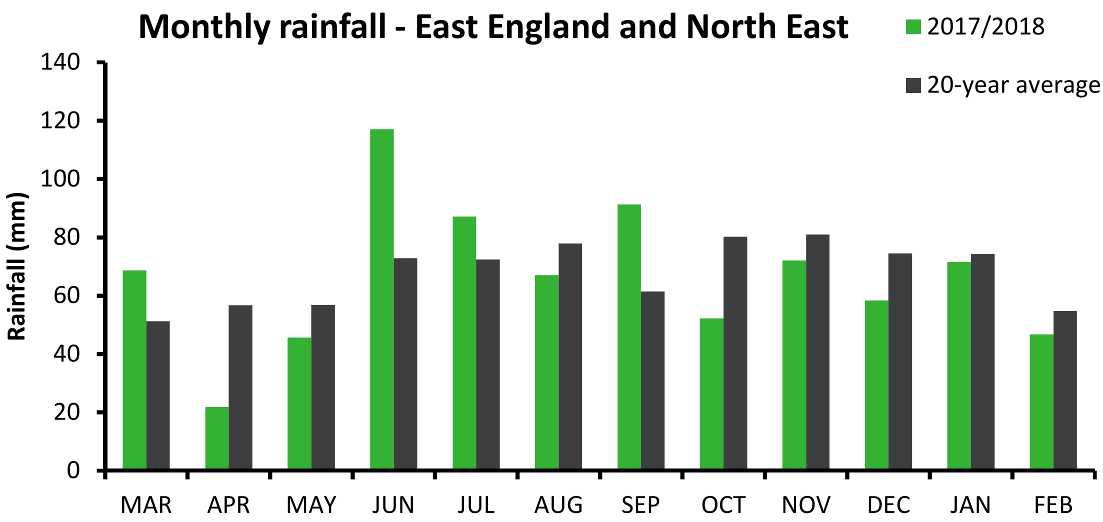
We have compared crop management practices and field characteristics to the resulting adjusted yields and % of yield potential achieved. Although we can see patterns in this data, care must be taken when evaluating these as each competition field was very different and there are many factors influencing yield (e.g. location, soil type, crop rotation). We see these graphs as giving us pointers as to where to focus our attention for next year, rather than giving any firm conclusions.

This year's weather

Rainfall

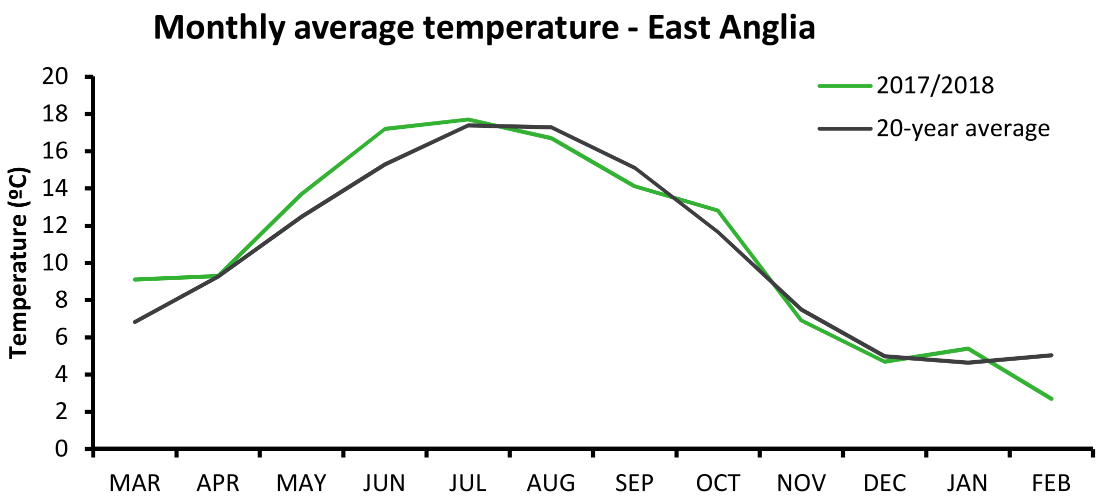
- Rainfall was below average at the start of the 2017 growing season.
- The dry weather in April led to a delay in some crop emergence and some fields had uneven emergence.
- There was higher than average rainfall in early summer which meant that crops only experienced limited water stress during this period.
- It was a dry autumn whilst winter was drier than average in the North East and East of England but a very wet December for East Anglia.

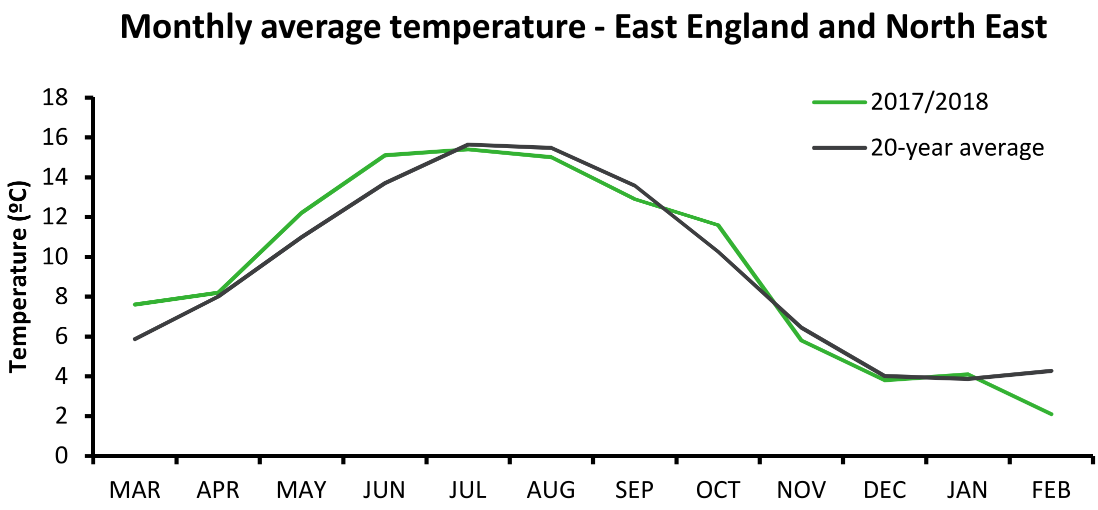




Temperature

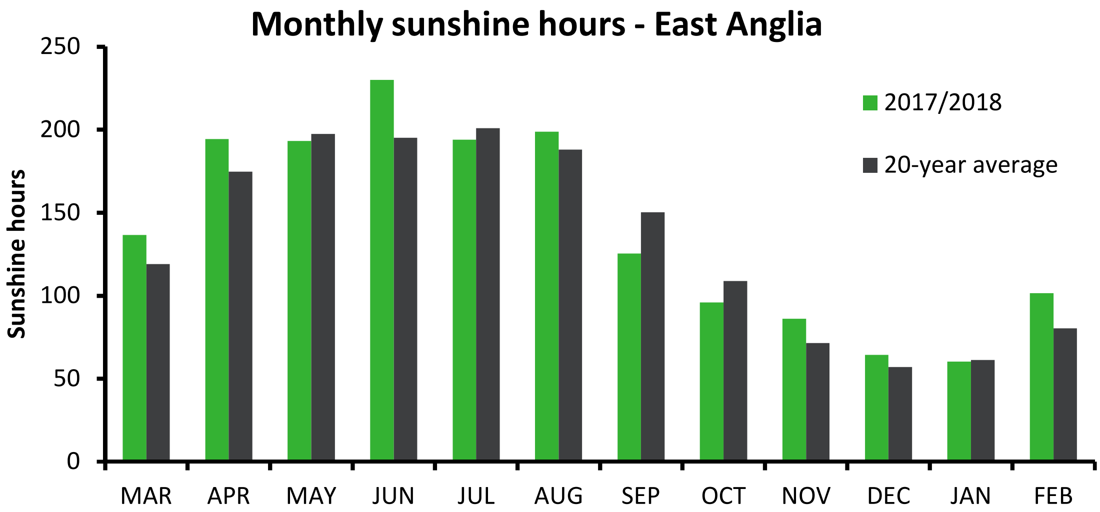
- Late spring and early summer was hotter than average. In particular, June was approximately 2ºC hotter than average. The plentiful water supply in late May and June combined with the high temperatures to create perfect growing conditions for sugar beet and led to very rapid canopy growth.
- The autumn was mild but during winter there were cold snaps in December and February.

