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Excellent yields and the lowest scores for both early and normal sown bolting on the 2018 Recommended List*

BLOODHOUND

*Full data set available at www.bbbro.co.uk
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**Industry update from British Sugar,**

**British Sugar and NFU update**

**2017 Sugar Industry Programme continues to invest in future of beet growers**

*Partnership between NFU Sugar and British Sugar goes from strength to strength in a momentous year for beet industry.*

As the UK’s sugar producers enter a new era following Brexit and the European Union’s (EU) decision to abolish production quotas, discussions around the future of the beet sugar industry are more important than ever.

And as part of that investment in the future of the industry, NFU Sugar, in conjunction with British Sugar, has hosted its 2017 Sugar Industry Programme (SIP).

Now in its seventh year, the 2017 initiative has seen a new group of young growers learn about the sugar beet sector in its entirety, including factory operations, policy discussions in Westminster, seed production and industry research through the work of the British Beet Research Organisation (BBRO). Participants also received training in presentation and media skills.

Aiming to support the future of the beet sugar industry as well as develop the existing skills of younger growers, the programme also looks at how the NFU influences, adopts and communicates policy to growers and how growers can get involved in shaping the future of sugar.

Tom Clarke is an Ely NFU grower and was one of the participants in this year’s programme.

“As a grower it’s easy to stay within the comfort zone of your own farm. The SIP opened our eyes to all aspects of the industry and challenged us all to take ownership and help shape the future of the homegrown sugar industry – which I believe is very bright.

“One highlight was realising, in a year which poses a number of changes for the industry, how crucial the BBRO will become in developing yields, protecting improvements and enlightening growers – to benefit the whole industry”.

**Participants in the 2016/17 Sugar Industry Programme.**

**BBRO update**

**Investing in the future**

In this edition of the *British Sugar Beet Review* we have contributions from all five of the BBRO supported PhD students. They have all been active, not only in delivering their projects, but also in meeting growers and supporting BBRO events. I hope you have had the chance to meet and hear from them at some of our BBRO Open Days and conferences over the last couple of years. Like any business, succession planning is vital; BBRO will continue to invest in supporting the future generation of applied researchers and scientists who, as the industry shapes up to face the future challenges in a more competitive landscape, will be critical to ensuring that we keep driving innovation within our Industry.

This year’s trials programme includes several projects evaluating new seed technology and we are aware that a number of growers have already received some of these new treatments directly for on-farm comparisons too. As part of any evaluation of new technology, BBRO has developed protocols that include testing products in a series of fully replicated trials that are undertaken at a number of different sites to reflect the range of varying soil types and conditions experienced in the beet growing areas. This ensures that technologies are tested robustly across different seasons and, once we have the final results, we will be releasing these data to you all via the *Beet Review* and BBRO events.

As mentioned in the last edition of *Beet Review*, Holmewood Hall has closed and the BBRO Field Team have now relocated to Bexwell Industrial Park at Bexwell Heath, near Downham.
As part of the course, which ran between November 2016 and February 2017, growers met with MPs and Ministers in Westminster to highlight both young growers’ and industry professionals’ commitment towards UK beet sugar production. The SIP participants held a parliamentary reception in the House of Commons to highlight the strength of the UK beet sugar industry throughout the whole value chain – from the farm to kitchen table, and the valuable part the UK beet sugar production industry plays in the country’s rural economy.

Managing Director of British Sugar, Paul Kenward said: “2017 is a hugely important year for the future of the sugar industry, and the lifting of European Union sugar quotas and leaving the EU offers exciting opportunities. “We are one of Britain’s most globally competitive industries and together with growers, importers and government we can design a UK sugar policy that allows our world-leading domestic sugar industry to continue to thrive. Our combined investment with the NFU in the next generation of growers is crucial to the success of the industry”.

NFU Sugar Board Chairman, Michael Sly said: “While there are challenges ahead, the UK beet sugar industry has a bright future, and it is inspiring to see so many talented young growers taking part. “The Sugar Industry Programme goes from strength to strength every year, and the team’s meeting with MPs and Ministers in January reinforced the importance of political backing of UK sugar growers, and its significance in the future of UK farming. “We have now come to the end of the programme and once again received high levels of positive feedback from participants and I would strongly encourage younger growers to sign up and get involved.”

For further information on British Sugar and the NFU, please visit: www.britishsugar.com www.nfuonline.com/sectors/nfu-sugar/

Introducing James Northen – new Head of Sugar at NFU

“I’m delighted to have joined NFU Sugar at such an important time for our industry. Working closely with the NFU Sugar Board, my team will continue to represent the interests of all sugar beet growers in Britain. I’m a farmer’s son and have spent my entire 20 plus year career in the food sector. Over the last 14 years I’ve worked with companies across the food supply chain on issues as diverse as food security and integrity, sustainability, health, employability and skills. I’ve also worked in commercial roles at the Meat and Livestock Commission and in research and consultancy. Outside work I have three smallish children so spend most of my spare time being a taxi service and relationship mediator… I look forward to working with you and to contributing my thoughts in future editions.”

The BBRO Open Days will soon be upon us, providing a unique opportunity for growers to see the trial sites and meet the research and field teams behind the plots. There will also be an opportunity to see the 2018 Recommended List in a field environment. More details are available on our website www.bbro.co.uk/events/. Email invitations will soon be issued so please remember to book. I and the wider BBRO team look forward to meeting you.
I am really excited to be taking on the role of Editor of the Beet Review and look forward to working with Denise and the rest of the Beet Review team.

I would like to thank Paul Simmonds for his significant contribution as Editor over the last three years.

We are entering a very exciting and challenging time for the UK sugar beet industry. We have a very strong industry and are well positioned for the future as growers and processor working closely together backed by the excellent work of the BBRO. I aim to ensure we continue to use the Beet Review to communicate to growers the latest BBRO work as part of the industries exceptional knowledge exchange programme.

I have been in the industry for 27 years first as Crop Adviser at Cantley and then as Agricultural Operations Manager at both Cantley and Ipswich. I moved to Peterborough in 2001 and covered a number of commercial agricultural and business development roles before spending four years working with AB Sugar supporting our China business. I currently head up our Central Agricultural team at Peterborough.

We have a great industry with everyone striving hard to ensure it continues to thrive. I would therefore welcome suggestions for articles and contributions which you feel would help us all ensure we have a great home grown sugar industry both now and in the future.

Thank you.

Simon Leeds
Editor
Maximising sugar beet yields via fungicide applications to control foliar diseases

As thoughts turn to summer, agronomy decisions move away from weed control and herbicide applications, to watching for the first signs of powdery mildew and rust to enable fungicides to be applied in a timely manner. This will ensure that each sugar beet field remains disease free for as long as possible, ultimately leading to continued autumn growth to maximise yield potential. Fungicides remain one of the most important tools available to all UK sugar beet growers for disease control, and consequent positive impacts on yield. Previous BBRO trials since 2010 have shown that a two-spray programme on a typical crop harvested in November provides an average 6% yield increase from the first spray and an additional 7% from the second. Benefits of a third spray, applied in September, have been observed by growers when delivering their beet late in the campaign, and previous BBRO trials have seen an increase in sugar content of harvested roots by up to 1% when trial plots were lifted after Christmas. In this article disease risks for 2017, and the results from BBRO trials conducted in 2015 and 2016, are compared and discussed in relation to weather and your yield potential.

2015 and 2016 BBRO fungicide trials

For each year, two trials were undertaken at sites in Lincolnshire and Norfolk. The main aim of these was to compare the impact of drilling date and the number of fungicide applications on disease control, ultimately measuring the impact of these decisions on yield at harvest. Each trial was designed so that appropriate plots could be lifted either in October/November or after Christmas to compare the impact of fungicides on later harvesting and yield. These data build on previous BBRO knowledge and findings, and also provide field data to support the current SPOREID InnovateUK project too (Ref. 1).

Three drilling dates were planned; these were between mid-March and late April (Table 1) to produce different canopy sizes when the first fungicides were applied. This was achieved in 2015 but the extremely wet conditions in 2016, particularly in Norfolk, affected the proposed drilling times and the final plots there were not sown until June. The actual fungicide timings are included in Table 2.

Disease data

Once sprayed, trials were assessed for disease every four weeks until the end of the autumn. In both years, little, if any, powdery mildew (Pic. 1) was recorded in plots (data not shown); rust (Pic. 2) was the most important disease at both sites (Figs. 1 and 2). However, these results highlight just how different disease development can be between

### Table 1 – Drilling and harvest dates.

<table>
<thead>
<tr>
<th></th>
<th>Garboldisham</th>
<th>Hibaldstow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drill 1</td>
<td>16th March 2015</td>
<td>24th March 2015</td>
</tr>
<tr>
<td>Drill 2</td>
<td>30th March 2015</td>
<td>17th April 2015</td>
</tr>
<tr>
<td>Drill 3</td>
<td>17th April 2015</td>
<td>24th April 2015</td>
</tr>
<tr>
<td>Harvest 1</td>
<td>23rd October 2015</td>
<td>30th November 2015</td>
</tr>
<tr>
<td>Harvest 2</td>
<td>6th January 2016</td>
<td>22nd January 2016</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Garboldisham</th>
<th>Hibaldstow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drill 1</td>
<td>24th March 2016</td>
<td>22nd April 2016</td>
</tr>
<tr>
<td>Drill 2</td>
<td>13th May 2016</td>
<td>16th May 2016</td>
</tr>
<tr>
<td>Drill 3</td>
<td>13th June 2016</td>
<td>29th May 2016</td>
</tr>
<tr>
<td>Harvest 1</td>
<td>25th November 2016</td>
<td>11th October 2016</td>
</tr>
<tr>
<td>Harvest 2</td>
<td>11th January 2017</td>
<td>26th January 2017</td>
</tr>
</tbody>
</table>

### Table 2 – Treatments.

<table>
<thead>
<tr>
<th>Treatment number</th>
<th>End June</th>
<th>Disease onset (July)</th>
<th>End August</th>
<th>End September</th>
<th>October</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Untreated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 – Escolta</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 – Escolta/Escolta</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 – Escolta/Escolta</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 – Escolta/Priori Extra/Escolta</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>6 – Escolta/Priori Extra/Escolta</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>7 – Escolta/Priori Extra/Escolta/Priori Extra</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

All programmes started with a full rate application, followed by half rates for all successive applications.
years and show the importance of undertaking such trials over several years.

In 2016 at both sites, only 2% of the leaf area of untreated plots was found to be infected with rust by mid-October. In contrast, in 2015, 24% and 37% was found to be infected at Garboldisham, Norfolk and Hibaldstow, Lincolnshire respectively in mid-October (Figs. 1 and 2). As expected, fungicide applications decreased the area of rust on the leaf surface but the actual sowing date of plots and timing of treatments were key. For example, later sown crops tended to have lower levels of disease early in the season. In 2015, when fungicides were applied before disease onset (the two-spray early treatment), there was a higher level of rust in these plots later in the season, as a consequence of treatments losing efficacy with time but with the disease still entering and infecting the plants during the autumn.

Yield data

Positive yield responses were observed from most fungicide treatments in 2015, although actual yield responses to equivalent treatments varied between the two sites (greater gains tended to be observed at Hibaldstow). Yields were also influenced by drilling date and the number and timing of treatments (Figs. 3 and 4).

Later sown plots tended to have lower levels of disease earlier in the season. However, such delayed drilling impacted on canopy development leading to lower photosynthetic potential in the early part of the season and consequently these plots suffered yield penalties over earlier sown crops regardless of disease control. This emphasises the importance of sowing crops as soon as possible, when conditions allow, to maximise yield return.

In 2016, yield responses to fungicide application were more varied regardless of harvest date and were clearly influenced by sowing date too, especially as the last sowing at Garboldisham was in June! The lack of disease and the heavy rain events, particularly those experienced at the Garboldisham site, also had an influence on soil structure (with some compaction) and overall yield (Figs. 5 and 6).
Cercospora leaf spot latest

Cercospora leaf spot (Pic. 3) can be a devastating disease in mainland Europe and North America where growers often apply up to EIGHT (no this isn’t a typo!) fungicide applications to control it; usually, growers have to use resistant varieties too. The disease is normally favoured by warm/hot weather, with high humidity or rainfall (such as thunderstorms), and can decrease yields by up to 40%. However, in the UK, it is not as our weather is not conducive for its development, although each year it can be found in some fields, particularly spray-miss areas, later in the season. Yield losses due to this disease under our conditions are considered minimal.

Unfortunately, in 2016, cercospora leaf spot could be found in most UK fields by the end of September, possibly favoured by the very warm, or even hot conditions experienced in August and particularly September (for example, 32°C in Cambridge on the 14th September). Although this disease is still not thought to have caused any significant yield losses during the 2016/17 season, particularly as most crops received at least one fungicide spray, it does serve as a timely reminder that disease threats can change. More worryingly, the latest analysis of three isolates collected by Bayer for resistance testing of cercospora leaf spot isolates across Europe, showed that all the UK isolates were resistant to strobilurin active ingredients. This resistance issue is similar to the threat already faced by other European countries, and will be something that will need to be closely monitored during 2017, as there is a high risk of disease carry-over to the new crop.

And don’t forget stemphylium...

Stemphylium (Pic. 4) also made a return in 2016 after its first appearance in the UK in 2014 (Ref. 2). Again, the BBRO will be watching how stemphylium develops in the UK, and would appreciate any observations that may relate to this disease as the 2017 season progresses.
Conclusions

Fungicides remain key to protecting the crop from foliar diseases whilst maintaining canopy cover for autumn growth, early frost protection and maximising overall yield potential. The trials in 2015 and 2016 continued to show good control of rust, the most abundant disease during these two years, although yield responses were more variable and not all treatments provided significant yield increases as seen in previous years, possibly reflecting the very variable weather and the impact this had on overall disease build-up, particularly during 2016.

In February and March 2017 only 20 ground frosts were recorded at the base weather station at Broom’s Barn, Suffolk. Consequently, the powdery mildew forecast indicates that 48% of the national crop is at risk from infection of this disease. However, with most of the crop now protected by a fungicide by early August, and with less than ideal weather for mildew development in recent years, this disease appears to have become less important than it used to be, and so rust may well be the disease to watch. However, as the 2015 and 2016 data show, weather will have a major influence on all the diseases, their development and prevalence.

In 2017, monitor crops for all diseases from June onwards, and apply a fungicide when conditions allow once disease is found and the crop is at full canopy closure (GS39). The BBRO bulletins will also provide regular updates of disease observations recorded across the four factory areas, and the BBRO Plant Clinic is available to confirm the cause of any unusual or uncharacteristic symptoms in your field.

References


Sugar beet varieties for 2018

The layout of the BBRO/BSPB Recommended List (RL) of sugar beet varieties has been changed for the 2018 list; this article explains the new format, provides a background to these data and introduces the six new varieties that have been added.

New look RL table for 2018

A number of growers had commented that the landscape format of cereal and other RL tables was easier to use than the portrait format used for sugar beet. So it was decided to change the RL to landscape. This allows the RL and Descriptive List (DL) to be combined, and also provides an easier comparison of varieties across different traits.

Beet Cyst Nematode (BCN) tolerant varieties were placed on the DL when first introduced because, although they were lower yielding than conventional varieties in the absence of the pest, they had such an important role to play in fields infested with BCN. Current new BCN varieties no longer yield significantly less than susceptible RL varieties, and they are now considered as fully recommended varieties for general use. However, there are some potential concerns regarding overuse of BCN varieties on non-infested fields, so please discuss this with BBRO or the breeders before using in non-infected situations.

In the new tables (pages 13 and 14-15) the fully recommended varieties are placed to the left with all provisionally recommended varieties to the right. The one variety listed for special use only (Sandra KWS, for use in AYPR rhizomania situations) is placed to the far right. This allows growers to compare easily their recent main-stay varieties with the newer, often higher yielding entries. As most growers use adjusted tonnes rather than sugar yield, the ranking of varieties has been changed to reflect this.