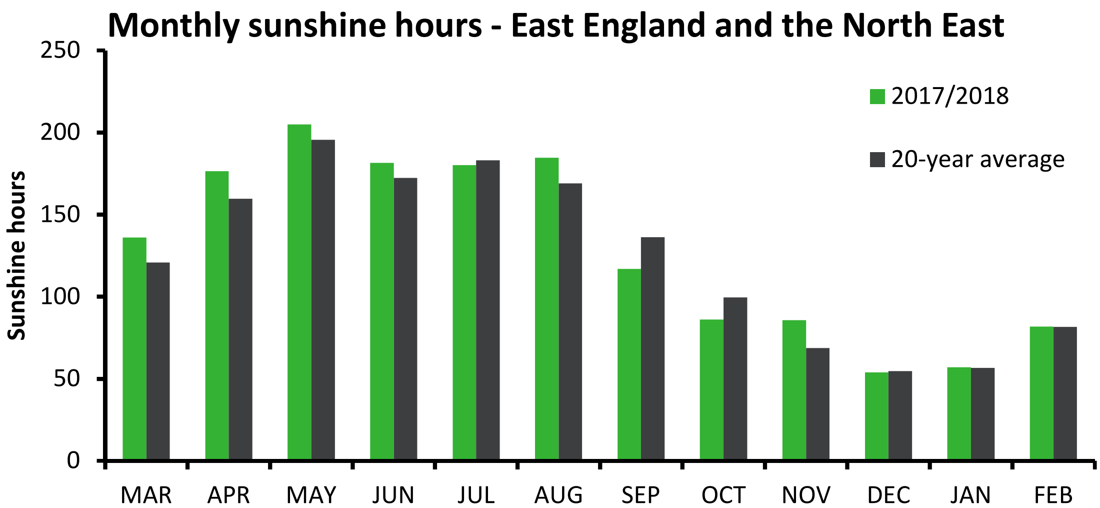




Solar radiation

- Sunshine hours, an approximation of the solar irradiance reaching the plants, was above average in June, in particular for East Anglia.
- The quickly expanding crop canopies in June were able to exploit this higher than average sunshine to help build yield.





Weather data

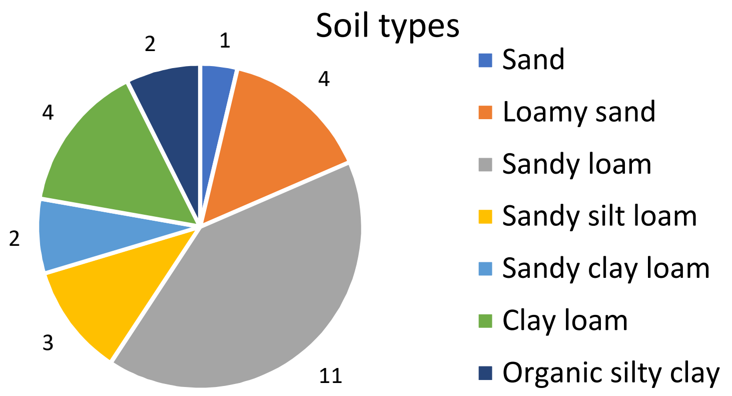
The weather data above is taken from the Met Office: https://www.metoffice.gov.uk/climate/uk/summaries/datasets Within these regions there were considerable variation and the graphs don't show the whole picture; in some areas during the summer the rainfall was sometimes sporadic but heavy, so most of the rainfall only occurred over several days.

Soil and nutrition

As part of the competition, each field had its soil analysed by NRM Laboratories to provide information on soil nutrient status, texture, soil organic matter and pH.

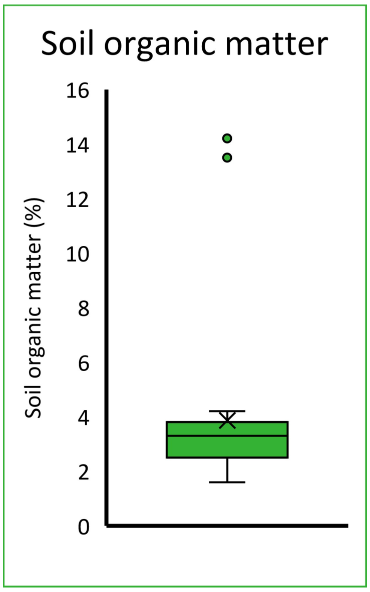
Soil type

- Competition fields represented soil types ranging from sand through to organic silty clay. The dominant soil type was sandy loam with 38% of fields.
- The highest yields and proportion of yield potential achieved tended to be located on sandy loam soils.



Soil organic matter

- Soil organic matter (SOM) ranged from 1.6% to 14.2% though the majority of soils were between 1.6% and 4.2%. Excluding the two organic soils, the average SOM was just over 3%.
- There was no clear trend between yields and SOM across the BYC fields.
- Some of the soil analyses had their SOM levels compared to levels typically expected on similar soil types and all these fields were within the target for SOM.
- One consideration is that these SOM assessments are from limited samples in each field and it may be that SOM values vary across the field and there are areas where SOM levels are low and possibly impacting on yields.



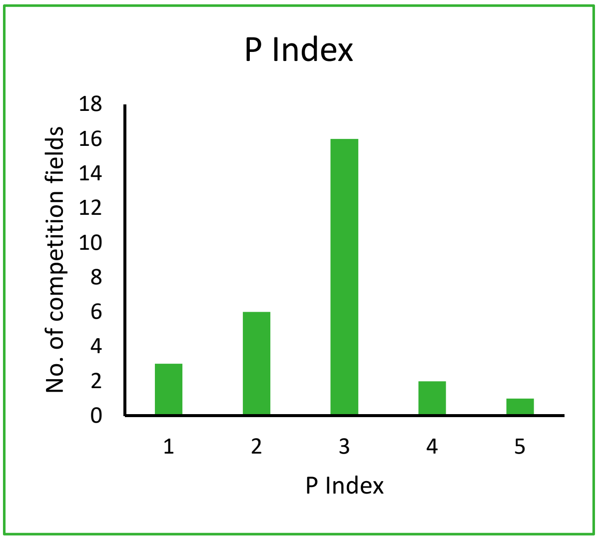
BBRO Reference Note

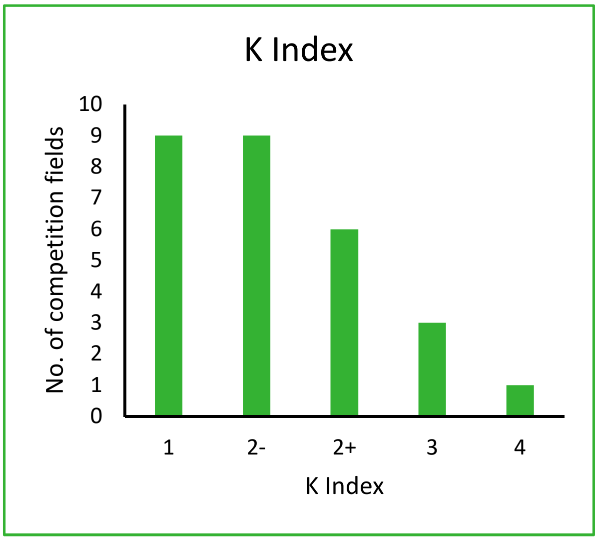
Whilst there is information of what typical SOM levels of different soils are, there is only limited information on the relationship between SOM and yield. The limited set of BYC data indicated no precise relationship across the range of fields. Some recently published work by Mahmood & Murdoch (2017) studying sugar beet in the East of England has shown that intra-field variation in SOM, ranging from 3-7%, significantly correlated with yield. There is also some evidence that shows where soil organic carbon is increased, sugar beet yields increase (Mukhwana et al, 2015). This is something BBRO is currently assessing.

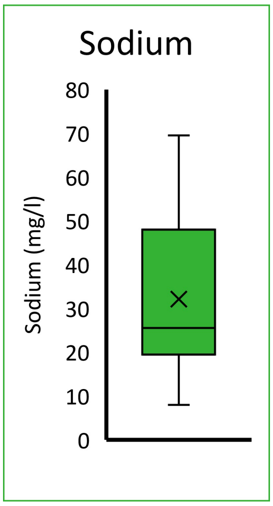
SOM is an important component of soil providing a number of interrelated functions such as nutrient supply, soil cation exchange capacity, moisture infiltration and retention, soil aeration, aggregate stability and microbial activity. In certain circumstances, such as drought stress, these factors are likely to provide improved resilience.

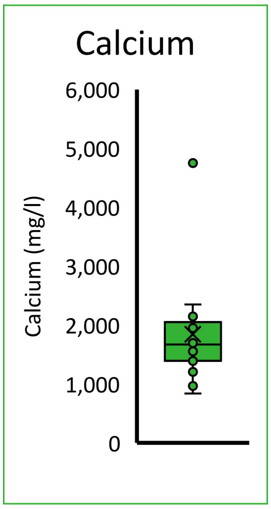
Soil nutrients

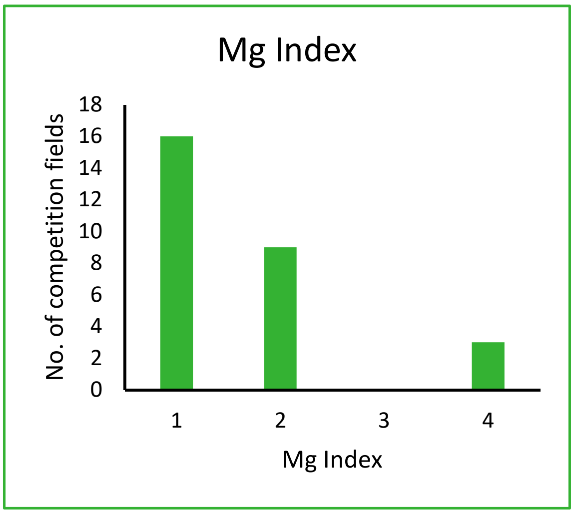
- The average level of nutrients found were typical of sugar beet growing land.
- Phosphorus (P): The majority of competition fields had a soil P index of 3.
- Potassium (K): Competition fields tended to have low soil K; 64% had soil K indices of 1 or 2-.
- Sodium (Na): This can partly replace potash for sugar beet. Soil Na varied between fields, but there was no indication of a relationship with yield.
- Magnesium (Mg): The majority of fields had low soil Mg.
- A higher average yield was recorded on soils where the Index was 3, 4 or 5 compared to where the Index was 1 or 2, reinforcing the need for sufficient P on low P index soils.
- There were no clear indications of relationships between soil indices and yield for K and Mg. It will be interesting to see if this is the same for 2018.
- Calcium (Ca): There was a considerable amount of variability in soil Ca between fields. There was no relationship between soil Ca and yields.





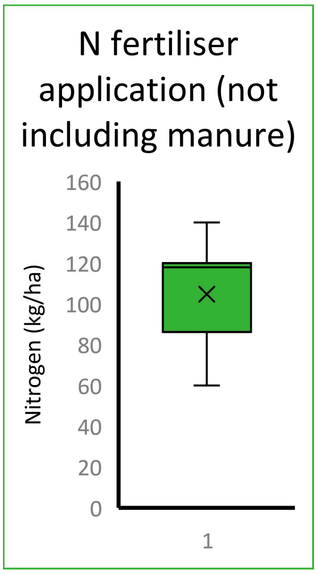






Nutrient	Soil Index	No. of competition fields	Adj. yield (t/ha)	% of yield potential achieved
P	1	3	82	67%
	2	5	94	76%
	3	16	98	72%
	4	2	113	76%
	5	1	97	80%
K	1	9	85	67%
	2-	9	100	75%
	2+	6	100	73%
	3	3	88	61%
	4	1	88	67%
Mg	1	16	91	70%
	2	9	99	74%
	3	0	N/A	N/A
	4	3	86	61%

Nitrogen



- The average rate of nitrogen application was 108 kg N/ha.
- Of the 25 fields with data on fertiliser application, ten applied organic manure (mainly pig slurry and poultry litter).
- The average yield of crops receiving organic manures was 106 t/ha compared to an average of 93 t/ha where no organic manure was used. The fields with manure applied achieved 76% of their yield potential, whereas fields without manure only achieved 71% of their yield potential.
- The majority of crops had between 30 & 40 kg of their nitrogen applied at drilling with the remainder applied after emergence.
- There were insufficient numbers of crops where the nitrogen was placed in the seedbed to make any comparison.
- The range of nitrogen rates was too narrow to identify any effects on yield.
- Sulphur was applied to 62% of the crops in the spring but it was not possible to detect any effect of these applications on yield compared to untreated crops.
- Manganese deficiency was observed in many crops and the majority received foliar applications of manganese.

BBRO Reference Note

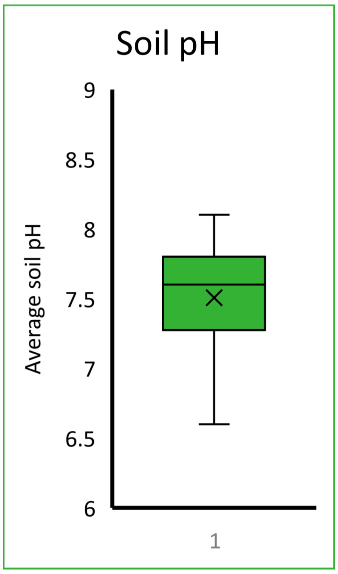
The recommended rate of nitrogen for a nitrogen soil Index of 0 and 1 is 120 kg/ha and 100 kg/ha for Index 2. Allowance for the nitrogen content of organic manures should be considered. Recent trials have failed to establish consistent evidence for higher rates of nitrogen. High rates of nitrogen, especially when large amounts of organic manures are used, can be associated with excessive foliage growth, lower root sugar content and higher rates of root amino-N content.

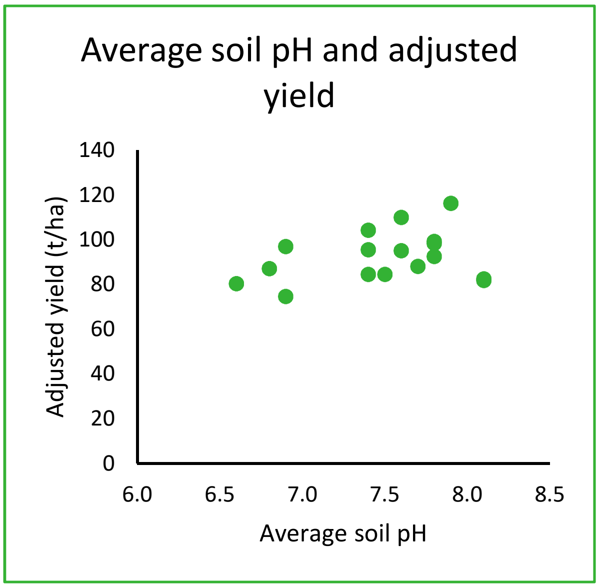
The recommended rate of phosphate for Index 2 is 50 kg/ha with none required on Index 3 soils. Phosphate is important for early root and shoot development and work is being undertaken to evaluate whether there is a benefit of applying some highly soluble phosphate at drilling or early canopy development, even on higher P index soils.

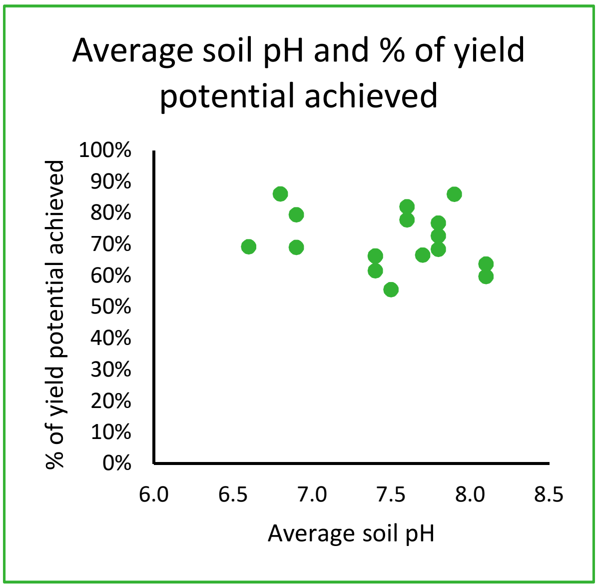
The recommended rate for potash aims to ensure the amount removed by the crop is replaced. If growing on Indices 0 and 1, additional K can be applied to raise the Index to 2 but this is not always possible on light sandy soils.

pH

- pH values were recorded in some of the soil analyses at field-level pH; these ranged from 6.6 to 8.1.
- It is risky to rely on a composite soil sample pH result as few soils are truly uniform for pH. Most fields had multiple samples taken and these showed that pH could vary across a field. For example, one field had pH values ranging from 6 to 8.5.
- Some fields showed a lower pH than recommended with seven fields having patches of soil with a pH below 6.5 and 3 with patches below 6.0.
- There was an indication of increased yields where the pH was higher. This was not seen when pH levels were compared against the proportion of potential yields achieved, indicating other factors were reducing this effect.







BBRO Reference Note

The target pH for mineral soils (sandy loams-clay loams) is > 7. For organic and peat soils the target pH is > 6.25

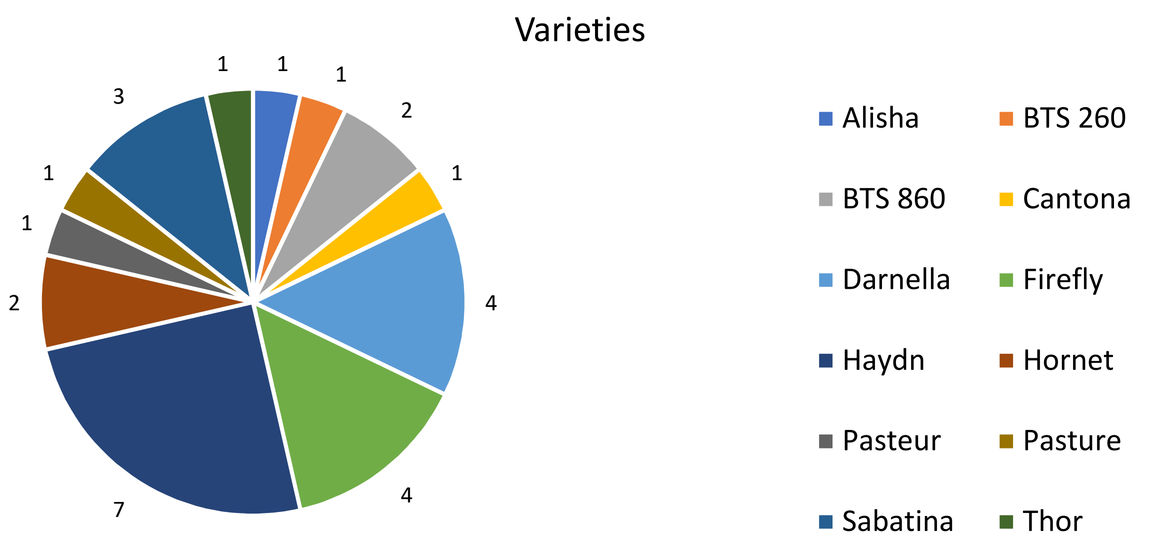
Soil pH has an influence on sugar beet yield through affecting the ease at which the plant can access to soil nutrients. Low pH reduces nutrient access and moderate yield effects can be seen on mineral soils below pH 6.5 whilst serious effects of soil acidity occur on the soils below pH 6.0.