A new supplementary table (pages 14-15) shows the three-year means of the varieties for the different traits measured. It also shows the provenance of the seed used in trials i.e. whether the seed was supplied as part of a commercial bulk or was from a smaller breeder’s seed lot (see section on Provenance for more details).

New additions to the RL

Six new varieties are added: Daphna and Senada KWS from KWS UK Ltd, Landon and Degas from Strube UK Ltd, BTS 3325 from Limagrain UK Ltd, and Bloodhound from SESVanderHave UK Ltd. Daphna is BCN tolerant.

All listed varieties are Rz1 rhizomania varieties with partial resistance to standard strains of rhizomania. Sandra KWS has an additional gene and has partial resistance to the AYPR strain of the disease.

Yield

Yield is the main criterion used by growers when selecting varieties, and the supplementary table is important as it shows the stability or variability in the data over the three years of trials used to determine the RL. Differences of less than 3% in adjusted yield should be treated with caution, as should differences in sugar content of less than 0.3%.

The trials are harvested with a six-row plot harvester (Pic. 1) and taken to the BBRO terrace at Wissington where they are cleaned and weighed before passing into the factory terrace for analysis on the normal commercial line.

The yield data are presented as a three-year mean based on 25 trials in total (eight in 2014, seven in 2015 and ten in 2016) with a mean plant population of 106,000/ha (see Establishment section for more details). Yield ratings are presented in comparison to the mean of the five control varieties of the latest trial year; in 2016 these were Cayman, Springbok, Haydn, Hornet and Pasteur.

The top three varieties for adjusted tonnes are newly provisionally recommended Daphna, Senada KWS and Landon. All three have shown consistent high yield potential over their three years of trials from breeders’ seed. The highest yielding PR2 varieties (with 2016 results from commercial seed) are Darnella KWS, Cantona KWS, Alisha KWS and BTS 860 closely followed by the PR3 varieties (with 2015 and 2016 results from commercial seed) Sabatina KWS and BTS 470.
Alisha KWS and Landon are the two conventional varieties with highest sugar content and Leesha KWS the highest BCN tolerant variety.

**Bolting**

The bolting data in the tables are calculated assuming a final population of 100,000 plants/ha (the BBRO target population for UK beet crops). Two sets of data are provided, one for normal sowings and one for early sowings. The early sown bolting data are derived from special trials sown between 21st February and 5th March, and should be used to compare varieties when considering sowing before mid-March or in cold conditions when high levels of vernalisation (which is a trigger for bolting) are expected. Those varieties marked with a red X are considered unsuitable for sowing before the middle of March. The 2014 early-sown trials had lower bolting levels than 2015 and 2016 because the trials were subjected to lower vernalisation that year. Details of the actual vernalisation experienced in the early-sown bolters trials can be found in tables on the RL section of the BBRO website (bbro.co.uk). These data also illustrate how the risk of vernalisation, and consequently bolting, usually declines the later the beet is sown. However, delayed sowing needs to be balanced against a potential reduction in yield.

The better varieties for early sowing, having consistently low early-sown bolting counts, are Bloodhound, BTS 3325 and Haydn.

For drilling after mid-March, the normal-sown bolting data should be used. These show the bolting levels experienced in the main yield trials, which are usually sown from the middle of March onwards.

The better varieties for normal sowing with consistently low normal-sown bolters are Bloodhound, Degas, BTS 860 and Haydn.

**Establishment**

A large number of varieties are compared in the trials (usually around 120 each year). This means that the trials are large and require even conditions across the whole area in order to allow accurate comparisons. In the past, the main cause of loss of trials was poor establishment or pest damage in a small area of a trial. Losses of trials are reduced if they are close-sown and gapped. Therefore, the current trials are sown at 9 cm spacing and gapped by hand hoeing when the crop is between the two- and four-leaf stages to produce a final even population of at least 100,000 plant/ha. This has saved around three trials per season compared to the previous sown-to-a-stand method; increasing data and ensuring the trials represent value for money to the levy payer and breeders.

The aim is to achieve an even population of 100,000 plants/ha to compare the genetic yield potential of the varieties. Establishment is the actual population measured prior to the gapping process. Whilst this count is taken slightly earlier than the traditional time of determining field establishment, it is a good measure of the differences in establishment as a result of the varieties genetics.

Pre-gapping establishment ranges from 103.3% to 96.3% of controls (100%), so differences between recommended varieties are small. For early sowing and/or where establishment can be difficult, varieties with higher establishment levels should be considered; these are Salamanca KWS, Landon (unsuitable for early sowing due to high bolting levels), Cayman, BTS 470 and Bloodhound.

Notwithstanding this, all seed must pass the stringent specification for seed certification to be sold in the UK.

**Rust and powdery mildew**

The rust and powdery mildew data are obtained from special trials that assess each variety’s reaction to these diseases. These trials are not taken to yield and are not treated with fungicide; except where the rust trials are at risk from heavy powdery mildew infection, then they may be treated with quinoxyfen (e.g. Fortress) to retard development of that disease. In contrast, the main yield trials are treated with a robust fungicide programme according to the host grower’s normal practice.

The data for the diseases do not indicate whether a variety is resistant or tolerant to a disease, but simply that the disease was recorded on the foliage in the trials. Note that disease infection in the RL table is shown using a 1 to 9 scale with 9 denoting a low level of infection whilst data in the supplementary table are actual % leaf infection.

Varieties are not entered in the disease trials until their third year of testing in the trial system. Therefore, it is not until varieties are in PR3 that there are three years of disease data. The level of powdery mildew in 2014 was too low to distinguish between varieties, therefore the data for powdery mildew is generally weaker than that for rust. In 2017 powdery mildew will be assessed in glasshouse trials as these should provide a more repeatable infection challenge from year to year.

Varieties with the lowest infection of rust in disease assessment trials are Leesha KWS, Landon, Alisha KWS and BTS 3325. Those that were more susceptible were Darnella KWS, Firefly and Flexter.

**Downy mildew**

This disease was noted in the yield trials in 2014 and, particularly, in 2015. The records taken suggested that some varieties had fewer symptoms of downy mildew than others (for more details contact BBRO or the breeders). Usually this disease has a patchy distribution and a variable occurrence year to year, and so it is seldom at a level that can be assessed in the main RL trials.

**BCN tolerance**

From the 2017 drilling season, all BCN varieties have a grey coloured pellet to distinguish them from BCN-susceptible varieties (see Pic. 2). Different shades of the colour are used for the insecticide seed treatments. The BCN varieties are included as
BETASEED. SIMPLY DIFFERENT.

<table>
<thead>
<tr>
<th>BTS 860</th>
<th>BTS 470</th>
<th>BTS 3325</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCELLENT YIELD &amp; HIGH SUGAR CONTENT VARIETY</td>
<td>HIGH YIELD VARIETY</td>
<td>GOOD YIELD ESPECIALLY FOR EARLY SOWING PERIOD</td>
</tr>
</tbody>
</table>
in the main RL trials to assess yields under uninfected conditions and therefore yields are directly comparable to the conventional varieties.

Owing to the variable distribution of BCN that is common in infected fields, it has not been possible to compare yields of the BCN varieties under infected conditions. All varieties on the list are regarded as tolerant to BCN and restrict the build-up in an average season; growing sensitive (non-tolerant varieties) could result in up to a seven-fold increase.

Currently, the breeders are required to confirm the tolerance of their BCN varieties prior to listing on the RL, although BBRO continue to investigate methods to provide an industry-wide assessment of such varieties. The tolerance is only against BCN, and growers should verify that nematodes present in their fields are specifically BCN and not free-living (Docking disorder) or other cyst nematodes such as Potato Cyst Nematode.

Growers considering growing a BCN variety on land where BCN has not been identified should discuss their requirements and risks with the breeder, BBRO and/or their Area Manager before ordering.

**AYPR rhizomania**

AYPR is a more aggressive strain of rhizomania, but fortunately infects only a very small proportion of the UK sugar beet area. If you suspect it is present in your fields consult your area manager or BBRO for advice. Resistance to AYPYR is confirmed in glasshouse tests carried out by the BBRO; new varieties are not tested in infected fields as part of the RL programme. Sandra KWS is the only variety on the RL that has enhanced resistance to this strain. It should only be used in AYPYR infected fields as it has a lower yield than other varieties in unaffected situations.

**Provenance of seed used in the RL**

Candidate varieties are usually tested using 1 kg samples of seed supplied by breeders. Once the variety has been provisionally recommended for commercial use, the seed is drawn from the commercial bulks as supplied to Germains. The bold figures in the supplementary table indicate varieties that have been tested with commercial seed: usually 500 units or more. PR1 varieties have only been tested using breeders’ seed provided as 1 kg sample. PR2 are likely to have been tested with commercial seed in the most recent test year but with breeders’ seed in the previous two. Similarly, PR3 are likely to have been tested with commercial seed in the most recent two seasons whilst only data for R varieties are likely to have come from trials using commercial seed in all three years. Since 2016, trials seed taken from seed lots smaller than 500 units are always classified as breeders’ seed. The data where all three years are in bold are most reflective of the commercial situation.

**Other characteristics**

There is no evidence from the trials to indicate that any recommended variety shows a response to early or late lifting or frost resistance, but BBRO are planning to do some trials on lifting date. In recent years the differences in top size between varieties have been small, and no records were taken. However, some differences between candidate varieties are now apparent, and top size may be recorded in the future.

**Impurities** (sodium, potassium and amino nitrogen) are measured in the tarehouse as part of juice quality assessments. At present there are no important differences between varieties so these characters are not presented in these tables. However, these data are available in the varieties section of the BBRO website.

**Preparation of seed**

Raw seed for use in the trials is supplied by the breeders as either breeders’ seed or a commercial bulk (see Provenance above). Germains process the seed and pellet them on a special trials line using the same techniques as they would use to treat normal growers’ seed. The treatments include thiram, tachigaren and Germains carbon plus pellet, but the seed is not primed. The reason for this, is that priming of small seed lots adds a further interaction in evaluating varietal performance and is difficult to perform reliably on small seed lots in time for use in the trials. The seed insecticide treatment for seed is clothianidin plus beta-cyfluthrin (Poncho Beta). Otherwise, the pellet type and treatment are the same as for the UK commercial seed supplied to growers.

**Acknowledgements**

The BBRO RL is derived from trials data from a programme of RL and National List trials. The tests are carried out by BBRO, British Sugar, KWS, NIAB and SESVanderHave with funding from BBRO and the member companies of the British Society of Plant Breeders (Limagrain UK Ltd; Lions Seeds Ltd; KWS UK Ltd; SESVanderHave UK Ltd; Strube UK Ltd; Syngenta Ltd).

**Definitions of susceptibility to pathogens.**

<table>
<thead>
<tr>
<th>Susceptible</th>
<th>A variety that becomes infected by a pathogen and shows full symptoms of the disease; significant yield penalties can result.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolerant</td>
<td>A variety that is infected by a pathogen to the same extent as a susceptible variety but may express few symptoms. Increased yield performance.</td>
</tr>
<tr>
<td>Partially-resistant</td>
<td>A variety that is infected by a pathogen, but the pathogen is inhibited in its movement or multiplication. The plant shows few or no symptoms and provides good to excellent yield performance.</td>
</tr>
<tr>
<td>Complete resistance (immunity)</td>
<td>A variety that is not affected by the pathogen at all.</td>
</tr>
<tr>
<td>Multiple resistance</td>
<td>Inclusion of more than one resistance genes to protect against different pests and/or diseases.</td>
</tr>
</tbody>
</table>

**Disclaimer:** The data provided on these pages are the intellectual property of the BBRO/British Society of Plant Breeders (BSPB). BBRO/BSPB seeks to ensure that the data provided are accurate. However, subject to the operation of law no liability is accepted for loss, damage or injury however caused or suffered directly or indirectly in relation to information and options contained in or omitted from these pages. These data are provided for the purpose of determining the choice of sugar beet varieties for planting and for no other purpose without the written agreement of BBRO. The information must not be published without the express written agreement of BBRO except for printing copies for personal use. © 2017 BBRO.
Sugar Beet Recommended List 2018

Rz1 rhizomania varieties

<table>
<thead>
<tr>
<th>Status: (C) = control variety</th>
<th>Cayman</th>
<th>Thor</th>
<th>Springbok</th>
<th>Haydn</th>
<th>Horset</th>
<th>Stingray</th>
<th>Pasture</th>
<th>Daphna</th>
<th>Sanden KWS</th>
<th>Lundén</th>
<th>Danniel KWS</th>
<th>Cantonan KWS</th>
<th>Atlantis KWS</th>
<th>BTS 315</th>
<th>Sabellana KWS</th>
<th>BTS 470</th>
<th>BTS 3235</th>
<th>Salamanca KWS</th>
<th>Dagga</th>
<th>Leesha KWS</th>
<th>Bloodhound</th>
<th>Fixter</th>
<th>Firefly</th>
<th>Aurora</th>
<th>Sandra KWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CROP YIELDS</td>
<td>MEAN</td>
<td>Adjusted tonnes % of C=100%</td>
<td>113.6 t/ha</td>
<td>100.4</td>
<td>100.2</td>
<td>100.2</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>99.4</td>
<td>106.9</td>
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<tr>
<td>Sugar yield % of C=100%</td>
<td>17.3 t/ha</td>
<td>100.5</td>
<td>100.4</td>
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<tr>
<td>Root yield % of C=100%</td>
<td>96.5 t/ha</td>
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<tr>
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<tr>
<td>BOLTER S per 100,000 plants/ha</td>
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<td>Early sowing, before 5 March</td>
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<td>Normal sowing</td>
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<tr>
<td>AYPR (Aggressive rhizomania)</td>
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<tr>
<td>BCN (as claimed by the Breeder)</td>
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<td>BREEDER/UK CONTACT</td>
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<td>Breeder</td>
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<td>STR</td>
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<td>STR</td>
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<td>SV</td>
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<td>STR</td>
<td>KWS</td>
<td>SV</td>
<td>SYN</td>
<td>SV</td>
<td>SV</td>
</tr>
</tbody>
</table>

1. Newly listed varieties (PR1/PS1) have results from three years using approximately 1 kg breeders’ seed. The after commercial seed should be used in RL trials. (See supplementary table).
2. Yields based on an average plant population of 106,000 plants/ha in these trials. Differences in yields of less than 3% should be treated with reserve.
3. The ratings from normal sowings are applicable for sowing after mid-March in most seasons.
4. Observations taken from inoculated trials not taken to yield.

(Brackets indicate figure derived from fewer than 3 years of data.)
## Rz1 rhizomania varieties
### 3-year data

**Status:** (C) = control variety

<table>
<thead>
<tr>
<th>Variety</th>
<th>Cayman</th>
<th>Thor</th>
<th>Springbok</th>
<th>Haydn</th>
<th>Hornet</th>
<th>Stingray</th>
<th>Pasteur</th>
<th>Daphna</th>
</tr>
</thead>
<tbody>
<tr>
<td>R(C)</td>
<td>R</td>
<td>R(C)</td>
<td>R(C)</td>
<td>R(C)</td>
<td>R</td>
<td>R(C)</td>
<td>PR1</td>
<td></td>
</tr>
</tbody>
</table>

**AYPR/BCN as claimed by the Breeder:**

- BCN

**ADJUSTED TONES (Gapped Trials)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean</th>
<th>% Mean of (C)</th>
<th>T's per ha</th>
<th>% Mean of (C)</th>
<th>T's per ha</th>
<th>% Mean of (C)</th>
<th>T's per ha</th>
<th>% Mean of (C)</th>
<th>T's per ha</th>
<th>% Mean of (C)</th>
<th>T's per ha</th>
<th>% Mean of (C)</th>
<th>T's per ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>113.6</td>
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<td>2015</td>
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<tr>
<td>2014</td>
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**SUGAR YIELD (Gapped Trials)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean</th>
<th>% Mean of (C)</th>
<th>T's per ha</th>
<th>% Mean of (C)</th>
<th>T's per ha</th>
<th>% Mean of (C)</th>
<th>T's per ha</th>
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<tr>
<td>2016</td>
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<td>17.4</td>
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<td>99.7</td>
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**ROOT YIELD (Gapped Trials)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean</th>
<th>% Mean of (C)</th>
<th>T's per ha</th>
<th>% Mean of (C)</th>
<th>T's per ha</th>
<th>% Mean of (C)</th>
<th>T's per ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>96.5</td>
<td>101.2</td>
<td>101.7</td>
<td>99.6</td>
<td>100.1</td>
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<td>101.4</td>
<td>97.7</td>
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</table>

**SUGAR CONTENT (Gapped trials)**

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<th>Mean</th>
<th>Sugar %</th>
<th>% Mean of (C)</th>
<th>Sugar %</th>
<th>% Mean of (C)</th>
<th>Sugar %</th>
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**EARLY SOWN BOLTERS**

<table>
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<tr>
<th>Year</th>
<th>Mean</th>
<th>Bolters/ha (per 100,000 plants)</th>
<th>Sown on or before 5th March</th>
<th>Mean</th>
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</thead>
<tbody>
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<td>4,070</td>
<td>10,169</td>
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**NORMAL SOWN BOLTERS**

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**PRE-GAPPING ESTABLISHMENT**

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**RUST**

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**POWDERY MILDEW**

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Data in bold from commercial seed.

Additional data tables for impurities and vernalisation days experienced by the early sown bolting trials are available in the variety section of the BBRO website (bbro.co.uk)
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**BCN** (as claimed by the breeder) | **AYPR** (Aggressive rhizomania) | *_* denotes insufficient or no data
British Sugar backs UK beet growers ahead of European quota lifting

New report suggests end of EU sugar quotas offers exciting opportunity to boost beet production

By Paul Kenward, Managing Director, British Sugar plc

2017 marks a significant year not only for the UK’s farming industry in the wake of Brexit negotiations, but also the future of the British sugar industry, as it prepares to go through its biggest change for a decade.

In October this year production quotas and export limits will be lifted, freeing us to grow and sell as much sugar as we choose. The European Union (EU) restrictions, which were imposed in 2006, are to be abolished as part of a reform of the Common Agricultural Policy. The reforms will mean that European producers can export as much as they like, and while export limits will be abolished, it will also mean that the guaranteed price for sugar beet farmers will be eliminated. And with these changes, the industry is being discussed more than ever before, as a fair deal for beet becomes a key priority for the UK’s beet growers and producers.

There has been much debate about how these changes will play out, but at British Sugar we are excited about the opportunities that lie ahead. We continue to supply 60% of the UK’s demand for sugar, and our commitment to the country’s sugar beet growers remains as strong as ever. In the wake of the upcoming policy changes we have commissioned a report to assess the importance of the UK beet sugar industry to the country’s regional economies, and to fully understand the impact of British Sugar’s future performance and its ripple-down effect on rural communities.
Contributing to local economies: The ripple effect

‘British Sugar: A homegrown success story’ outlines the significant contribution the UK beet sugar industry makes to the communities in which it operates, and its distinct multiplier effect. British Sugar currently partner with 3,500 growers and we employ 1,400 skilled people. Given the complex nature of the sugar production process, the growth and refinement of sugar beet requires a skilled and efficient workforce. The British beet sugar value chain also supports up to 9,500 jobs in the UK economy.

The report’s findings show that the sugar industry, which involves 7,000 different firms, has a significant impact on rural areas, particularly in the east of England. British Sugar is one of the largest customers for many goods and services in the region, and we are confident that the policy change in October will create more opportunities in new markets, with greater capacity to increase sugar production.

Working with growers: Improving efficiency and higher yields

With the end of EU sugar quotas, there are likely to be more opportunities for sugar beet growers, and beet factories to operate at full capacity.

British Sugar is optimistic that improved growing efficiency and higher yields should mean that existing growers will grow more beet in the future, with opportunities for more growers to come on board. We continue to work closely with NFU Sugar and growers to improve productivity across the entire sugar beet supply chain. Each manufacturing site works to an improvement plan, and with seed breeders continually looking for improvements through enhanced varieties, and growers constantly exploring technical innovations, together we are helping to drive productivity.

Beet sugar yields in the UK have improved by more than 25% in the last ten years, and British growers achieve higher sugar yields than most of the EU. Over the past five years we have invested £250 million in our four advanced manufacturing plants, introducing new technology and practices to improve resource efficiency. Our factories are now some of the most efficient in the world. And the combined investment in our operations and R&D, together with growers’ improved efficiency, enables us to produce much more. The British sugar sector is truly a world leader, and we hope that the ultimate outcome of Brexit will enable us to capitalise on this joint expertise.

The lifting of quotas will mean that we can grow well over the 8 million tonnes of beet a year we currently process across the UK, to produce about 1.5 million tonnes of sugar – which would allow us to significantly increase our exports. It also means we can continue to grow and invest in our four factories in the East Midlands and East Anglia.

The beet industry: More than sugar

The research shows that the benefits of the UK’s sugar industry reach is far beyond the production of white sugar for industrial and retail use. The refinement of sugar beet not only produces its well-known end product, but also a number of co-products. Improved efficiency throughout the whole production process has led to waste reduction (British Sugar’s production process produces virtually zero waste with less than 200 grams of waste...
for every tonne of sugar produced), as well as the ability to use and recycle elements such as water and topsoil.

25% of our revenue is from non-core sales. In addition to topsoil being sold for landscaping (80,000 tonnes of British Sugar’s topsoil was used to landscape the Olympic Park), lime is used for soil conditioning, and stones are recycled for the building industry. Additional sugar co-products include animal feed (500,000 tonnes of animal feed are produced annually from sugar beet pulp), chemicals for the cosmetics industry, and liquefied carbon dioxide for a range of industries.

The sugar production process also generates enough electricity to power a city the size of Peterborough, and through its Combined Heat & Power plants, we export electricity back to the national grid.

Sugar beet: A valuable part of UK agriculture

As growers are aware, sugar beet is also a cornerstone crop of arable rotations and is commonly grown in conjunction with wheat, barley or pulses. Its growth as a rotational crop means that it is an important contributor to the sustainability of the UK’s arable farming sector. Its production not only supports in reducing soil erosion, but also in increasing soil fertility and crop yield. It provides a valuable break crop returning organic matter to the soil and preventing the build-up of disease.

Moreover, sugar beet rotation has a positive impact on biodiversity, particularly for bird life, providing cereal stubbles for winter habitat and food, whilst providing a nesting ground in spring. A wide variety of species benefit in this way, including internationally important populations of stone curlews and pink footed geese.

The success of the sugar industry, and the wider benefits not only to regional economies and communities, but also to the environment and the UK’s agriculture sector are clear. And with the lifting of EU quotas in October this year, beet growers and businesses should be optimistic about their opportunities to prosper.

Backing British beet growers

In the run up to October, and as part of the Government’s negotiations following Brexit, British Sugar is working hard to ensure a level playing field for sugar producers, and I am optimistic that with the right tariff framework in place, the UK sugar beet industry can continue to prosper.

By working in partnership, I am confident that the dismantling of the EU sugar regime will present opportunities for beet farmers, enabling us to jointly maximize the returns from the marketplace in a new commercial environment.

British sugar has been a homegrown British crop for more than 100 years, and with its success firmly rooted in the efforts and accomplishments of its farmers, this is a success story that could expand significantly in years to come.

To keep in touch with the latest information on British Sugar, please visit www.britishsugar.com
Backing British Farming For Over 50 Years

Maximise Your Sugar Beet Crop with Germains' Seed Technologies

Germains continues to be committed to delivering innovative seed technologies to the UK's Sugar Beet Industry.

Benefits of Xbeet® Seed Technologies:

1. Increased tolerance in stressful conditions
2. Faster field emergence
3. Improved uniformity
4. Increased yield potential

Supporting UK Growers

Tessa Seymour
Commercial Development Manager

Dedicated to backing British farming by promoting sustainable and environmentally friendly cultivation practices, Tessa Seymour works directly with UK sugar beet growers in trialing new seed treatments to help increase your yield.

Contact Tessa for more information about our current and future products:

Xbeet®enrich®

M: +44 (0) 7889 593 146
E: tseymour@germains.com

germains.com

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The President of the NFU, Meurig Raymond, delivered the opening address at the International Convention Centre in Birmingham. He emphasised that, whether it be access to markets, trade and labour, the recognition for environmental work or the economic contribution that agriculture delivers to the UK economy, the farming industry needs government commitment, and our sector needs to unite to provide a strong voice into Westminster.

Agricultural policy post-Brexit was also high on the agenda, with the NFU making clear that a future domestic agriculture policy should enhance the productivity and competitiveness of farm businesses, recognise and reward the environmental goods that farmers deliver, and help mitigate volatility where it impacts on farm commercial viability.

So the message to Defra’s Secretary of State, Andrea Leadsom and Minister George Eustice was clear: we need the best access to available markets and a labour policy in place now, to deal with the needs of agriculture in 2019 and onwards.

These messages were carried over to the Sugar breakout session. Matteo Lagatti, independent consultant to NFU Sugar, started the breakout session with a presentation of his work looking at the linkage between the World and European beet prices. Matteo’s commentary highlighted that European sugar prices have not been strongly correlated with world markets, despite the assumption that they are linked. European prices are much more dependent on European supply and demand. This outcome provided some food for thought both for NFU Sugar growers and British Sugar, and gave an indication of the analysis that could help growers get the best returns from the market.

For sugar beet growers, it was encouraging to hear the recent advocacy work of British Sugar for the benefit of the Sugar industry in the UK. Paul Kenward, Managing Director of British Sugar, described the recently published ‘British Sugar: A homegrown success story’. This has the purpose of putting homegrown sugar production as a clear economic, social and environmental win.

For UK agriculture, and the beet sector to be competitive global players, UK production needs to be resilient and profitable. Growers need government commitment on labour and trade, retailer commitment on sourcing, and wider support for the economic advantages that British agriculture delivers to wider society. From the dialogue at the NFU Conference, the NFU will continue to communicate the case for UK agriculture; NFU Sugar, alongside British Sugar, will be pushing for the needs of UK sugar producers to be at the centre of the discussion.

A final thank you and acknowledgement from the growers was given to William Martin, the outgoing NFU Sugar Board Chairman, who stood down at the end of February after nine years of service.
New grower days

British Sugar is looking to increase the crop area for 2017/18 campaign after the lifting of European Union sugar quotas in October 2017 and addressing high stocks carried over from 2014/15. The current increase of over 30% in area has come from existing growers taking on additional tonnage, and for the first time in many years, new (or ex-growers) have the chance to grow sugar beet for British Sugar.

To support new and returning growers and provide them with an introduction to the UK beet sugar industry, two joint meetings hosted by British Sugar, the NFU and BBRO, were held earlier this year.

Everyone had the chance to hear from Colm McKay – Agriculture Director for British Sugar, introducing British Sugar and the confidence that growers can have from British Sugar being part of the AB Sugar Group, as well as part of Associated British Foods plc. Colm also spoke about how the company is committed to finding workable solutions to the obesity crisis and educating people on the role sugar can play in the diet through the Making Sense of Sugar campaign (www.makinsenseofsugar.com).

William Martin (then Chair of NFU Sugar Board), spoke about the work of NFU sugar, pointing out that there is no other crop where the sampling and analysis of loads delivered by growers receives such scrutiny.

Colin MacEwan – Head of the BBRO introduced the work of the BBRO, explaining how it is jointly BBRO funded by growers and British Sugar. Colin also described the governance process and the uniqueness of the Knowledge Exchange programme with such a short ‘supply chain’ allowing growers to readily benefit from the BBRO work to drive the competitiveness of the crop on farm.

The last of the presentation sessions was British Sugar Agriculture, introducing the work they do to support growers in maximising the return from the crop on farm by focusing on driving crop yields.

We were delighted to take growers around the factory to see first-hand the delivery and sampling of sugar beet to the factory and then the processing of the beet into sugar.
Focus on the lack of liming

Introduction

Current liming trends in both arable and grassland rotations have remained static for over a decade. At the same time, robust survey data shows that whilst there are big differences in liming practice by crop, approximately 20% of arable land and over 50% of grassland remain at or below pH 6.0. At these levels, applied fertiliser efficiency is being compromised, resulting in reduced crop yield, and quality at sub-optimal pH levels. Furthermore, not all liming products are of equal quality, and many farmers are unaware of the quality parameters that will determine a liming material’s capacity to correct pH and increase available calcium in their soils. In times of economic pressure, liming has often been one of the first inputs to be deferred or, at worst, cut out completely. This article will review current liming trends, present quality criteria for product selection, and re-examine the true value of liming relative to cost.

Liming trends

For almost two decades the annual rate of liming, as recorded in the British Survey of Fertiliser Practice (Ref. 1) has fundamentally remained static (Fig. 1).

The 10-year average trend to 2015 shows that less than 9% of arable land, and less than 4% of grassland is being limed annually. However, the long term liming trend (Fig. 2) collated over time shows a very different picture, and in real terms over this c.80-year period, there has been a doubling in the 1950s and 1960s then falling to only a modest increase in overall liming compared to 1937.

What drove the change in lime use from 1937? Following a decade of agricultural depression and the increasing risk of war in Europe, there was concern for future food security. So in 1937 a scheme was introduced to subsidise the spreading of lime on agricultural land to boost soil fertility and the Minister of Agriculture was given powers to regulate the cultivation and management of land, end tenancies and even take possession of land, under the Defence of the Realm Regulations.

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Fig. 1 – Percentage area limed (1997 to 2015) as recorded by the British Survey of Fertiliser Practice.
On 1st September 1939, these powers were delegated to County War Agricultural Executive Committees – known as the ‘War Ags’, and war was declared on 3rd September 1939. The UK entered the war prepared for the maintenance of food supply but with less than 40% of the country’s needs home produced. The Ministry of Food was formed on 8th September and became the sole food buyer and importer, regulating prices, and so guaranteeing farmers prices and markets for their produce. Recruiting began for the Women’s Land Army and, in 1940, food rationing was introduced and remained until July 1954, nine years after the war had ended.

The increase in total lime use peaked in the mid 1950s to over six million tonnes, however there was reluctance to remove the subsidy.

The ‘Agricultural Lime Schemes Order’ was subject to significant debate, as recorded in the following extract from the House of Commons Debate on 2nd July 1959 at 10.23 pm (Ref. 3). This was led by the Joint Parliamentary Secretary to the Ministry of Agriculture, Fisheries and Food, Mr. J. B. Godber – MP for Grantham:

“I beg that the Agricultural Lime Schemes (Extension of Period) Order, 1959, that applies to the whole of the United Kingdom is extended for five years. The lime subsidy enables the farmer a refund of 60% of his liming costs – in recent years increasing in the summer to 70%, to encourage farmers to lime hill, grassland and marshy and other land on which summer liming is practicable. The cost of the subsidy for the whole of the United Kingdom is between £9 million and £10 million per annum. Soil chemists of the National Agricultural Advisory Service estimate we are short of that target by about 30 million tons of lime product. 9 million tons of liming materials a year would have to be applied to the soils of the United Kingdom to get the position right over, say, the next six years, nearly half of this quantity being required to replace our annual lime losses. The current rate of consumption is close to the practical limit of agricultural lime production under average conditions. Average consumption for the last four years has been six and a half million tons of lime product for the United Kingdom”.

To put this into context, the subsidy cost would be equivalent to at least £190 million per annum today! So the benefit of liming was taken extremely seriously. Lime use data since 1995 has been harder to estimate. Total lime use is currently in the

Fig. 2 – Estimated lime use in the UK from 1937 to 1995; source Agricultural Lands Preservation Committee (ALPC), MAFF and Defra (Ref. 2).
Amongst sugar beet growers defies the England and Wales trend (Fig. 2) for arable and grassland rotations (Fig. 6), so it would appear that beet growers ‘get it’ when it comes to the value of liming!