Ideally, soils should be grid sampled to show the range of soil pH values and to address field variability.

The British Survey of Fertiliser Practice shows that circa 25% sugar beet is limed ahead of cropping. More detailed Information on liming can be found in the BBRO Reference book.

Varieties

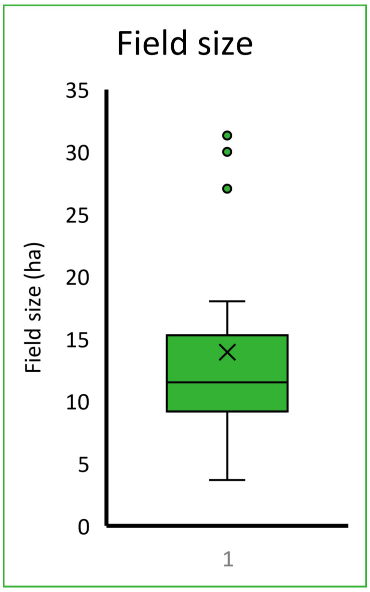
- A total of 12 varieties were used.
- The most popular was Haydn followed by Darnella and Firefly.
- Two participants used two varieties in their competition fields (where this is done, BBRO recommends marking where each variety is so that each can be managed individually).
- The sample size is too small to draw any conclusions about the impact of variety selection on the competition results. Comparing the varieties grown across multiple competition fields does not show significant differences in yield.
- The Recommended List highlights the yield potential of different varieties and BBRO are starting field experiments this year to better characterise key varieties and to identify how we may be able to use varieties more tactically. Where different varieties are grown it is valuable to mark out fields, so you can manage varieties individually as well as to monitor performance, which will help to complement BBRO's work into impact of variety selection.

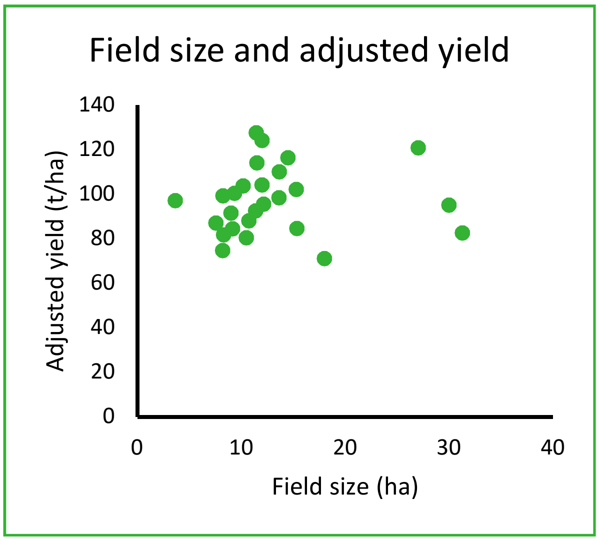


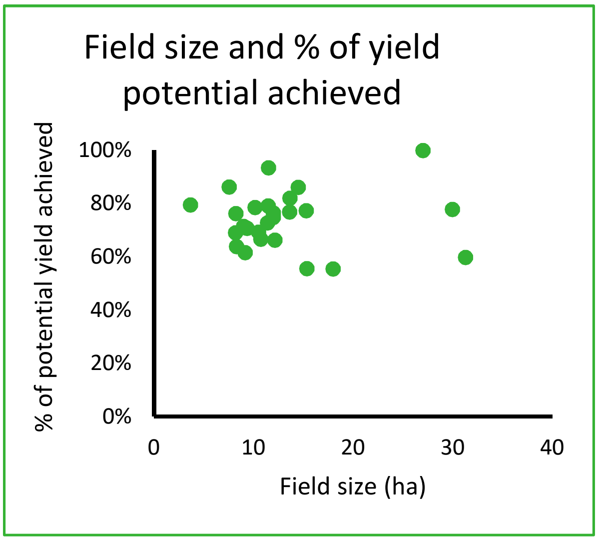
Drilling

Field size

- The competition limited field size to a minimum of 2 ha, including headlands.
- The competition fields ranged in size from 3.66 ha to 31.81 ha with an average of just under 14 ha.
- As we are measuring yield across the field, we were interested to see if there was a yield trend with increasing field size because, in general, the proportion of field taken up by headlands decreases with increasing field size. Conversely, having a smaller field could allow a greater focus on management. However, we found that field size did not correlate with adjusted yield this year.

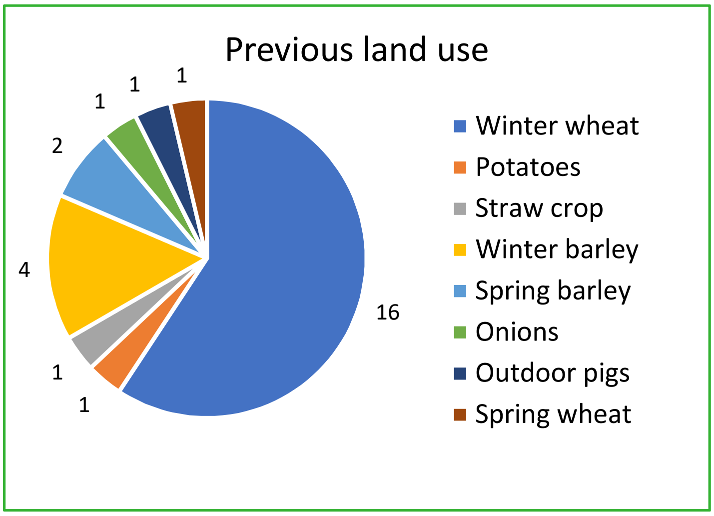






Previous land use

- Over half the competition fields had winter wheat as the previous crop.
- There were a mix of other uses.



Soil preparation

- Cultivation practices varied across the competition fields. Most of the competition fields were ploughed with only three being prepared using min-till cultivation. The extent of secondary cultivations also varied from finishing with a press to the use of a power harrow. We need to examine these operations in relation to yield more closely in 2018.
- The number of crops which were proceeded by a cover crop was too small to draw any conclusions.

BBRO Reference Note

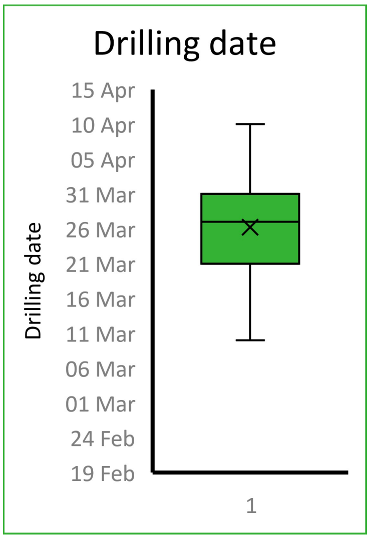
Sugar beet is very sensitive to poor soil structure. Poor seedbed conditions can lead to yield losses of >30% through poor establishment, compaction and poor moisture availability.

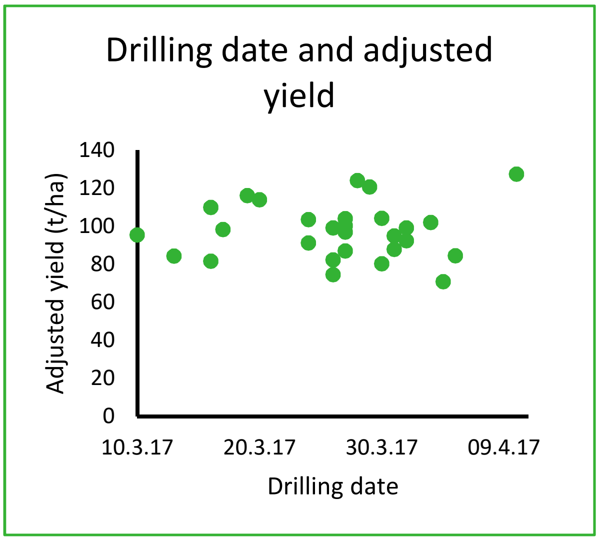
The target of cultivation regime is to provide a level consolidated seedbed in the spring with 5-7 cm of tilth. Aim for a minimum of 30% of soil particles <3 mm around the seed to improve availability of moisture to support good early root development.