In the case of sugar beet rotations, value of liming is better understood, with the entire rotation benefitting from optimal soil pH for maintained plant health that will underpin yield.

Lime quality

Many natural liming products used in agriculture are derived from crushed limestone and chalks. Agricultural Lime quality is regulated by UK or EU regulation; known as ‘partial-harmonisation’ and producers decide their marketing compliance. The majority of UK producers adopt the UK standards. The development of new EU regulation, based on easier access for recycled and waste materials, will see safety and efficacy as the principal criteria. Longer term it may not be inconceivable, despite Brexit, the UK might adopt EU regulation as the sole standard.

‘The UK Fertilisers Regulations 1991’ have stood the test of time, but from a liming materials perspective falls short

Consider now the annual cost of primary macro-nutrients. Work conducted on mineral soils in the USA and reported in ‘Efficient Fertilizer Use Manual – Soil pH Management’ (Ref. 5), draws attention to the impact that sub-optimal pH can have on the utilisation of applied N, P and K fertilisers (Fig. 5).

This reduction in N and P efficiency from pH 7.0 is not linear, and the absolute values may be challenged; however the principle is robust and would suggest that the minimum pH on a mineral soil should be 6.5 for arable and grassland rotations.

However, the liming trends are not all doom and gloom! Note that lime use region of 2.5 to 3.0 million tonnes per annum, so despite the increases in yield and fertiliser use combined with crop nutrient offtake that has taken place over this period, total lime use is not much higher than it was during the war years.

So, given the level of technical support and advice that is currently available to UK agriculture, is it fair to assume that pH and liming are being adequately managed?

Before responding to this question, consider soil sample data (Fig. 3), collated via the Professional Agricultural Analysis Group (PAAG) (Ref. 4) showing the percentage of field samples falling within a range of soil pH measured on dried and ground samples as part of routine soil analysis. The ‘as found’ pH in the field may be lower than these levels if the drying and grinding breaks down coarse alkaline material, such as limestone chippings.

The three-year trend shows 40% of arable land to be at or below pH 6.5 (almost 20% at or below 6.0), with 55% of grassland at or below pH 6.0. The impact of soil pH on macro- and micro-nutrient availability is well understood (Fig. 4). This is why a pH range 6.7-7.2 is ideal on a mineral soil for optimum nutrient uptake.

Nutrient efficiency (utilisation)

<table>
<thead>
<tr>
<th>Soil pH</th>
<th>N</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
<td>30%</td>
<td>23%</td>
<td>33%</td>
</tr>
<tr>
<td>5.0</td>
<td>53%</td>
<td>34%</td>
<td>52%</td>
</tr>
<tr>
<td>5.5</td>
<td>77%</td>
<td>48%</td>
<td>77%</td>
</tr>
<tr>
<td>6.0</td>
<td>89%</td>
<td>52%</td>
<td>100%</td>
</tr>
<tr>
<td>7.0</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Fig. 5 – Nutrient efficiency at a range of soil pH.

% soil samples by pH by rotation

<table>
<thead>
<tr>
<th>pH range</th>
<th>% samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5.0</td>
<td>7</td>
</tr>
<tr>
<td>5.0-5.49</td>
<td>14</td>
</tr>
<tr>
<td>5.5-5.99</td>
<td>25</td>
</tr>
<tr>
<td>6.0-6.49</td>
<td>23</td>
</tr>
<tr>
<td>6.5-6.99</td>
<td>19</td>
</tr>
<tr>
<td>7.0-7.49</td>
<td>13</td>
</tr>
<tr>
<td>7.5-7.99</td>
<td>10</td>
</tr>
<tr>
<td>&gt;8.0</td>
<td>7</td>
</tr>
</tbody>
</table>

Fig. 3 – Soil samples by pH and rotation (Ref. 4).

Fig. 4 – Nutrient availability at different soil pH.

In the case of sugar beet rotations, value of liming is better understood, with the entire rotation benefitting from optimal soil pH for maintained plant health that will underpin yield.

Lime quality

Many natural liming products used in agriculture are derived from crushed limestone and chalks.

Agricultural Lime quality is regulated by UK or EU regulation; known as ‘partial-harmonisation’ and producers decide their marketing compliance. The majority of UK producers adopt the UK standards. The development of new EU regulation, based on easier access for recycled and waste materials, will see safety and efficacy as the principal criteria. Longer term it may not be inconceivable, despite Brexit, the UK might adopt EU regulation as the sole standard.

‘The UK Fertilisers Regulations 1991’ have stood the test of time, but from a liming materials perspective falls short
on a number of indicators including the ‘reactivity’ test that is proposed within the European regulation.

In simple terms lime quality can be assessed on the basis of neutralising value (NV) expressed as a percentage compared to pure calcium oxide that indicates the liming potential. However the second quality parameter is particle size, and Fig. 7 shows the sieve testing performance for a range of liming products. Research from the USA on lime quality (Ref. 5) is now recognised by the Agricultural Lime Association (ALA). This research has concluded that coarse hard stone greater than 1.3 mm offers very limited neutralising value, and that it is the proportion of particles finer than 0.25 mm (250 microns) that deliver the majority of pH correction. The ALA (Ref. 6) says “There is a considerable reduction in the effectiveness of liming materials containing particles above 600 microns (0.60 mm), unless the material is easily broken down”.

The 1991 Regulation has three sieve testing standards, for the percentages passing 5.0 mm, 3.35 mm and 150 microns (0.15 mm).

These are the ‘as tested’ values for a range of commercially available stone based products, and the minimum values for LimeX.

So do you know the quality of the lime you are buying? For example, ground limestone product found on farm last autumn in Cambridgeshire was independently tested and only 4% passed the 150 micron sieve. At best, poor quality liming products will be very slow to work.

Guidance on application rates from the ALA (Ref. 6) assumes a quality product of 52% NV, of which 40% is less than 150 microns – the regulatory granulometric standard. However, whilst lime rate calculators can be adjusted for NV, they cannot be adjusted to take account of the sieve testing/granulometric value, and in practice may offer limited accuracy in comparison.

In response to legitimate concerns around lime quality, the ALA as a product group within the Mineral Producers Association (MPA) have just launched an AgLime Quality Standard (AQS) (Ref. 7) that will allow lime producers to have their products independently analysed (or supply analysis via accredited laboratories) with a robust UKAS (United Kingdom Accreditation Service) audit trail to verify the standard. This is mandatory for MPA members and voluntary for other agricultural lime producers.

Parameters will include % NV, % dry matter, sieve testing performance and, importantly, the ‘reactivity’ test as per the proposed European regulation. This is a great step forward for the UK agricultural lime industry, setting a new benchmark for guaranteed analysis and certification.

The value of liming

James F W Johnston was a 19th century agricultural chemist, who co-founded the British Association for the Advancement of Science in 1831, whilst reading in chemistry and minerology at Durham University. In 1844 Johnston wrote the ‘Catechism of Agricultural Chemistry’ that was translated into most modern languages, and he was closely associated with many leading European agricultural chemists and mineralogists, such as Liebig and Voelcker – the early agronomists!

In 1849 Johnston wrote ‘The use of lime as an application to the soil is of high antiquity, and its utility has been recognised in almost every country in which agriculture has attained any degree of perfection. In our country it has been called the basis of all good husbandry – and it certainly is more largely and more extensively used than any other mineral substance available in practical husbandry’.

So, why is it that in times of economic pressure farmers attempt to make savings by deferring lime application?
Historically, the cost of liming was much more expensive than it is today, and this may partially explain why this behaviour initially manifested itself – and has remained an almost automatic response since this time!

For example, in 1939 one tonne of lime typically cost 25 shillings and 6 pence, whereas in 1959 this had increased to 43 shillings and 10 pence (Ref. 3). Using robust RPI models (Ref. 8) these are equivalent to £68/ton in 1939 and £46/ton in 1959. Compare that to current pricing for agricultural lime, quoted at c.£23 per tonne within John Nix (Ref. 8), then in real terms agricultural lime has never been cheaper, as long as the quality can be proven via robust analysis – that is %NV and % passing 150 microns.

Indeed, many products offer greater value for money than this – for example LimeX70 delivered and spread at say 30 miles from the dispatching factory will cost approximately £17/t.

Referring again to John Nix’s quoted variable cost figures (Ref. 8) for a four-year rotation comprising winter oilseed rape, winter wheat, winter barley and sugar beet, the gross variable costs are £2.4k per hectare.

Liming once at say 7.5 t/ha over the rotation adds just 6% or less to this cost, however the cost benefit of liming delivers so much more potential!

Therefore a ‘red-amber-green’ (Fig. 8) approach to liming is an easy model to follow, and by keeping in the green and amber bands crop yield and quality will not be compromised by sub-optimal pH.

**Recent liming research in sugar beet**

There have been very few replicated liming trials conducted in sugar beet within the UK in the past two decades, however in 1998 a trial at Hardingham in Norfolk on a sandy clay loam site conducted by British Sugar’s Agricultural R&D team (Fig. 9) (Ref. 9) did show significant increases in yield (tonnes of sugar per hectare). Although it must be remembered that the yields then do not compare with what we can achieve in 2017, so the returns to growers are potentially even greater.

More recent trial work conducted in Sweden by the Nordic Beet Research foundation (NBR) at 52 sites between 2009 and 2015 (Ref. 10) has delivered very positive yield responses to the application of limestone and sugar factory lime products. In 2014 and 2015 (Fig. 10), 11 trial sites showed increased average sugar yields in the second rotation after liming three to four years earlier compared to the untreated control. Trial sites that showed no positive response on yield in the first rotation, did so in the second rotation of sugar beet.

The NBR summary concludes that liming is required more often than is currently recommended to Nordic sugar beet growers, with a change in advice to growers to lime at least once in the beet rotation.

What was perhaps most interesting was that in the 52 trials, the greatest yield improvement was achieved from the 31 sites deemed not to require liming, so yield increases are achievable even when pH is above 7.0. (Ref. 10) This may be an effect of increased available calcium, and not just ‘as found’ pH.

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**Fig. 8 – Target pH for sugar beet.**

**Fig. 9 – Results of sugar beet lime response trial at Hardingham in 1998.**

**Fig. 10 – Results of 11 field trials by Nordic Beet Research (2014 and 2015).**
**The value of calcium**

Soil pH is no direct measure of available calcium. In fact many low pH mineral soils can contain reasonable levels of available calcium and fenland soils, despite their low pH, can often contain a luxury of available calcium. By contrast, high pH soils, such as the Wisbech series can exhibit a range of available calcium levels, and can border on deficiency.

So, why is this important? Calcium is a fundamental macronutrient that is vital for healthy crop growth and yet we know relatively little about it, or what constitutes a reasonable level of available calcium. At a generic level, replicated LimeX field trials conducted over the past decade in a range of high value crops have coincidently led to the development of an ‘available calcium’ threshold that aligns well with the NBR trial programme previously referred to in this article. NBR’s threshold for ‘available calcium’ in sugar beet is 2500 ppm (Refs. 11 and 12). LimeX field trials have shown the threshold to be in the 2000-2500 ppm range, with little or no yield response above 3000 ppm.

The role of calcium in soil structure and aggregate stability is another valuable benefit from rotational liming with a quality material.

In order to support more objective decision making, requesting an ‘available calcium’ determination on a standard soil sample will add very little to the cost, requesting an ‘available calcium’ determination on a standard soil sample will add very little to the cost, and is likely to be an option for those having independent testing via their agronomist or lime/fertiliser supplier.

Robust soil pH testing and mapping should be conducted at least once in the rotation to provide a better and objective understanding of field pH variability and the overall liming need. For more specific guidance and information on sampling refer to the article by Nikki Downs in the last issue of the *British Sugar Beet Review* (Ref. 13).

**Acknowledgements**

The author appreciates the co-operation of Chris Dawson for the long-term liming-trend data and graphs, and Stephen Hill (ALA/MPA) for the use of ALA website information and the AQS documentation provided in advance of the MPA scheme launch. In addition, Desiree Börjessedotter and Åsa Olsson of NBR made valuable contributions to the article following timely discussion around their extensive study that was financed by the Swedish Farmers Foundation for Agricultural Research.

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Review of 2017 BBRO Winter Technical Events

With a new, shorter, faster-paced style the BBRO Winter Technical Events came to Newmarket and Newark for the 2017 season. The events were divided into three sections, each covering a different stage of crop development and how to maximise the crop’s potential each step of the way, under the theme ‘Sugar beet – realise its potential’. After filling up on bacon sandwiches and armed with electronic voting cards, the audience was ready for an information packed morning!

Introduction and welcome
(Colin MacEwan, Head of the BBRO)

The events began with Colin giving an overview of the BBRO’s new activities and initiatives for the coming season. These included the new demonstration farm network, benchmarking and the launch of the Beet Yield Competition.

Part 1: The Foundations
The Value of Yield Benchmarking
(Prof. Neil Crout, University of Nottingham)

Neil, an expert in environmental and biological systems computer modelling, introduced the subject of yield benchmarking by asking the audience to vote on what percentage of their potential beet yield they estimated they achieved, and how they knew what their potential yield was. Both the Newmarket and Newark groups voted that they achieved 80% of their potential, and that they worked out their potential by using official statistics. He went on to explain about a new BBRO/Innovate UK project, starting in the summer 2017, that will produce a crop yield predictor specific to individual growers’ situations. He stressed that grower engagement in the creation of “apps” and data sharing would be vital in making the project a success.

Making every Hectare Count
(Dr. Jenny Bussell and Tamara Fitters PhD student, University of Nottingham)

Jenny summarised her research on linking measurable soil properties to successful crop establishment. She highlighted the importance of low shear strength, bulk density and high proportions of 1-2 mm aggregates as key factors in good establishment, based on her analysed data from the 2015 campaign. She explained how she was now analysing the data from 35 fields in the 2016 campaign, to test and consolidate her initial findings.

Tamara led on from Jenny’s work to talk about her research on improving water uptake in sugar beet. By growing sugar beet plants in 1 m tall columns, Tamara has been identifying the role that soil compaction plays in root growth and water uptake. Her findings show that, in highly compacted soils,
water uptake is limited, even when soil moisture levels are high. This introduced the subject of soil structure and its importance, a topic which was addressed by Philip Wright.

Soils, Cultivations and Effective Crop Establishment (Philip Wright, Wright Resolutions Limited)

Soil specialist, Philip, brought a practical approach to the issue of soil structure, focusing on the importance of good seedbed drainage. After explaining the basic principles of soil water content and the germination benefits of maintaining soils at field capacity, he gave some practical advice on creating the perfect seedbed. Prevention rather than cure was his key message, with good soil management starting at harvest.

Uncovered – The Benefits of Cover Crops (Jake Richards PhD student, University of Nottingham and Dr. Simon Bowen, BBRO)

The mystery of how exactly cover crops can alter soil structure was uncovered by Jake. He explained that his glasshouse research had shown that cover crops do change soil aggregation, but he cautioned that we need to wait for his field trial results before we can be sure that cover crops have the same effect in a field setting. He had used the University of Nottingham’s CT scanner to produce some fascinating images of root channels, showing the differences between cover crop species.

Simon went on to explain the BBRO’s research into cover crops. With so many different cover crop options available, the emphasis is on collecting lots of data so that reliable conclusions can be made. Although more data are needed before scientific conclusions can be drawn, initial observations have shown clear differences between cover crop species. It was announced that BBRO are part of a collaborative project with AHDB and Newcastle University, aimed at gaining a better understanding of soil health and how it can be boosted in a sugar beet rotation. Simon also directed people to the British Earthworm Society, encouraging people to find out more about these industrious creatures, and how they provide an indicator to good soil health.
Part 2: Established and Healthy

Precision Nutrition – Nitrogen Rates and Fertiliser Placement
(Dr. Debbie Sparkes, University of Nottingham)

The second section of the programme began with Debbie explaining the role of nitrogen (N) in crop growth, and the reasoning behind the recommended application rate. Armed with the BBRO N-response trials data from 2010-2016, Debbie argued the case for 120 kg/ha still being relevant for today’s high yielding crops, and that currently there was no evidence that fungicide treatments resulted in a higher N requirement. Nutrient placement was also discussed, with work underway to evaluate yield response. There was also a cautionary note about mistaking paler canopies for N deficiency in some pale-leaved varieties.

Keeping Crops Healthy
(Dr. Mark Stevens, BBRO and Alistair Wright PhD student, University of Nottingham)

Mark gave the annual crop stability update, reviewing the issues that were faced in the 2016 season. The appearance of stemphylium in Norfolk showed the importance of staying ‘one step ahead’, especially with climate change bringing new diseases and additional pest generations. Cercospora leaf spot was highlighted as an important disease during 2016, with the highest ever reported UK levels. This is of particular concern due to the potential spread of fungicide resistant strains currently on the continent. The importance of maintaining growers’ ‘chemical arsenal’ was also discussed. Mark told the audiences that the BBRO was currently investigating alternatives for use if neonicotinoid seed treatments are banned, but that growers also needed to play their part by maintaining good farm hygiene. There was also a call for any observations in varietal differences in disease susceptibility.

Alistair led on from the crop stability update to talk about his work on beet cyst nematodes (BCN). After explaining the BCN life cycle, and how there is the potential for three to four BCN generations each year, he discussed the differences between BCN susceptible, tolerant and resistant varieties. Half of the audience voted that the UK did have BCN resistant varieties, when in fact these are only tolerant. This misconception makes Alistair’s research into the effect of different beet varieties and hatch/trap crops on BCN abundance particularly interesting. However, it was stressed that more data were needed before any conclusions can be made.

Part 3: Reap the Rewards
Opportunities in Crop Recovery and Storage
(Dr. Simon Bowen, BBRO)

The final section of the morning focused on harvesting and storage, with minimising yield losses the key aim. Most of the Newmarket and Newark audiences thought that the biggest part of the yield loss was mass loss due to root breakage. But the audience was split on the cause of this loss, with both operator skill and variable crops being blamed. The BBRO harvester testing programme supported the general opinion, identifying root breakage as the probable major cause of yield loss. Simon explained that, by continuing the harvester testing programme, more data could be gathered (including testing cleaners and loaders) so that a benchmarking data base could be created. New technology, including thermal imaging cameras for monitoring clamp temperatures, was also discussed. Use of this technology would allow growers to make informed decisions about which clamps should be moved first, and to identify any issues arising within the clamp which may not be visible to the naked eye.

Presentations from the events are available at www.bbro.co.uk/our-news/. Further updates on the BBRO research programme will be available at the BBRO Open Days and in the Annual Report due out at the end of May 2017.
Work Safe – Stay Safe – Go Home Safe

This is the message British Sugar and UK Power Networks want to promote to all beet growers, hauliers and vehicle machinery operators involved in the sugar beet and wider farming industries.

Life can be lost, or terrible life-changing burns inflicted within seconds, if you come into contact with overhead power lines.

Every year, workers in the industry are killed or seriously injured. These tragic incidents have far-reaching, devastating effects on family, friends and colleagues.

As part of this safety campaign, we would like employers, and employees operating vehicles and machinery near or around overhead power lines to STOP, WORK SAFE, THINK ELECTRICITY. Everyone should be able to go home safe.

Overhead electricity wires can carry anything from 400 volts, through 11,000 volts up to 132,000 volts; all can be fatal if you come into contact with them. You don’t even have to make contact: getting too close to the lines means electricity can arc to earth through you or your machinery, with fatal consequences.

How and when we work impacts on safety

Working long hours with tight delivery and harvest times, often in poor light and bad weather, all threaten our ability to work safely. In a familiar environment we may not noticing the hazards and potential dangers.

Repetitive tasks, rushing the last job of the day and taking shortcuts, alongside distractions such as mobile phones and in-cab technology can impede our awareness; we stop seeing the shortcuts, alongside distractions such as mobile phones and in-cab technology can impede our awareness; we stop seeing the potential hazards surrounding us. Is it worth the risk?

Planning work and assessing risks is essential to staying safe.

Avoid operating machinery near overhead power lines; machinery should be more than 10 m away from an overhead line. Remember that lines sag!

Barriers, goal posts and warning signs should be used, where required, to maintain safe clearances.

Don’t assume that lines on wooden poles are telephone wires: most overhead electricity wires are also supported by wooden poles.

Know the height and maximum reach of your machinery. A sticker is enclosed in this edition of the British Sugar Beet Review. Please put it in the cab of your vehicle(s) and mark on it the maximum height of that vehicle. If you need more stickers, contact your Area Manager or the British Sugar Agriculture Helpdesk on 0870 2402 314. The electricity network operators have introduced a new 3-digit telephone number 105 – to give an easy-to-remember number to call that will put you through to the local people who can help with any supply related problem or incident.

UK Power Networks distributes electricity to the East of England, London and the South East through its network of overhead power lines, underground cables and substations.

Further advice and guidance can be found – www.hse.gov.uk/pubns/gs6.pdf

Beet for all seasons

Strube’s range of excellent sugar beet varieties for 2018 will all deliver you high yields, good sugar contents and excellent establishment and have been developed to give you vigorous and profitable crops. See our website or call for more information.

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**Haydn**
- From early March
- Very low bolting and consistently good yields

**Degas** NEW
- From early/mid March
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**Pasteur**
- From early/mid March
- Low bolting and consistent performance

**Landon** NEW
- From late March
- Very high sugar yields from later sowings
Advanced Sugar Beet Technology Course 2016

The Advanced Sugar Beet Technology Course was established with funding from the BBSRC’s Modular Training Partnerships, with support from BBRO and British Sugar. Now in its fourth year, it has been incorporated into the Agrifood Advanced Training Partnership, providing links with other advanced training courses in agronomy and crop physiology through to food science and animal production (www.agrifoodatp.ac.uk). The course is recognised by BASIS as an advanced module (worth 30 CPD points) and can be applied towards the BASIS Diploma in Agronomy.

The course comprises six days of training, divided into three, two-day units. There is also a fourth, optional unit, on water management and irrigation, delivered by Cranfield University. There were 14 delegates on the course in 2016, including growers, agronomists, British Sugar Area Managers and colleagues from across the wider industry (e.g. plant breeding and the agrochemical industry). The first unit, ‘Foundation in Sugar Beet’, was held at the University of Nottingham’s Sutton Bonington Campus on 2nd-3rd November. It set the scene for the rest of the course by covering topics such as the global sugar market and the UK sugar beet industry, physiology and agronomy of the crop, and soil management. Delegates also heard about current BBRO-funded research on water and nutrient uptake by the crop, and visited a field experiment comparing the effect of a range of cover crops on soil structure and yield of the subsequent beet crop (Pic. 1).

The second unit, ‘Crop Protection’, was held at the BBRO in Norwich on 23rd-24th November, and covered the wide range of pests and diseases that can affect the crop, plus the principles of weed control. Alongside the talks, there were lots of hands-on opportunities for the delegates, such as analysing plant clinic samples and identifying different aphid species (Pics. 2). Delegates also heard about the new ALS technology being developed for sugar beet, current research on beet cyst nematodes and the latest on the Spore ID project (Ref. 1).

Eight of the delegates on the course elected to take the ‘Water Management and Irrigation’ module held at Cranfield University on 6th-7th December. Topics included estimating the seasonal and peak irrigation requirements for given soil and climate, evaluating different types of irrigation systems and selecting appropriate irrigation scheduling methods.

The final unit of the course was divided between ‘Plant Breeding, Seed Production and Seed Technology’ (13th December), and ‘Harvest, Storage and Processing’ (14th December). Delegates learned about the history of plant

Pic. 1 – The cover crop experiment at Sutton Bonington.

Pic. 2 – BBRO-funded PhD student Alistair Wright demonstrating how to assess beet cyst nematode infestation.
breeding and seed production, and how breeders select for disease resistance. This was followed by a visit to Germains where the focus was on the technology of priming and seed treatment, including tours of the priming and pelleting factories. The final morning of the course was largely in the field, with practical demonstrations of harvester management. Delegates worked through a harvester loss assessment, and learned how to trace back losses to possible problems with the harvester (Pics. 3 and 4). We then moved inside for a discussion on minimising losses in storage, and a tour of the Wiswington Sugar Factory including the trials tare house.

I would like to thank the many contributors to the course, too numerous to name individually, who together provide a unique training course in sugar beet production. I would also like to thank Germains who kindly hosted a dinner for delegates on 13th December.

If you would be interested in attending the course in 2017, please contact Debbie Sparkes (Debbie.Sparkes@nottingham.ac.uk).

References
The establishment of the BBRO Demonstration Farm Network is a new initiative for 2017. The network of farms will allow BBRO to work more closely with growers on farms, with three key objectives in mind:

- To work on aspects of crop development that are best addressed at a whole field and farm rotational level. This includes areas such as cover cropping and the use of organic amendments to boost soil biology and health.

- To support and assist with grower-led, on-farm innovation. There are some fantastic examples of growers innovating in areas such as soil cultivation, strip-tillage and drilling systems, and supporting this work and measuring impact is an important role for BBRO.

- To scale up new agronomic approaches and technology from BBRO replicated plot trial work to a commercial scale. Taking forward latest research findings in crop establishment, nutrition and protection and demonstrating these at a field level is essential to building confidence in introducing novel ideas on farm.

We have identified an initial group of six demonstration farms across the beet growing area, not just to give us a range of soil types but also to demonstrate some existing on-farm innovation in different areas of beet production. Our sincere thanks go to all the growers for supporting the establishment of this network and for the work being undertaken.

There will be different aspects of production being explored on the various farms: from cover crops, tillage regimes, fertiliser practice, crop canopy protection through to harvesting and storage. Whilst the work undertaken at each farm will differ to some extent, one common element we have decided to incorporate at each farm, is to drill out commercial strips of eight key varieties from the existing Recommended List (RL). This will allow us to gather additional information to complement and build on the data generated by the RL trial system. This includes gathering observational information on pest and disease susceptibility, relative yield performance at different harvest dates, and different soil types. In addition, we will apply some common treatments such as different nitrogen rates, fungicides and insecticides across the eight varieties to explore interactions between variety, actives and soil type. Whilst we appreciate that this work is observational in its nature, and lacks the statistical rigour of replicated small plot work, we believe it can provide complementary, supportive data and evidence, and in particular will help identify and focus key new areas of research.

It is important that we’re able to collect good data from the Demonstration Farms and we will be using a range to techniques which will include aerial sensing and digital soil mapping to gather information on the larger areas of crop. We will be using the KisanHub platform to manage all the data.
generated on the Demonstration Farms. This is a new and innovative software system that allows us to integrate different sources and forms of data such as soil analysis, canopy development and health and crop yields, providing a basis for comparison and analysis across the sites. In essence, turning the data into information that growers can then make decisions about their crops. Understanding these new approaches to data collection and integration is a development project in itself and we are hopeful to be able to demonstrate the value of this to growers, especially in deciphering some of the causes of both within field and between field variation in crop yields and how these can be improved further.

‘Demonstration Farms’ section of the BBRO website. We will be following the progression of different crop treatments throughout the season. We will also be sharing results as and when they become available.

There will be opportunities to visit the Demonstration Farms throughout the season, and a programme of grower visits is currently being planned to coincide with key timings on the beet growing-crop calendar. These visits will be advertised on the BBRO website or through contact with your local British Sugar area manager. We will be targeting group visits of between 15-20 people as we want to ensure a good two-way discussion and exchange of knowledge during these visits, so numbers of participants may be limited. Multiple visits can be arranged when there is a lot of interest.

So, we invite you to follow the work and activity of the BBRO Demonstration Farm network in 2017, and we look forward to seeing you on-farm. Please don’t hesitate to contact us with any questions or suggestion that we can use to develop the network and discussion further.
Getting to know the BBRO

In each issue we meet a different member of the BBRO team, asking them about their day-to-day roles and what they think is important in the future of sugar beet growing.

Name:
Stuart Harder

Role:
Trials Analyst

Where are you from?
Norfolk

How long have you been with the BBRO?
4 years.

What did you do previously?
Masters Degree in Plant Genetics and Crop Improvement.

Why did you want to work here?
I wanted to contribute to crop research in an applied and focused way. Get out of the lab and into the field.

What does a typical day look like for you? (at this time of year)
At this time of year, I am preparing the fungicide spray programmes for all of the fungicide trials as well as developing and producing content for most of the technical boards that are put up at the Open Day events. I am also supporting the Trials Officers in achieving trial milestones and collecting the correct mid-season data to a high standard.

What is your favourite part of the sugar beet year?
Just before drilling; I advise on protocols for the coming season as well as prepare randomisations of the different treatments for every trial at every site. I also manage the protocols and projects that come in from companies in the wider industry.

What projects are you involved in?
Every single field project will come across my desk. To give a few examples this year we have a number of trials looking at how different varieties respond to fungicides, as well as trials on sulphur, nitrogen placement and the Recommended List programme.

What do you think is the ‘next big thing’ in agriculture?
I believe that the farming process must become more like manufacturing; a streamlined, heavily monitored, data driven industry that reduces inputs and drives up yields. Obviously, we have this in the form of precision farming but I feel there is still a long way to go.

However, the next big challenges for agriculture that I see are the potential changes in subsidies and markets over the next few years. I am very interested to see how individual farmers, as well as the agricultural industry as a whole, respond to face these challenges.

What are your aspirations for the future?
In the future, I hope to further develop my career within BBRO as well as taking an active role in helping to establish benchmarking and the Beet Yield Competition.
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www.cropscience.bayer.co.uk
PhD updates

Delivering sugar to improve yield

By Rachel O’Neill, University of Leeds and Rothamsted Research

The goal of my PhD project is to advance the understanding of the internal structures of sugar beet roots to identify key aspects, which may point to useful breeding targets to drive crop improvement. These could range from increased sugar yield to enhanced root structure and strength, as well as a potentially more valuable pulp once the sugar is extracted.

To aid my research I have been utilising various methods to analyse the internal structures of sugar beet roots. These methods have included microscopy of root cross sections with the areas of interest highlighted using fluorescent probes, as well as the analysis of root composition when converted into pulp. Using these methods, I have been able to gain insight into the structures dictating sugar content, and characteristics which may affect root strength. In this PhD update I will share some of my results and how these could be beneficial to the industry.

The search for the sugar highway

Sugar (sucrose) in plants is a product of photosynthesis, the process where plants use light energy from the sun and convert it into sugar. Sugar is a store of chemical energy which the plant can use to power everyday functions. Many plants transport this sugar to storage organs such as fruit or grain and, in the case of sugar beet, roots. Specialised transport tissues called xylem and phloem form the plant’s vascular system and are required to allow movement throughout a plant (Pic. 1). Xylem transports water from the roots to the leaves and phloem transports the products of photosynthesis (sugar) from the leaves to the rest of the plant, including the roots. The structure of these transport tissues is very specialised.

In sugar beet roots the vascular system is in a novel arrangement of repeating vascular rings starting from the centre of the root, and each ring contains an additional set of phloem and xylem tissues (Pic. 2). This arrangement of the transportation tissue is one explanation for the amazing ability of sugar beet to store sugar at such high concentrations. Having the phloem arranged in repeating rings ensures sugar is being delivered and can be stored throughout the root, which would not be the case if the phloem were located in one vascular ring as is the case with most other plant species.

A fascinating part of my work uses fluorescent probes to highlight the internal root layout and visualise structures which have a direct effect on sugar concentration in the roots. I have been using a new fluorescent probe (Ref. 1) developed in my lab at the University of Leeds. This probe is able to highlight the location of the phloem cells within the sugar beet root (Pic. 3) and fluoresces green when phloem is present. Using this probe at different stages of root development, I am providing understanding about where and when phloem is being created.