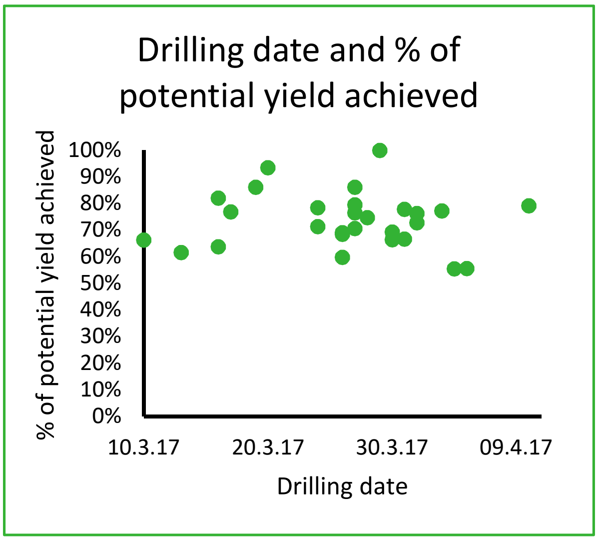
Compaction lower in the soil profile can make the crop more vulnerable to drought because of restricted rooting. Check areas such as headlands, where soil type changes and low-yielding areas where compaction may be an issue and may need correction.

Drilling date

- The earliest crop was drilled on the 10th March whilst the latest was drilled on the 9th April.
- The average drilling date was the 26th March.
- This compares with an average of 30th March across the national crop.
- Normally, earlier drilling leads to greater yields; however, this wasn't seen in the BYC fields (though our comparison does not consider lifting date). This year, the dry weather during April delayed some crop emergence so some crops drilled early did not emerge until much later.

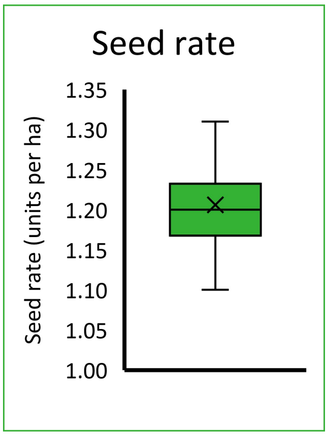


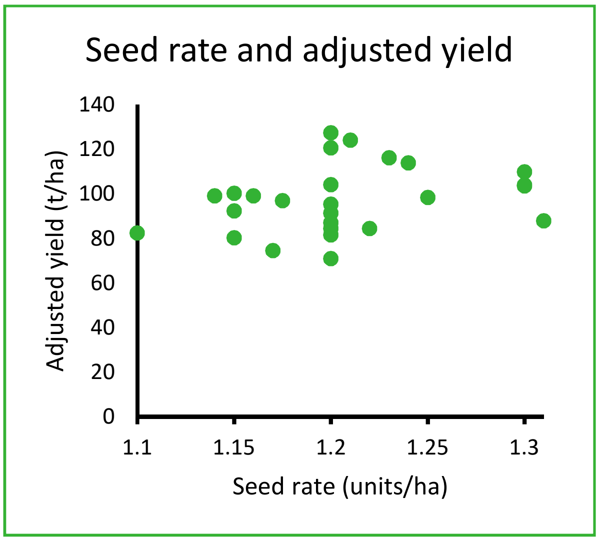


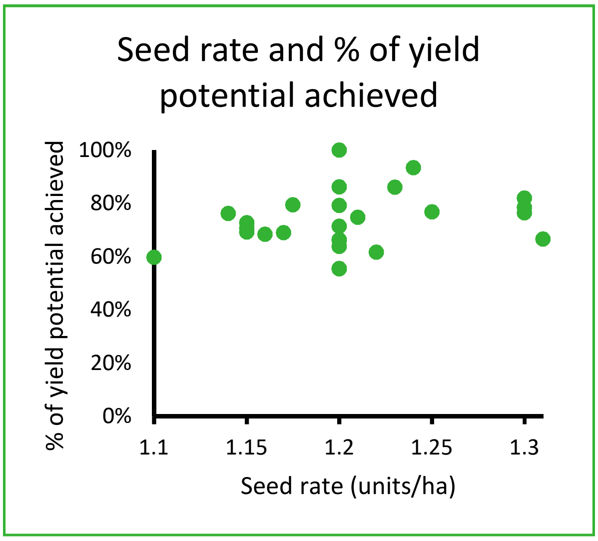


Seed rate

- Seed rates ranged from 1.1 to 1.31 units/ha.
- On average, 1.2 units/ha were drilled.
- There was a trend for higher yields with higher seed rates.
- No participants reported using variable seed rates.







BBRO Reference Note

The average drilling date for the UK crop over the last five years is the 25th March.

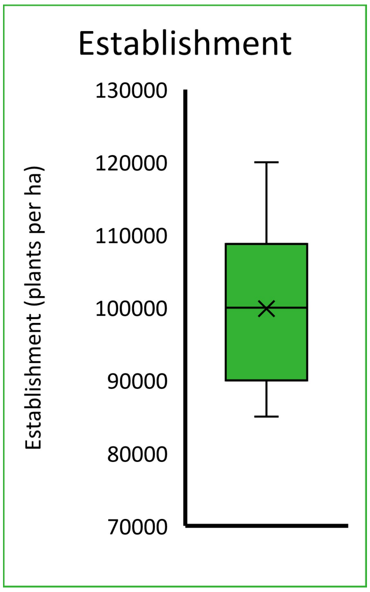
Ideally, drilling should be completed before the end of March. Historically, data has shown that drilling after the 10th April could lead to yield loss of over 4 adjusted t/ha per week on average.

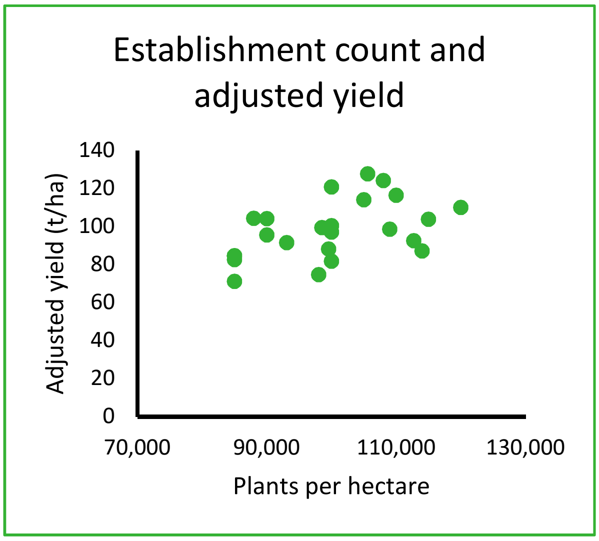
The recommended seed rate is 1.25 units/ha when the expected establishment is 80%. Where establishment is expected to be less than 80%, a higher seed rate should be considered. A table giving the seed rate for different expected establishment levels can be found in the BBRO Reference Book.

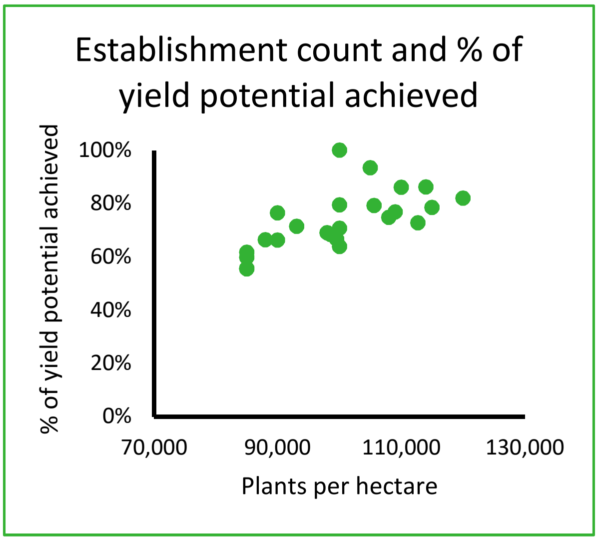
Plant establishment is often lower on headland and parts of fields where seedbeds are poor. Higher seed rates should be considered in these areas.

Establishment

- Establishment ranged from 85,000 plants/ha to 120,000 plants/ha. This corresponds to 69-98% emergence.
- The average plant count was 95,000 plants/ha.
- 34% of participants had lower plant counts than the recommended 100,000 plants/ha while 17% had less than 90,000 plants/ha.
- The relationship between establishment and yield will depend on how patchy establishment is. If the missing plants are evenly spread, then the remaining plants can compensate but when there are large patches of poor establishment then yields will suffer. As seen in the drone photography section, there were some fields that had large patches of poor establishment.
- BBRO recommend an establishment rate of 100,000 plants/ha and from the graphs it can be seen that yields dropped off below the target but showed no clear increase above the target.







BBRO Reference Note

BBRO recommend an establishment rate of 100,000 plants/ha. Establishment is determined when plants are at the 6-leaf stage. For most crops, the benefits of optimal populations come from improved leaf cover and light interception.

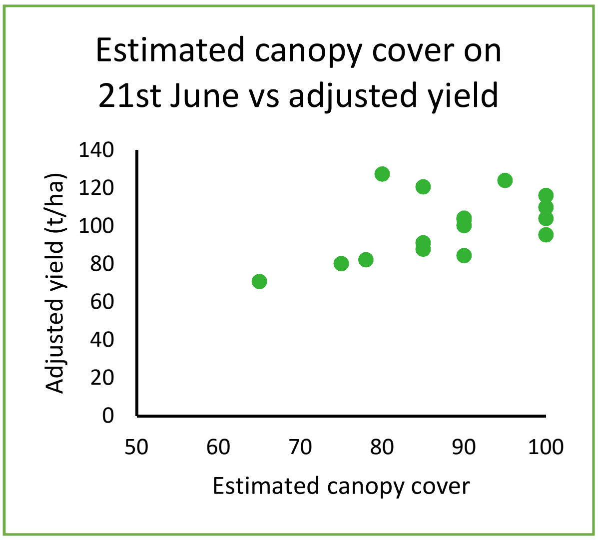
Trials looking at higher seed rates have not found consistent data to support a higher target plant population.