Combining the ability to pinpoint the stage where all phloem rings have developed with genetic knowledge allows for breeding targets to be identified. These breeding targets would aim to increase the number of phloem cells and/or vascular rings containing them. It is known that larger roots do not correlate with higher sugar content, as large roots have a higher water content (Ref. 2). This is because sugar has to...
travel out of the phloem and along a concentration gradient between the storage cells (parenchyma), meaning that the sugar is not readily stored far from the phloem, and water is stored instead. Consequently the number of phloem present per cross-sectional area of the root is very important in the pursuit of increased sugar concentration in the roots. Increasing the number of vascular rings increases phloem number and therefore is a key factor in increasing sugar concentration, as more rings leads to more sugar being deposited in the roots. This theory has been supported by comparing beetroot and sugar beet, both are the same plant species and have the ring structures in their roots, but with differing sugar concentrations and yield. Beetroot have up to seven vascular rings on average where sugar beet can have up to eleven, supporting the hypothesis that fewer phloem cells relates to a lower sugar concentrate.

**Spending or saving sugar?**

In addition to visualising tissues within the root structure, I can use similar probes (Ref. 3) to highlight other characteristics of the sugar beet root which relate to its structural strength, such as flexibility. This is important because the sugar beet root can go through high impact environments on its journey from field to factory during which root damage can cause sugar loss.

Plant cells are protected by a cell wall, which surrounds the cell and maintains the cell shape. The composition of cell walls differs between different plant parts, depending on their function.

The overall strength of the sugar beet root arises from each individual cell within it. The cell walls form the skeleton of plants and dictate the overall structure and strength, as well as providing protection and defence from environmental pressures like harvesting or pests and diseases. The mechanical strength of cossettes rendered during the processing of sugar beet is also dependent on the cell wall properties.

In the lab, I can break down the roots to assess what makes up the cell wall. I have been looking at samples from a large number of different sugar beet lines to understand what effect different compositions have upon their physical attributes. These data on root composition can allow for improvements during processing. Roots that damage less easily will suffer less sugar loss post-harvest, increasing overall yield.

Cell walls also make up the majority of sugar beet pulp, produced after sugar extraction. Assessing its content can lead to improved and additional uses of this resource. If improvements can be made to the composition of the pulp, this can lead to enhanced animal feed with higher nutritional value. Additionally the pulp is a source of energy, which could be used for industrial digestion into bioethanol, increasing the value of the crop.

For further information and updates of my research contact me at bsreon@leeds.ac.uk.

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**Acknowledgements**

I would like to thank both Professor Paul Knox and Dr. Belinda Townsend for their excellent supervision, seemingly endless knowledge and continuing advice. I also acknowledge financial support from the UK Biotechnology and Biosciences Research Council (BBSRC, CASE Industrial Studentship BB/K011456/1), the British Beet Research Organisation (BBRO grant 13/200) and AB Sugar.

**References**


It is 12 months since the last update on my project. Eighteen months through my four-year PhD programme and experiments and field trials are now in full swing. Over the year I have spent a large proportion of my time on preliminary experiments and perfecting soil sampling techniques. As planned, my focus has been to look at how cover crop species affect soil structure and how these effects influence the subsequent sugar beet crop.

Glasshouse experiments

My initial experiment of the project was to look at rye (Secale cereale), tillage radish (Raphanus sativus) and Phacelia in the glasshouse. The aim was to look at the rooting structure of the three cover crops on their own, as well as in combination, and how their growth affects the soil structure.

The three species were chosen based on their popularity as a cover crop. All three come from differing plant groups, with radish being a brassica and therefore closely related to OSR, and rye being related to wheat and barley whereas Phacelia is not related to any major crop species. Three plants were grown in pots of five litres for two months in a glasshouse. By the end of the growing period, the pots were opened up and samples of the soil and roots were taken.

As well as being interesting, the results of this first experiment have posed questions that I plan to investigate further. As expected, growing any of the cover crop species led to drier soil than when the soil was left bare, but there were also differences between species, with tillage radish leading to the driest soil. When roots from the cover crops were washed and scanned to look at total rooting length and root diameter (Pic. 1), there appeared to be a relationship between aggregate size and root diameter, which is of particular interest when comparing species and an aspect that I will be investigating further. There was also a relationship between soil moisture and aggregate size, although it is not clear whether this is a direct relationship, or an indirect effect of the root system: another aspect that I will be following up in future experiments.

The findings, and questions which have come out of this initial experiment have gone on to inform a more detailed look at radish and rye, also in the glasshouse, but this time looking at their roots at depth. Those present at the technical meetings in February will have seen an example of the one metre deep soil columns that I am using to grow the two species in (Pic. 2).

When the cover crop was destroyed, half of these columns were used to collect root and soil data, which is being processed as I pen this article. The other 20 columns were sown with sugar beet, to test whether the impact of the different cover crop species on soil structure affects the growth of a subsequent beet crop.

One very useful technique for looking at the impact of the cover crop is the X-ray CT scanner we have at the University of...
Nottingham. The scanner has allowed me to look at the soil inside these columns of cover crops without disturbing them and will allow me to re-scan the same columns while the sugar beet are growing. I will also compare sugar beet growth after cover crops with different rooting traits (Pic. 3). I will be presenting results from this experiment at the BBRO Open days in June.

Field trial at the University of Nottingham

The first replicated field trial of the project started on the 1st September 2016. In this trial, seven cover crops are being compared to bare soil (Table 1) in 3 m x 12 m plots with four replicates on a sandy loam (Pic. 4).

The cover crops were established using a combination drill after a shallow pass of a spring tine cultivator and received no fertiliser during the autumn and winter. In order to capture the effects of the cover crop, the beet will be established by direct drilling towards the end of March. To avoid problems with trash, particularly after the mustard, the cover crop was flailed in December, allowing the soil to dry and avoid creating a layer of crop ‘mush’ on the topsoil. Further to this the rye and vetch required spraying off with glyphosate in February.

Table 1 – Treatments in cover crop field trial at University of Nottingham.

<table>
<thead>
<tr>
<th>Treatment no.</th>
<th>Cover crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bare soil</td>
</tr>
<tr>
<td>2</td>
<td>Tillage radish (Raphanus sativus)</td>
</tr>
<tr>
<td>3</td>
<td>Oil radish (Raphanus sativus)</td>
</tr>
<tr>
<td>4</td>
<td>Forage rye (Secale cereale)</td>
</tr>
<tr>
<td>5</td>
<td>Black oat (Avena strigosa)</td>
</tr>
<tr>
<td>6</td>
<td>White mustard (Sinapis alba)</td>
</tr>
<tr>
<td>7</td>
<td>Vetch (Vicia)</td>
</tr>
<tr>
<td>8</td>
<td>Berseem/Egyptian clover (Trifolium alexandria)</td>
</tr>
</tbody>
</table>

During the growing season, measurements of the soil structure, soil moisture and cover crop biomass were taken. Drilling date is an important factor in the success of the sugar beet crop and is greatly influenced by soil temperature and moisture. The impact of the cover crop on soil moisture may persist into the following spring and may provide some benefit to growers. The impact of the cover crop on the moisture content of the top layer of soil can be seen in Fig. 1. It seems that the brassicas, in particular mustard and oil radish, had a drying effect that persisted into the onset of winter. This is an interesting observation but does represent just one year’s data and will need to be repeated in order to draw more robust conclusions.

One major drawback of soil surface measurements is that they do not provide any information on the effect of the cover crop at depth. To look at this, in collaboration with Lancaster University, we are using an electromagnetic probe to measure soil conductivity to a depth of 1-2 m without damaging the cover crop or disturbing the soil. Soil conductivity has a strong relationship with soil moisture: the higher the soil moisture, the higher the conductivity. While also being from a single year, the soil resistivity at depth agrees with the data in Fig. 1 (see Fig. 2) for November and should provide an interesting insight into the water movement through the profile.

Since the destruction of the cover crop, further soil resistivity measurements have been taken alongside soil penetration resistance and soil mineral nitrogen samples from each plot. This should give a good understanding of how the cover crop has changed the soil and what conditions the sugar beet will be going into.

Commercial field sites

The opportunity to look at how cover crops are applied to a commercial setting is extremely valuable. Over the last 18 months I have been monitoring three sites; one at Salle on clay soil, Holkham on light sandy soil and a third for 2016/17 at Shimpling on very heavy clay soil.

On the Holkham field site, half of the field was left as over-wintered stubble and the other was established with a radish cover crop in Autumn 2015. The cover crop was grazed by
While all experiments and field data are from a single year, I am able to repeat all three parts of the project in order to produce a clearer explanation of how cover crops may affect the growth of sugar beet. 2017 is set to be a productive year and I look forward to updating people at the BBRO Open Days this summer.

**Acknowledgments**

I would like to thank Salle Farms, Holkham Farms and P&M Richards for allowing me to use their crops. Guillaume Blanchy and Professor Andrew Binley for their Electromagnetic resonance expertise and the Staff at BBRO and the University of Nottingham for their help and support throughout my experiments.
Open Days 2017

4th July
Bracebridge Heath
Lincolnshire, LN5 0AS

6th July
Morley Farms
Norfolk, NR18 9DH

- Latest neonicotinoid update
- Demonstration plots on nitrogen rates, fungicide use, soil/root interactions and **agronomy demonstration plots**
- Soil health. **Digging up the facts about improving soil health**
- Crop data collection and management. **From data to decisions - improving how we use farm data**
- **Introducing the new Varieties for 2018** from the Recommended List

The days will start at 11:00 and come to a close at 15:00.
For more information please visit: [www.bbro.co.uk/events](http://www.bbro.co.uk/events)
PhD updates (continued)

Understanding the water use efficiency of sugar beet

By Georgina Barratt,
The University of Nottingham

Having started in October 2015 I am in the early stages of my PhD project which aims to further our understanding of sugar beet water use efficiency (WUE). This project will examine factors that affect sugar beet WUE and how they may be managed to enhance WUE in practice.

Background

I am originally from Essex but currently live in the East Midlands where I attended the University of Nottingham to study BSc Agriculture. I initially decided to study mechanical engineering at Nottingham but realised in my first year that it wasn’t for me. I already had an interest in agriculture and decided that I would be better suited to undertaking an agriculture degree.

I enjoyed studying both the practical science associated with farm operations and the wider skills needed for farm business management, but it was the summer at ADAS Boxworth where my understanding of crop research developed. From this I decided that I wanted to undertake a crop science PhD after graduation. The BBRO / University of Nottingham PhD project on offer was particularly appealing to me as it focuses on applied crop science and dissemination of information to growers.

Why focus on sugar beet water use efficiency?

Sugar beet yield is directly proportional to water use, as light intercepted by the crop drives both photosynthesis and water loss (Ref. 1). This means maximising sugar beet yield requires adequate water supply, but this is often restricted due to insufficient rainfall, or is financially un-justifiable with regards to irrigation. Additionally, water scarcity is an ever increasing threat, and sugar beet characteristics which enable yield to be maintained, or at least losses minimised, under water stress are of growing importance. In the UK, irrigation of the sugar beet crop is often uneconomical, but periods of drought in the season are common and can result in yield losses of up to 25% (Ref. 2).

Characteristics, which enable sugar beet to better withstand water stress whilst maintaining yield, are therefore of key interest and can be explored through the approach of water use efficiency (WUE) which is the focus of my project.

As my project is currently at an early stage I have been undertaking a review of existing research which relates to sugar beet WUE. Previous studies highlight the challenges in measuring water use due to the range of environmental factors which affect it. For this reason my early research will be focused in controlled environment glasshouse and large box experiments where it is easier to measure water use, with field experiments planned for later in the project.

My research

My initial work will focus on understanding WUE at the leaf level to develop a fundamental understanding of how sugar beet leaves control water use by the plant. At the leaf level WUE can be assessed by measuring the amount of CO₂ entering the leaf, to be used in photosynthesis for plant growth, compared to the amount of water lost through transpiration, as shown in Pic. 1. Water is lost as a consequence of this need for CO₂ uptake, and thus reducing the amount of water lost relative to CO₂ uptake can increase WUE. This CO₂ uptake and water loss occurs through plant stomata, which are tiny pores present on both sides of the leaf, and can be measured using a gas exchange system which attaches to the leaf, such as the LI-COR 6400XT shown in Pic. 2. Some water loss is necessary to drive nutrient flow through the xylem and uptake in the roots but more responsive stomata enable plants to manage water loss more precisely.

Sugar beet is derived from its wild ancestor, sea beet (Beta vulgaris ssp. maritima). It is highly adapted to live in a saline environment where plants encounter high levels of water stress as the salt in the environment means the concentration gradient encourages water to leave the plant. Sugar beet retains some of the characteristics which enable sea beet to survive saline conditions, and this is evident in the way it initially responds to
managing water loss, which is different to many other crop species.

Due to its ancestry sugar beet does not, however, initially respond to water stress by closing its stomata. This is because it retains a characteristic from sea beet whereby stomata can remain open for CO₂ uptake, and thus growth, under initial water stress. This is possible due to the ability of sugar beet to osmotically adjust, which means it is able to manipulate water gradients through the movement of solutes to ensure water is where it is needed to keep stomata open.

Keeping stomata open and continuing CO₂ uptake may at first appear beneficial, as it may be assumed this will help to continue growth and maintain yield performance under drought. This may not, however, be the case, as the process of osmotic adjustment can divert resources away from growth, and yield may not be maintained and the losses that are commonly observed under drought are incurred (Ref. 3). The behaviour of sugar beet stomata will therefore need to be fully understood to explain sugar beet WUE, and whether these stomatal responses can be manipulated, especially at times of drought, will be a key area of my project.

Alongside understanding how sugar beet responds to water stress, the influence this has on WUE and what management practices may be able to increase WUE, I will also look at whether physiological differences are evident between commercial sugar beet varieties and if these differences affect WUE.

I have undertaken some initial examinations of sugar beet stomata from plants grown as part of the other projects undertaken at Nottingham. To examine stomata, clear nail varnish is applied to the leaf where it is allowed to dry and adhere to the leaf to produce an imprint of the leaf surface. It is then peeled off and mounted onto a glass slide so it can be examined under a microscope. As expected, sugar beet stomata were observed to be more numerous on the bottom surface of the leaf than the top, as shown in Pics. 3 and 4. The top surface of the leaf is more susceptible to water loss and hence fewer stomata, compared to the bottom surface, reduce unnecessary water loss. This difference in stomatal number between the two sides of the leaf can vary between 20-40% depending on variety. Exploring physiological differences between varieties, such as stomatal density, may help in identifying what factors influence WUE in practice.

**Future work**

Based on my review of previous research, and the overview of the key points outlined here, there are three areas which I wish to explore initially to characterise how sugar beet control water loss. First, I will examine water losses at the leaf level and how leaf physiology changes in relation to the timing and severity of drought and the effect this has on WUE. Second, I will use glasshouse studies to look at the behaviour of sugar beet under water stress to further understand how the plant responds to water stress. Third, I will examine the response of sugar beet stomata in a number of commercial varieties to changes in temperature, humidity, light and CO₂ concentration, to identify how quickly they respond to changes in the environment. Through developing an understanding of the fundamental factors affecting sugar beet WUE, I can then undertake field scale experiments which will help to identify which management practices may be able to enhance sugar beet WUE on farm.

**Acknowledgements**

I would like to thank the BBRO and The University of Nottingham for supporting my PhD studentship. I would also like to thank my supervisors; Dr. Debbie Sparkes, Dr. Erik Murchie and Dr. Mark Stevens for their support and guidance.