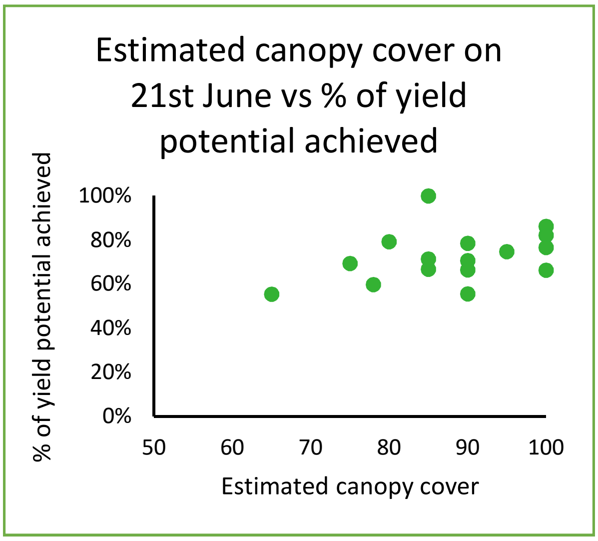
Losses between drilling and establishment may be due to: poor seed germination, weather, soil capping, bird and small mammal, other pest and diseases. Seed bed conditions have a significant effect on crop establishment.

The average establishment value for the UK crop over the last 5 years is estimated at 92,720 plants/ha.

Canopy cover

- Participants were asked to provide canopy cover estimates and we received these for 16 fields.
- As canopy emergence was particularly fast, only limited measurements were made before canopy closure.
- We extrapolated from the data that was given to us, to estimate canopy cover on the 21st June (the longest day of the year where there is the most opportunity for solar radiation interception) and plotted this against adjusted yield and % of yield potential achieved. There tended to be higher yields and % of yield potential achieved for greater canopy cover on the 21st June.
- New techniques, such as using drone photos combined with image analysis, may provide more accuracy in canopy cover measurements in the future.





BBRO Reference Note

Sugar beet needs a Leaf Area Index (LAI) of 3 to intercept 90% of light. The LAI is the leaf area per m^2 of ground. A LAI of 3 broadly corresponds to 90-100% crop cover but can vary between crops and varieties depending on soil characteristics and plant growth habits.

Leaf area development is strongly correlated with nutrition, especially the amount of nitrogen in the plant. Trials have shown that plants need approximately 30 kg N/ha to produce each unit of LAI. Deficiencies of other nutrients such as manganese, magnesium and sulphur in this rapid growth phase will also limit canopy expansion and affect yields.

Development of leaf area is also very temperature-dependant with crops taking approximately 1050 degree-days from drilling to 90% crop cover. This equates to an average temperature of 12oC for 75 days (mid -March – mid-June) Clearly, in warmer conditions, acquiring more degrees per day, crops will reach 90% cover faster.

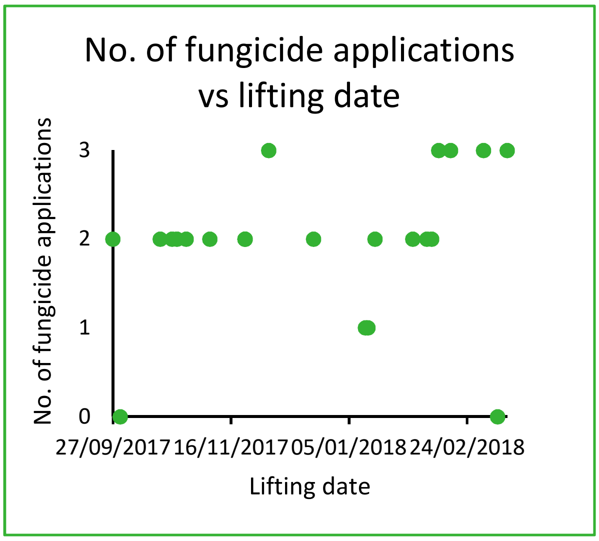
Crop management throughout the year

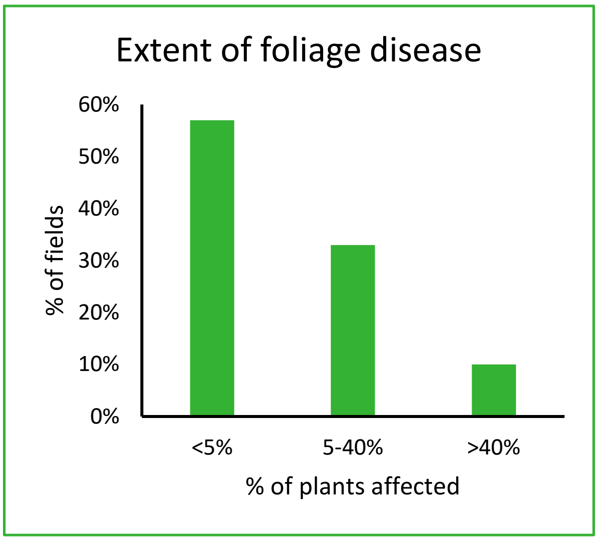
Fungicides

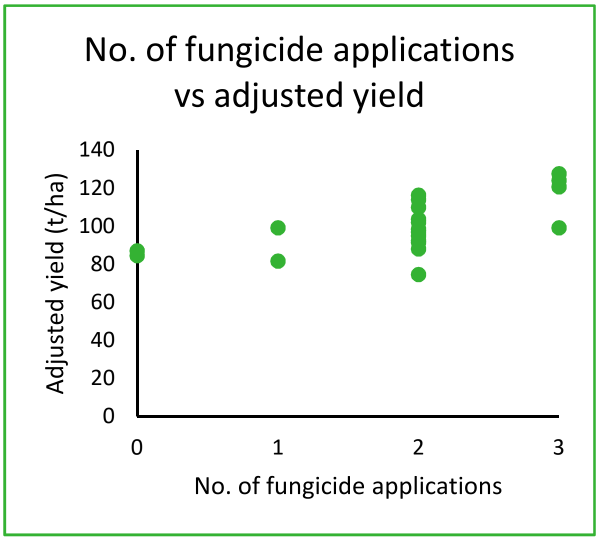
- Data was collected during the growing season using British Sugar's field spec survey. We've focused on crop disease in our analysis. Of the 24 fields included in the British Sugar field spec survey, 22 used at least one application of fungicide.
- 10% of the fields were shown to have foliage disease levels on more than 40% of plants and 33% with diseases on between 5 & 40% of the plants.
- The main diseases were rust and cercospora. Rust was more uniformly distributed across fields, whereas cercospora was patchier in its distribution suggesting field factors may be important.
- There was no relationship between the level of foliage disease and the varieties grown in the BYC. BBRO has, however, identified some consistent differences between varieties (see photo) and this is worthy of consideration when deciding on fungicide programme.
- Insufficient data points are available to draw precise conclusions about the number of fungicides and yield although there was a trend for actual yield to increase with more fungicide applications. This trend was less clear with the % of potential yield achieved, possibly as there were too many multiple factor interactions. Modelling of foliage diseases and their control is an area for further development, especially in late-harvested crops where canopy recovery is possible when conditions for diseases become unfavourable.
- Escolta was by far the most widely used fungicide.

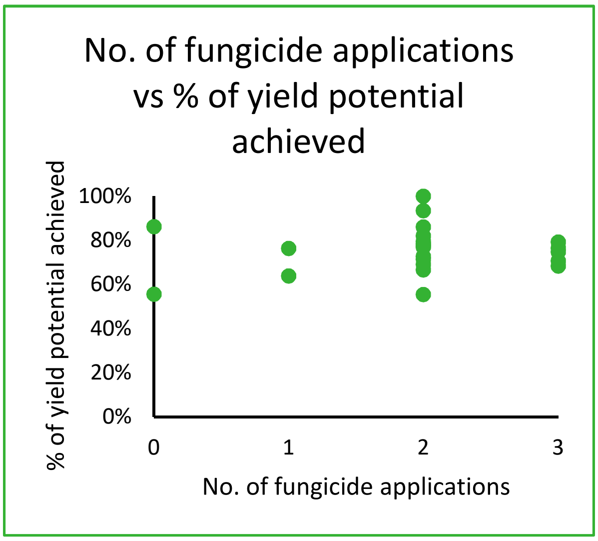
The photo, taken from BBRO fungicide trial plots in 2018, highlights the loss of crop canopy in a very susceptible variety (no longer on the variety RL)

No. of sprays	Average harvest date	Average adjusted yield (t/ha)	Average % of yield potential achieved
0	19/12/2017	85.8	71%
1	12/01/2018	90.5	70%
2	30/11/2017	98.2	78%
3	08/02/2018	111.1	74%









BBRO Reference Note

BBRO trials indicated that disease pressure in 2017 was certainly higher than 2016 but less than that experienced in 2015. In north Lincolnshire, average untreated levels of diseases (% leaf cover infected with rust) were 8, 2 & 36% in 2017, 2016 & 2015, respectively. Cercospora levels in both 2015 and 2016 were considerably lower than those observed in 2017.

BBRO advice is broadly for one fungicide spray to be applied at onset of disease for early harvested crops (before October) and two sprays for crops harvested after October. The potential benefits of three spray programmes, especially for later harvested crops is being evaluated. Over 60% of crops in 2017 received two fungicide sprays, <5% received three fungicide sprays.

The threat and extent of foliar disease through any season may change and influence the number and timing of fungicide sprays.

Drone photos

- During the summer we took drone photos of some of the fields in the competition. Time constraints and flight limitations meant that not all fields could be photographed.
- These photos allowed us to have a different perspective on what was going on in the fields.
- We have presented some photos here to highlight some of our findings.

We did see evidence of weeds in some of the competition fields. In this field, there is a significant problem with fat hen.

This field had issues with weed beet. This demonstrates the importance of controlling weed beet before it becomes a significant problem.

BBRO Reference Note

Yields can be reduced by 11% or more by just one tall weed (e.g. volunteer oilseed rape, fat hen or redshank) for each square metre of crop.

Similarly, just one weed beet or bolter per square metre can reduce yields by 11%. On average, 1,500 viable weed beet seeds are produced per weed beet plant.

Weed beet hosts pests and diseases such as BCN, rhizomania and downy mildew.

Several fields showed patchiness of establishment. There are several reasons why this could be the case with the dry weather in spring being one of the main reasons. Where there are localised patches of poor establishment throughout the rotation, it suggests that targeted soil preparation and higher seed rate may help.

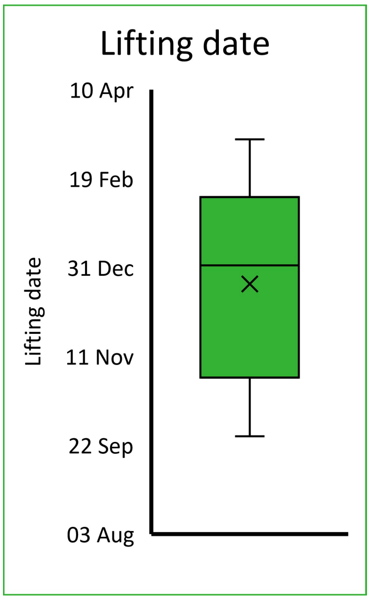
Uniformity of the crop is linked to establishment and we wanted to investigate its impact on yields. We divided fields into three categories and calculated the average performance in each: 1) good & even; 2) some thin growth; and 3) patchy.

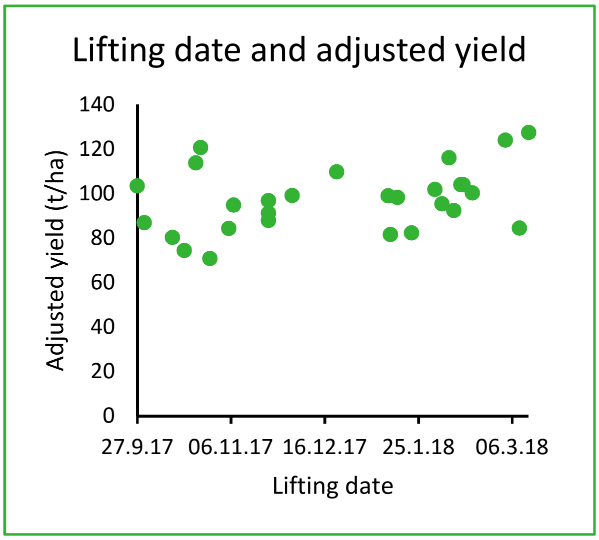
Uniformity score	Average % of yield potential achieved
1	77%
2	61%
3	65%

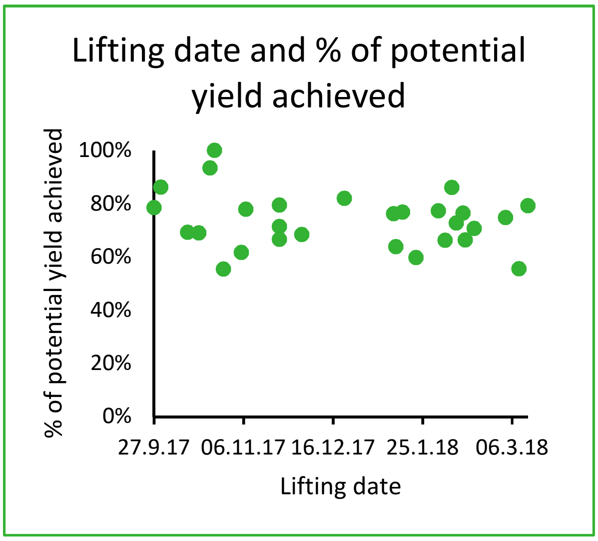
The best yields tended to be seen on those fields with uniform canopies.

Harvesting

- The earliest lifted crop was on the 27th September whilst the last lifted crops were in mid-March.
- On average, the competition fields were lifted on 12th December.
- Whilst there was trend of actual yields increasing with later harvesting, this was less clear when yields were expressed as a % of their potential, with the % of yield potential tending to decrease throughout the harvest period.
- This is of course to be expected as crops are subject to a number of stresses such as diseases, leaf senescence and cold and frosty weather. Some sugar in the root may be remobilised to maintain canopy growth in this period. The longer that the beet is left in the ground, the more care that must be taken to provide a healthy canopy.
- There were insufficient data points to show any difference between varieties and harvest date, and yield in the BYC.

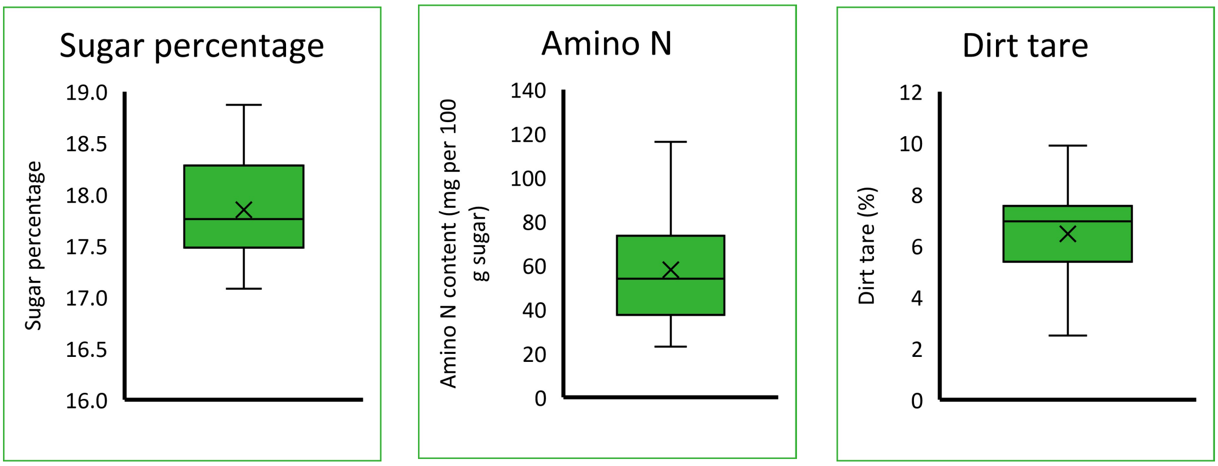






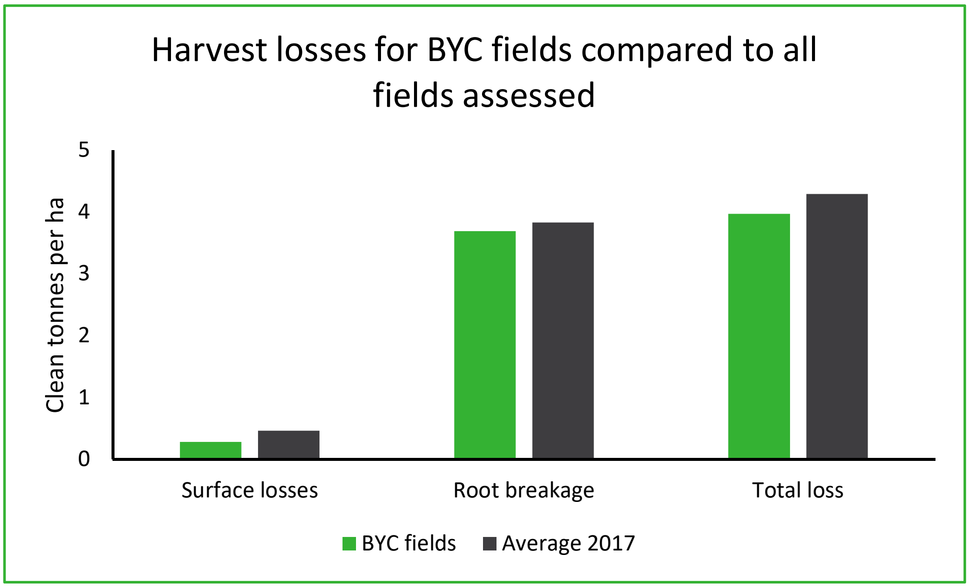
Sugar, amino N and dirt tare

- Sugar ranged from 17.08% to 18.87% with an average of 17.85%.
- Dirt tare ranged from 2.5% to 9.9% with an average of 6.5%.
- Amino N ranged from 23 to 116 mg per 100 g sugar, with an average of 58 mg.