**References**

PhD updates (continued)

Understanding water uptake in sugar beet

By Tamara Fitters, The University of Nottingham

Background

My project is looking at the limitation to water uptake in sugar beet. On average there is a 10% yield loss annually as a result of drought. In dry years this can increase to up to 25% yield loss (Ref. 1). We also know that sugar beet can grow roots to over a metre deep, but for some reason there is hardly any water uptake from depth. Around 80% of the water used by sugar beet is taken up from the top 30 cm of the soil (Ref. 2) and hardly any water gets taken up below 100 cm. There are several possible reasons why water uptake is so concentrated in the top layers of the soil. One of these is compaction. Another could be that the roots that grow at depth are not capable of water uptake due to physiological restraints. To find out what is really happening, several experiments have been conducted over the past two years.

What is possible?

To find out whether or not sugar beet could take up water from depth an experiment was conducted to look at uptake at different depths under different water regimes. This experiment was done in the glasshouse, in 1 m tall columns, in unrestricted conditions. Soil moisture content was measured continuously at 30, 50, 70 and 90 cm depth (Fig. 1). The results of this study showed that sugar beet does take up water from deeper layers as the layers above become depleted. These results showed that under unrestricted conditions deep root growth was possible and there was water uptake from depth. However, there appeared to be a delay in water uptake: after roots had grown to a certain depth, water was not taken up straight away. This might have been caused by a physical restraint in the roots that prevented them from taking up water. One possible reason is that the xylem is not mature yet, we are looking into that with a separate experiment. The next step was to find out what happens when there are restrictions in the soil.

Consequences of compaction

Again, a glasshouse experiment was done with 1 m tall columns, but this time the bottom 50 cm of the column was compacted to different bulk densities while the top 50 cm was not compacted at all. There were four compaction levels: 1.4 g cm⁻³ (no compaction), 1.6 g cm⁻³, 1.8 g cm⁻³, and 2.0 g cm⁻³. In this experiment the soil moisture content was measured in the non-compacted and the compacted parts of the column (Fig. 2). There were two findings that were particularly interesting:

1. With an increase in compaction there also is an increase in soil moisture content.
2. When there were high levels of compaction (1.8 g cm⁻³ and 2.0 g cm⁻³) there was reduced root growth.

From this we can conclude that, even though water is abundant in the compacted soil, it is not necessarily available for the plant to take up. Compaction severely impairs root growth and therefore water uptake. However, compaction at depth is difficult to resolve – one of the aims of Jake Richards’ project (see pages 42-45) is to look at the effect of cover crops on soil structure and on growth and water uptake by the following sugar beet crop.

Fig. 1 – Schematic view of a column with the placement of soil moisture sensors.

Fig. 2 – Schematic view of a column with the placement of the soil moisture sensors and the compacted lower section.
Upscaling a bit

Both previous experiments have been done in a glasshouse while looking at individual plants. To assess root growth under field conditions, a field trial was held where we grew three varieties of beet and then irrigated half of it while the other half was only rain fed. On two occasions we took soil cores to look at the root growth. Unfortunately, 2016 was extraordinarily wet and therefore we did not find a response to irrigation. However, we did find that there were varietal differences in root growth; one variety grew more roots compared to the other two.

Alongside the field trial, a box trial was carried out which allowed us to have total control over the water availability. Beet were grown in big potato boxes and half of them were left to dry out (Pic. 1). Once again we monitored the soil moisture content over time. The roots were also monitored with the help of a camera that could see through tubes inside the boxes. The soil moisture changed in the same way as we saw in our first glasshouse experiment; deeper soil layers get depleted when water becomes scarce in the soil layers above it. The changes in root growth over time are still being analysed. However we have already found that, over time, stomatal conductance significantly decreases when drought occurs. In Fig. 3 we can see that water uptake is severely reduced as the soil gets more and more depleted. This results in a significantly lower root dry weight and water content, compared to beet grown in well-watered conditions.

What’s next?

Since it is not possible to draw conclusions from one year of field data, we will be repeating the field trial this coming season. However, we will look at five different varieties instead of three. The varieties have been chosen based on their early rooting traits, whether they seem to have shallow or deep roots. Half of the field will be irrigated again and the other half will be rain fed. Soil cores will be taken to determine the root growth of the different varieties under different watering regimes. Stomatal conductance, soil moisture content and NDVI (normalised difference vegetation index – NDVI measures the live green canopy, the more green the higher the NDVI value) will be monitored over the season to see how the water availability changes these different parameters (Pic. 2). At the end of the season the beet will be taken to the factory and sugar yield determined. The two years of field data will enable us to explain more about the differences in root growth between different varieties and under different water availabilities.

Another box trial is also planned. This year, however, we will look at the difference between early and late drought, simulating a dry spring compared to a dry summer. The soil moisture content will be monitored closely and the overall plant health will be recorded. At the end of the experiment water use efficiency will be calculated to see if the timing of the drought has any influence on water use and if there is an effect on storage root growth. We will also monitor root growth at different depths again as the plants continue to grow. The information we gather from this should give us a better understanding of when a water shortage is more damaging: early drought or late drought.

All in all, we are working hard to get a better understanding of the limitations to water uptake in sugar beet. With this information we hope to give growers a better idea about the consequences of water limitations throughout the season. This project will highlight the sensitivity of sugar beet to drought at different points in the season. For growers who have irrigation capacity, this information might help to target water application at the most crucial time.

References

PhD updates (continued)

Beet Cyst Nematode – research update

By Alistair Wright, The University of Nottingham

It has been a busy year as I’ve been continuing with my PhD research looking into interactions between Beet Cyst Nematode (BCN), sugar beet and brassica crops. In cases of moderate infestation, BCN causes estimated annual losses in the region of £4 million each year across the UK (Ref. 1), and individual losses per hectare can exceed £450 (Ref. 2). My research is focusing on three main areas to control BCN and maximise beet yields. Firstly, looking at the canopy development of susceptible, tolerant and resistant beet varieties; secondly the controlled testing of different varieties in large boxes to investigate the response to BCN infestation; and finally the investigation of brassica cover crop varieties which have the potential to lower BCN populations prior to beet cultivation.

Aside from these areas of research, another important consideration is both on-farm hygiene and rotation length. BCN can go unnoticed for many years whilst populations build up on host crop species to damaging levels. Cysts can easily be moved around the farm on any implement which moves through the soil, such as cultivators, drills and, of course, beet harvesters. BCN infested fields should be, where practical, harvested together and then the harvester cleaned before entering uninfested fields, thus minimising the spread of the cysts.

Current BBRO surveys estimate that 6% of the beet growing area is infested with BCN (Ref. 3) but audience responses at the BBRO 2017 Technical Meetings showed that BCN is an issue for over 23% of attendees, and a further 29% weren’t sure if they had an infestation. If you have any suspected infested plants then they can be dug up and their lateral roots checked for cysts (Pic. 1). Cysts appear white when they are immature and can usually be seen from late May through to September. Samples can be sent to the BBRO plant clinic for confirmation of BCN.

Rotations in infested fields should also be kept at five or more years between hosts. Common crop hosts are beet, OSR and other brassicas. If you suspect an infestation, or are at risk of one developing, then soil sampling should be undertaken regularly, to check. If BCN is found, then a tolerant beet

Fig. 1 – BCN variety classifications.

Pic. 1 – Sugar beet root heavily infested with BCN with immature females present.
variety should be grown. Whilst we have had tolerant varieties available in the UK for the best part of a decade there is still more to learn about how they can be used effectively, and how the tolerance mechanisms work; this has resulted in the first two areas of my PhD research involving both the variety field trial and the BCN box trials.

Although 51% of the audiences at the BBRO Technical Meetings thought we have resistant varieties in the UK, this is not the case. There are three main types of varieties available in terms of BCN; susceptible, tolerant and resistant. Unlike our European counterparts we do not have BCN resistant beet varieties available to grow in the UK (Ref. 4) due to lower BCN infestation levels in the UK and the poorer yields associated with the resistant varieties. However, they could prove a useful tool as they do reduce populations without any additional changes to cropping. Also, in cases where short rotations are needed, they could be very beneficial by preventing population build-up.

Spring 2016 saw the planting of my first field trial at Sutton Bonington. This trial was aiming to look at the canopy development of sugar beet varieties which differ in their
susceptibility to BCN. Along with the introduction, by plant breeders, of the resistance trait from wild beet (*Beta procumbens*), additional negative traits have also been introduced to these varieties. From the variety study in the glasshouse in 2015, it was found that one of these traits was a less vigorous canopy, which was slower to expand and never reached the size of the commercial varieties. The field trial was established to test whether resistant varieties have a higher optimum plant population due to their less vigorous canopies. To monitor canopy expansion and development, a camera rig was created to take photographs directly above the plants at either end of the plot (Pic. 2). These could then be analysed to look at the green cover, and differences measured between the varieties at each of the seed rates.

The results from this trial showed that the resistant beet, when sown at a higher seed rate, could compensate for the smaller canopy per plant. The resistant variety was consistently the slowest to develop and expand its canopy, so would always need to be sown at a higher seed rate until these negative traits are bred out by the breeder (Fig. 2).

**BCN box studies**

The box study technique, developed at Brooms Barn (Ref. 5), has been further refined as part of my research.

Forty large boxes filled with 600 litres of top soil and each weighing well over a tonne, were planted with 16 beet last April. Half of the boxes were then inoculated with hatched juveniles (J2s) directly around the plants (Pic. 3). Each plant was infested with just under 3000 J2s and then the responses of the plants measured to see whether any more information about the tolerance mechanisms could be learned.

There may be many different tolerance mechanisms in operation within the beet and these may only be stimulated by infestation. The boxes allowed for both BCN reproduction to be measured and yield of the beet, which directly relates to the level of tolerance. As all BBRO variety trials for the recommended lists are conducted in the absence of BCN, a method to uniformly and reliably inoculate beet, such as these large boxes could become part of variety testing. This could allow for tolerant varieties not only to be selected for yield in ‘clean’ fields but also under infestation and allow growers to choose which will be best in specific field by field situations.

Interestingly, the results showed no significant difference in yield (Fig. 3). This indicates that infestation was not severe enough to cause significant damage to the beet, even to the susceptible variety. However, the yields do follow expected trends and it is hoped this year, when the experiment is repeated, an increase in infestation, coupled with earlier infestation, will result in more pronounced yield differences.

However, the reproduction data produced very interesting results (Fig. 4). The tolerant and resistant varieties produced significantly lower BCN populations at the end of the season, indicating a slower build-up of BCN populations versus the light tolerant variety and the susceptible control. This suggests that it is very likely that the tolerant varieties are partially resistant in terms of BCN hosting ability.

Dirt tare was also measured on the beet harvested from the boxes. The tolerant varieties had significantly lower dirt tares when infested than the other varieties.

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**Pic. 3 – Top: Beet growing in boxes. Bottom left: Beet being inoculated with juveniles. Bottom right: Cysts visible on lateral roots at harvest.**
Brassica hatch crops

Work is currently on-going looking at their effectiveness, and for any economic benefit which could be gained by planting a BCN resistant brassica before sugar beet. The results of this work will be available at the BBRO Open Days this summer.

Conclusion

The BCN research will continue for the next year allowing for more replicates of all three of the major experiments. These results, coupled with laboratory and controlled environment work, will provide a greater insight into the mechanisms at work in tolerant varieties and how these can best be used by growers to manage BCN.

Summary of results to date:

- Resistant beet would need to be established at a higher seed rate to achieve yields similar to commercial varieties.
- Tolerant beet result in slower BCN population build up.
- The tolerance mechanisms may be associated with rooting and canopy responses.
- Rotation length and on-farm hygiene remain important BCN management techniques.

Acknowledgements

I wish to thank the BBRO and The University of Nottingham for their joint sponsorship of my PhD, as well as my supervisors Drs. Mark Stevens, Matthew Back and Debbie Sparkes. The Morley Agricultural Foundation and BBRO are also thanked for their funding towards a new microscope. I’m also grateful for the support from British Sugar for supplying over 100 tonnes of top soil and Syngenta Seeds for the resistant beet variety.

References

Germaines Seed Technology commits to back British Farming

Have you ever considered what farmers contribute to the UK’s economy, culture and landscape? Farmers are responsible for maintaining the English landscape that is so valued but their primary purpose is to produce the majority of ingredients found in almost all of the foods we eat. What’s alarming is, that in the United Kingdom, the number of people regularly working in the agriculture sector has substantially decreased between 2000 and 2010, as about 97,000 (18.8%) people stopped working on the farms. Currently, the agricultural labour force represents only 1.4% of the British active population (Ref. 1). Sadly, countries in the EU and the United States are reporting similar statistics. When you compare the United Nations 2015 world population reports, that are forecasting the population to grow from 7.2 to 11.2 billion by 2100 (Ref. 2), to the fact that only 1.4% of the British population is farming (and the same likely holds true for other developed nations), that is a tremendous reason for concern.

In a race to meet the world’s growing demand for food, plant breeders are making incredible advancements in new, hybrid varieties for a multitude of crops, and companies such as Germains Seed Technology are developing industry-leading innovative seed treatments to maximise the yield of crops such as sugar beet, vegetables, and flowers. Other advancements and scientific breakthroughs are being made in all segments of the agriculture industry, but what good will these advancements be if we do not have enough farmers today, or in the future, to produce the crops to feed the growing population? We need also to ask, what can organisations do to support today’s farmers, and attract future generations to pursue a career in farming, so that we can meet the demand?

Addressing the need to back British Farming

For over 50 years, Germains Seed Technology has been providing UK sugar beet growers with innovative seed technologies that help maximise their crops’ potential. Due to its successes in helping sugar beet growers improve plant populations, produce earlier and more uniform crops, and increase yields, the company has been able to diversify its portfolio of seed treatments to include industry-leading seed treatments for several varieties of vegetables and flowers.

Understanding that UK growers face more than just environmental changes, labour shortages and global market competition, Germains is also striving to reach out and help the UK’s grower community by providing resources such as updated informative materials and extensive field trials, and is adopting more transparent business practices, so that we support farmers however possible.

In 2015, Germains opted to invest in their commitment to back UK growers by recruiting Tessa Seymour as the Commercial Development Manager. Tessa is the spokesperson for Germains Sugar Beet division, and is responsible for identifying and being actively involved with the major organisations that support UK growers.

Carrot seed coated with Germains’ conventional and organic seed pellets.
Attracting future UK farmers is a Must!

Germains has become a prominent supporter of agriculture events that engage the UK’s future farmers: essentially the country’s children. Germains participated with Monach Farm at the ‘Kids Country Food and Farming Day’ event in 2016. This annual event hosts approximately 5,500 children from over 50 primary schools across the Eastern region of the UK. The event is dedicated to educating children and teachers about all there is to know concerning the origins of food, farming, and the countryside. This year, Germains will be present at both the Suffolk Agricultural Associations’ School Farm and Fair and Kids Country Food and Farming Day. In order for the UK’s agriculture to move to self-sufficiency, Germains believes that it is vital for the industry to start educating school children on the importance of farming, in the hope of attracting future generations to pursue careers in farming.

Learning to milk baby goats at Monach Farms.

Educating UK sugar beet growers, one tour at a time

Since taking on her position, Tessa has been actively hosting plant tours at Germains headquarters in King’s Lynn. The purpose of the tours is to give farmers a clear understanding about the seed treatments that are applied to the seeds they plant in their fields. The tours offer farmers the opportunity to ask questions and to exchange ideas about problems they are having in the field that Germains may be able to solve by developing a new seed technology. For generations, Germains has earned its good reputation in sugar beet. However, as more and more UK farmers opt to

Learning to milk baby goats at Monach Farms.
international organisations and community groups, and is working directly with farmers so that they may collectively develop strategic methods to support the UK’s farmer community. Not only is it vital that the farmers of today be provided with support via various means, but it is essential that farm education be introduced to children so that they may consider a career in agriculture. If we are going to sustain the UK’s food supply, it is vital that we support the industry, however possible, one farmer at a time.