Harvest testing

- Participants were offered the opportunity to have their harvest losses assessed by BBRO's Stephen Aldis.
- Eight of the competition fields were assessed and average results are presented below next to data showing the average losses for all the fields assessed in 2017/2018 (132 fields).
- Both surface losses and root breakage were slightly lower for BYC fields than the average. There is scope for growers in the BYC to increase yield through reducing losses during harvesting.
- Soil type and weather conditions influence a harvester's efficiency, and how aggressively crops have to be cleaned in wet conditions, which could increase potential losses.



BBRO Reference Note

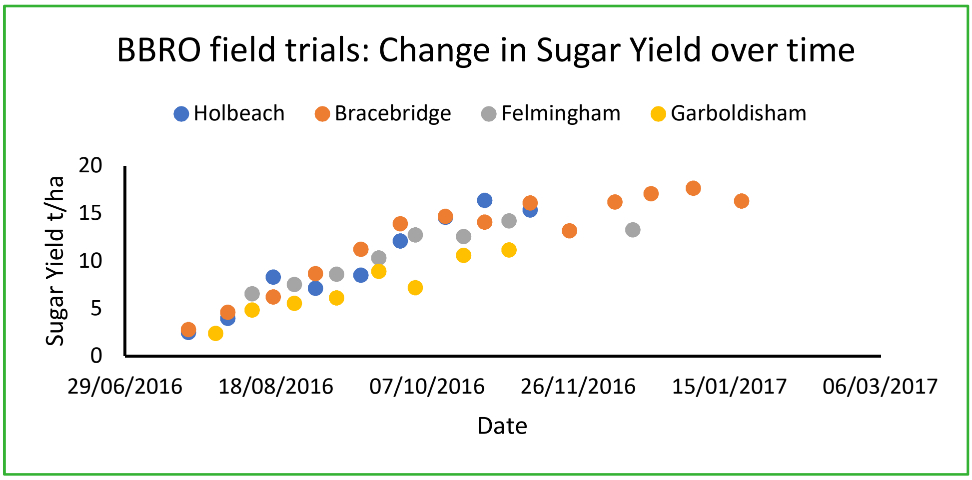
Crop yields can increase by up to 30-40% between September and January (see graph below for crops in 2016).

The ability of a crop to optimise its yield potential in this period will be more challenging compared to crops harvested earlier. This will depend on the weather, canopy health and soil type and structure. Select crops with strongly growing canopies and ensure the canopies are well protected against disease for later harvests. A vigorous canopy will also help protect against any frost, although geographic location will determine the risk of frost.

Well-draining soil types and structure will be more resilient to water-logging and root rots during the later season growing period.

Crops should be assessed regularly during harvest for root damage and roots left in the ground. Yield losses of 3-5% are typical but vary considerably and can be much greater. Ensure a steady flow of beet across harvesting and handling equipment and when transferring beet that drop heights are kept to a minimum to avoid additional bruising damage.

Where root damage is more severe there will be an additional post-harvest loss of sugar which will increase with time. Operate a 'just in time' harvesting and delivery schedule as much as possible. Where beet is likely to be stored for any length of time, a managed clamp approach will help reduce sugar losses. Average losses in clamp are circa 0.1% of total sugar volume per day. See BBRO Reference Book for more details on harvesting and storage.



Spotlights

Identifying some key focus areas from the BYC

As you will have noticed from the various graphs in this report there is a lot variance or 'scatter' between data points and it is often difficult to see clear or precise relationships. This is a reality of measuring performance in commercial crops and at a whole field level where there are multiple factors at work, all interacting to influence the yield. As more data is added across more seasons and sites this form of data collection analysis will become more consistent and insightful.

This is of course why BBRO undertake replicated trials. These are designed to minimise the effects of unwanted variables as much as possible, in order to measure the target ones.

The lack of detailed data at an individual farm level has also made it difficult to identify farm-specific focus areas and actions. Something we all need to work on for 2018. Additionally, the good weather in 2017 has masked some of the expected impacts of different factors.

However, some key focus areas can be identified, and these are outlined below. These are not presented in order of priority and are based on trends which clearly will not apply to all the fields in the BYC. Hopefully, these may help point you in the direction of making some improvements.

- **Seedbed quality - establishing a uniform 100,000 plant/ha** across the field is key to optimising yields. The BYC has clearly identified the impact of field variability on establishment and shown that, even in a high-yielding year, between 12 & 17% of potential yield was lost as a result of patchy establishment in 2017. The challenge is to identify the causes. In many crops, this was related to soil type and the ability to produce a good moisture-retentive seedbed tilth in the spring. Cultivation strategy is clearly dictated by soil type and it is difficult to identify the relative merits of different approaches from just one year of the BYC. As more crops are entered over successive seasons, this should become possible. In 2017, patience and timing of the final cultivation was key, especially on heavier soil. Multiple cultivation passes to produce sufficient tilth resulted in drying out of the soil and producing cloddy seedbeds.

- **Seed rates** – the use of higher seed rates **should not be used** as a substitute for poor seedbeds but there is an indication that higher seed rate BYC crops resulted in better yielding crops in 2017, providing some compensation for the difficult early season conditions. Where poor seedbeds are unavoidable, adjusting seed rates in areas where lower establishment is expected such as with changing soil type, is worthy of consideration. The use of higher seed rates on headlands and increasingly in tramlines is something that is currently practiced. As well as adjusting seed rates, ensuring drills are placing at the right spacing and depth is important. We did not measure this in 2017 but something we are measuring in crops in 2018.

- **pH levels** – sugar beet is sensitive to pH which can have a large effect on yield. There was an indication of increasing yield at higher pH in the BYC. It is worthwhile to check fields for variability in more detail and to ensure all areas of the field meet the target pH.

- **Early canopy growth** – the stand-out feature and base for the high yields in 2017, once seed had germinated, was the very rapid canopy establishment in May and June. Crops reaching higher crop cover scores by June 21st (the longest day of the year) had the largest yields. Ensuring canopy growth is not compromised in this period is key. As for establishment, good seedbeds are key here as well particularly ensuring soils can hold on to moisture. In dry springs, higher SOM in soils will provide a better buffer against water stress. In wet springs, poor soil structure and soil compaction leading to waterlogging will slow canopy growth. Ensuring rapidly-developing plants have adequate nutrition such as N, P & Mn is important in this phase. Don't wait until you see symptoms of Mn deficiency before applying foliar sprays. Ensure any potential checks to growth from pests & diseases which can damage root systems, such as nematodes and Rhizoctonia, are identified and managed.

- **Weed control** – the aerial photography showed how the incidence of weeds in some crops can impact on the canopy cover across a field. Early identification of the weeds present allows selection and tailoring of herbicide programmes to be more targeted. Many weeds tend to be patchy in their distribution so knowing where these are and perhaps using some patch treatments may be an approach to getting a more uniform canopy distribution. Weed beet clearly need controlling before they compete with the crop and reduce yields.

- **Foliage disease** – foliage disease was clearly a yield-limiting factor in many of the BYC crops. The incidence of disease, initially rust and then cercospora, clearly impacted on canopy productivity. Whilst most crops received two fungicides, the levels of disease suggested that foliage disease control could be improved. Early identification of disease and good canopy penetration and coverage of sprays are areas to address. Depending on the level of active disease, a third fungicide spray for later harvested crops is a worthwhile consideration (see below). Research work is focusing on understanding varietal susceptibility and which fungicides programme are most effective against cercospora.

- **Later harvesting** – the ability to maximise yield potential by leaving crops for later harvesting is challenging. The trend for yield to increase is clear at later harvest is clear but to maximise the potential requires attention to managing the interaction of number of factors. The importance of protecting the foliage for later harvest crops should be a focus. Five out of the thirteen crops harvested after mid-November had three fungicides and eight had two fungicides applied. There was a trend for an increase in yield with the number of fungicide application made. Selecting the right crop to harvest later can help optimise yield. New data on varieties and their growth habits is currently being collected but selecting crops with vigorous and healthy canopies with an upright canopy architecture are indicators. Ensure soils are in good condition where harvesting is likely to be later. This will help reduce the impact of water logging on growth as well as the need for aggressive cleaning at later harvesting dates when weather is likely to be less than ideal.

Final message

We'd like to thank all the growers for getting involved in the inaugural BYC. This has been a learning experience for us and we thank the participants for their patience as we have developed the BYC throughout the year. We look forward to our current participants joining us again for 2018's BYC. Building on the success of the first BYC, we are expanding it by increasing the number of participants and the amount of information we will be collecting from each competition field. This will allow us to better identify areas where we can support all sugar beet growers to improve their yields.