About Germains Seed Technology

Founded in 1871, Germains Seed Technology began developing solutions to maximise the yield of sugar beet nearly a century ago. Germains revolutionised the sowing of sugar beet by introducing one of the first seed pellet technologies to the agriculture industry. Our in-depth knowledge of the sugar beet industry has allowed Germains to invest in, and diversify, our portfolio. Today, Germains Seed Technology is committed to delivering industry-leading innovative seed technologies for sugar beet, vegetable and flower seed producers and growers globally.

Specialising in seed priming, pelleting, filmcoating, health, and polymers, our team of industry experts are here to work in collaboration with grower and seed producers to provide seed treatments that are appropriate for various crops, cultivation practices, and environmental conditions. Germains seed treatments deliver value throughout the seed supply chain, ultimately helping both conventional and organic growers to improve their crop’s performance in the field or greenhouse.

References

USA sugar beet experience – the battle against cercospora leaf spot

In August 2016 I moved to Fargo, North Dakota for a six month research placement at the USDA-ARS Northern Crops Science Laboratory with Dr. Melvin Bolton. My research was concerned with cercospora leaf spot (CLS) a foliar disease of sugar beet caused by the fungal pathogen Cercospora beticola. I had an extremely exciting and interesting experience whilst working in Fargo. I learnt numerous valuable laboratory skills and techniques as well as gaining plant pathology knowledge attending lectures and seminars. Importantly it gave me a much wider perspective of the problems that crops face.

The Red River Valley

In the USA, sugar beet is grown in 5 regions encompassing 11 states. Two regions are situated east of the Mississippi River whilst three are in the Great Plains and Far West. The largest and most dynamic region is situated in, or close to, the Red River Valley of western Minnesota and eastern North Dakota (Pic. 1). This region accounts for at least 50% of the total planted USA sugar beet acreage, and the crop is produced by three grower-owned cooperatives: American Crystal Sugar Company, Minn-Dak Farmers and Southern Minnesota Beet Sugar (Ref. 1).

Pic. 1 – Distribution of sugar beet crop production in the USA.
The USDA-ARS Northern Crops Science Laboratory (Pic. 2) is located in Fargo, on the campus of North Dakota State University (NDSU) which is right on the border between the states of North Dakota and Minnesota.

Cercospora leaf spot

Members of the Fungal Kingdom are ubiquitous in nature and, over the course of evolution, fungi have adapted to occupy specific niches. Modern agricultural cropping systems harbour fungal plant pathogens which result in disease development. *Cercospora beticola* is a parasitic fungus species infecting sugar beet. This pathogen is endemic in all sugar beet production areas, and is considered the most destructive foliar pathogen of sugar beet worldwide. Yield and quality losses from CLS, in conjunction with costs of extensive fungicide applications, result in annual losses in excess of several million dollars in the USA alone. CLS is so damaging because it causes significant reductions in both the harvestable root weight and the extractable sucrose, owing to a reduction in photosynthetic capacity as well as diversion of photosynthate away from roots to regenerate foliage killed by the pathogen. Warm, humid growing regions are most severely affected by CLS; these constitute greater than 30% of the area under sugar beet cultivation worldwide. The situation is only likely to be exacerbated in the future if the forecast of more extreme climatic variations is correct, and the evolution of fungicide resistance in most *C. beticola* populations occurs.

Whilst collecting leaves for laboratory analysis, I witnessed for myself how badly the 2016/17 crop was affected in North Dakota (Pics. 3 and 4; Ref. 2). Characteristic symptoms of CLS include the random distribution of tan to light-brown leaf spots with reddish borders, typically 0.2-0.5 cm in diameter across the surface of mature leaves (Pic. 5); in some cases the spots coalesce.

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**Pic. 2 – The USDA-ARS Northern Crops Science Laboratory-Fargo, ND.**

**Pic. 3 – Harvest of a CLS field trial in September.**

**Pic. 4 – A sugar beet leaf severely infected with CLS.**

**Pic. 5 – A leaf spot under a light microscope.**

**Pic. 6 – Coalescing of spots with cell collapse.**
Located at the necrotic centres of spots, stromata can be visible as minute black dots. Lesions produced by CLS feature near-simultaneous collapse of cells (Pic. 6) in an area many millimetres in diameter. Ultimately, a combination of numerous lesions and accumulation of phytotoxins induces complete leaf senescence, and blighted leaves soon fall from the crown (Ref. 3).

**Fungicide resistance and CLS**

Few mitigation strategies exist to combat CLS. Crop rotations including non-host crops, as well as using fields at least 100 m away from land used for beet in the previous year, have been demonstrated to effectively control outbreaks. Fungicides are unlikely to be a viable solution indefinitely. Tetraconazole is the active ingredient in the class of sterol demethylation inhibitor (DMI) fungicides. These act by blocking an enzyme required for the biosynthesis of ergosterol, a component of the fungal cell membrane. Without an intact cell membrane, degradation of the organism takes place. However, *C. beticola* is a ‘high-risk’ pathogen for developing fungicide resistance, due to its high genetic variability, abundant sporulation and polycyclic nature. The reliance on tetraconazole, particularly with its high number of repeat applications, has exerted a selection pressure on *C. beticola* populations (Ref. 4).

Clearly, there needs to be a greater understanding of the molecular interaction between *C. beticola* and tetraconazole in the hope of overcoming resistance. Trying to understand the molecular basis of fungicide resistance is one of Dr. Bolton’s primary research objectives.

**Laboratory studies at the Northern Crops Science Laboratory**

We initiated a project utilising a strategy called Genome Wide Association Study (GWAS) with the aim of identifying, in the genome of *C. beticola*, mutations that are associated with tetraconazole resistance. GWAS is a powerful tool that can determine the genetic basis of resistance (Pic. 7).

Firstly, we collected CLS infected sugar beet leaves from a field in North Dakota. Back in the laboratory, we isolated *C. beticola* spores and cultured them on growth media. DNA was extracted from each isolate and then subjected to Polymerase Chain Reaction (PCR). We also performed EC50 tests which determine the fungicide dose required to cause 50% inhibition of germination of the isolate as compared to a non-fungicide-amended control (Ref. 5). Using these data, we selected a set of resistant, sensitive and intermediate isolates to take forward. We sent off the DNA for whole genome sequencing so that bioinformatics analysis can be performed on the results.

The end goal of this project is to be able to deploy spore traps in growers’ fields. Scientists will then collect the spore samples and assay the *C. beticola* spores to identify the percentage of them that are resistant to tetraconazole.

Growers can then make an informed decision as to whether or not they should apply a fungicide, and what type they should utilise. As well as growers saving money by reducing unnecessary applications, the selection pressure on *C. beticola* will be reduced. Importantly, it would also improve our understanding of the evolution of fungicide resistance.

**Acknowledgements**

I am very grateful to The Morley Agricultural Foundation for funding my research project in the USA and to Dr. Melvin Bolton and Professor Gary Secor who were my supervisors. I am also thankful to Dr. Mark Stevens for first introducing me to Dr. Bolton and Professor Secor.

**References**


![Pic. 7 – Genome Wide Association Study workflow.](image-url)
Growing for potential gains

The Beet Yield Competition (BYC) is now underway following the launch at the recent BBRO Winter Technical Events. Thirty two growers have engaged in the project and everyone is off the starting blocks with soils tested and drilling complete. The competition covers 440 ha with fields ranging from 3 to 31 ha, including headlands. The programme will include an in-depth look at crop development and the elements influencing that all-important yield potential. As part of the soil analysis we have tested for N, P, K, Mg, pH and organic matter, providing a sound base of data to work from. The soil textural classification has provided a vast range of variables, which will be really interesting to compare across the growing area. Of course, whilst we are all aiming for an increase in yield compared to previous years, this has to be balanced against the unknowns, such as weather and the impact of pests and diseases.

The BYC is a collaborative partnership between BBRO, British Sugar, NFU Sugar Board and Hutchinsons, with independent support from agronomist and adviser, Philip Draycott. It aims to support growers to improve their crop performance: identifying small changes to practice that can provide overall gains. British Sugar Area Managers will be working closely with growers to assist in the monitoring of the crop and data collection, whilst BBRO will interrogate the data and process it using the BeetGro model. BBRO have also engaged the services of KisanHub; a data analysing company who work with multiple data sets from different sectors. Crop development will be monitored throughout the growing season, utilising remote sensing and satellite data to ascertain establishment and crop canopy development, this element will be managed by Hutchinsons.

Those participating will receive a full report, bespoke to them, with advice for improving their performance in the future. The growers achieving the highest percentage of their potential yield will win an all-expenses-paid trip to Spain, to take in the harvesting of the over-winter beet crop in the South, and the establishment of the crop in the North. The winners will also visit AIMCRRA, the Spanish equivalent of the BBRO, to discuss their current research portfolio. Please follow the progress of the competition on the BBRO website www.bbro.co.uk/on-farm.
The BBRO Stakeholder Board

I would like to extend a warm welcome to Andrew Dear who has recently joined the Stakeholder Board. Andrew is based at the Cantley factory and brings a great deal of industry knowledge to the board; we look forward to working with him. Andrew has replaced Paul Simmonds who was Yield Development Manager for British Sugar and has now moved to a new role within the company. Paul joined the Stakeholder Board with a wealth of industry knowledge, including time spent at Cornerways at Wissington, and has been a key member of our team. Along with Susie Emmett, Paul has overseen the development of our new website and contributed fully in the work we do. We thank him for his commitment to, and hard work for, the BBRO, and wish him every success in his new role.

The Stakeholder Board has been busy evaluating potential new ideas for research projects, following our Crop Stability Call in September 2016. At our last meeting, we were presented with a wide range of proposals from different areas of our industry. Projects put forward ranged from electrical weeding, forecasting and monitoring virus yellows and their resistance to neonicotinoids, and understanding the influence of maize on the emerging threat of rhizoctonia. The projects are also scrutinised by the Technical Board who check each proposal for scientific content and rigour. Dr. Debbie Sparkes from the University of Nottingham chairs the Technical Board and keeps the Stakeholder Board informed of their technical recommendations.

Of the initial 16 applications, we have given full support to the following two:
1. Understanding variety-fungicide interactions: maximising future yield potential. Mark Stevens, BBRO.
2. Managing resistance evolving concurrently against two modes of action, to extend effective life of fungicides. Dr. Neil Paveley, ADAS.

There were a number of elements in the remaining applications that were of interest, including use of digestate and its potential risks to soil/crop health, alternative weeding methods for the crop, and insecticide resistance management; these will all be pursued further.

From me, a big thank you to all of those who have registered for the Beet Yield Competition. We are looking forward to seeing what the next crop brings... and seeing the lucky winners enjoying a study tour to Spain where the sugar beet crops probably enjoy a little more sunshine!

I hope you all enjoyed the Winter Technical events held in February. We had two fantastic thought-provoking events, and I would like to extend my thanks to all the speakers, in particular our PhD students who presented updates on their research. If you were unable to attend, please check out the events page of our website for the presentations.

Plans for our BBRO Open Days are now underway, so keep an eye out for your emailed invitation. The BBRO really value the opportunity to meet with all growers and the wider industry; the Open Days are a great opportunity to hear your feedback, meet and exchange ideas and plan future developments.
Dr. Malcolm Branch was one of the most respected and influential managers in the history of British Sugar. He played a key role in developing and advancing the technology, people and overall business efficiency of the company, putting it in the vanguard of the European sugar industry. He was respected not only within British Sugar, but also around the sugar world for his knowledge, integrity and commitment.

Malcolm started work at Ipswich factory in September 1963 as a graduate trainee. Ipswich was undergoing a large investment programme at the time, and expansion and reconstruction projects were to be a constantly recurring element of his career.

In 1964 he started work at Central Office, Peterborough, as part of a small team working on a sugar factory process modelling project. This was something that he would become very committed to, leading later to him obtaining a PhD from Cambridge University for a thesis on mathematical modelling and the automation of a sugar factory.

Malcolm moved to Wissington in the late 1960’s, first as shift superintendent, and then progressing on through the role of reconstruction superintendent to that of assistant factory manager. He was a key figure in transforming Wissington from a small factory producing only raw sugar, into British Sugar’s biggest white sugar factory. People development was a passion for Malcolm throughout his career, and many people have greatly benefitted, owing their success to his belief in giving people opportunities to continuously develop their knowledge and experience.

There are many anecdotes about Malcolm that have passed into company folklore, but the one that he will probably be most remembered for is the accidental re-shaping of a bulk molasses storage tank where he, with some assistance, managed to implode the vessel, thereby proving conclusively that all tanks need to be vented when being emptied. Even Malcolm was not infallible.

Malcolm later moved to York as works manager, and then to Bury St. Edmunds as factory manager. In 1984 he was promoted to the new role of group production manager, giving him oversight of Ipswich, Bury St. Edmunds, Newark and York factories – a role that he loved, as it gave him the opportunity to have a major impact on several factories, and thus the company as a whole.

In 1986 Malcolm was appointed to the main board of British Sugar, as production director. At the time the board was initiating a programme of overseas investments – something that Malcolm was passionate about. The formation of the SugarPol joint venture in 1989 saw British Sugar having a controlling shareholding in two small factories in Northern Poland. The investment in SugarPol also gave Malcolm an opportunity to continue his relationship with Harvard University in Boston, Massachusetts, where a few years earlier he had gained an MBA. Other foreign trips included one to the Soviet Union to investigate the possibilities of developing the industry, as a guest of Alexander Rutskoy, who was then President Yeltsin’s deputy.

In 1976 he visited a new small factory in Yian province in Northern China, a factory that was purchased some 30 years later by British Sugar Overseas. He also worked very closely with the Beta San Miguel group in Mexico for a short time.

In 1993 Malcolm, now operations director, took over responsibility for British Sugar’s agricultural department, a role which he relished and used to create greater understanding about the impact on sugar processing of fertiliser inputs such as nitrogen and potassium.

Malcolm retired in October 1996, after 33 years of total commitment and dedication to the company. His role over that time was pivotal in transforming British Sugar from a small, and not particularly efficient company, into the major international business it is today. Through his enthusiasm and drive he helped develop employees at all levels to achieve higher performance than was ever thought possible. He established a reputation for himself, and British Sugar, that was respected not only at home, but across the world.

To this day, a plaque still hangs on the stairway at Wissington factory, paying tribute to Malcolm’s many great achievements, not least of which was the further expansion of Wissington in the early 1990’s, allowing it to become one of the biggest sugar producing factories in the world. This permanent tribute to his contribution still remains unique within the business. From a personal perspective, he will always be one of the most inspirational characters I ever had the privilege to work with.

By Robin Limb
(with acknowledgement to Peter Robbins for his contribution to this obituary)
BBRO field team

On the back of one of the most successful trials harvesting seasons we began a challenging drilling season that was helped by great weather for drilling sugar beet. The weather always seems better when things go well!

Before the drills could get going in the fields, the BBRO team had been finalising the trial plans as well as servicing and calibrating the drill, and undergoing training updates both for using it and for setting up the John Deere hire tractor’s RTK interface with the drill.

The meticulous process of putting together field plans began back in the winter. Following trial protocols, fields were selected and tested to check that trials could be situated in them. Once the fields were chosen Gina Gould, one of the BBRO trials officers, produced electronic plans of all the proposed drilling sites. These plans are used to place as many different trials as possible at the BBRO sites. As they are followed by the drill operators in the field, they need to be as accurate as possible and show trial sizes, plot lengths, tramlines and drill start points. During drilling these were extremely successful and a credit to the team that put them together for 2017.

For 2017 the BBRO has drilled around 5,000 plots over eight different sites in the sugar beet growing area. It is important to note that more plots could be drilled in one single location, however, we believe having different locations over the sugar beet growing area is vital to obtaining a representative spread of trial results. Operationally, this poses a problem and can lead to chasing correct drilling conditions but never finding them. There is a lot of thought and effort put into delivering plans that achieve fast movement of machinery to and from various sites. Good planning and constant communication between myself, the trials officers and host growers ensure we lose only the smallest amount of time due to the logistics and challenges of drilling all over the sugar beet growing area.

Drilling began on the 14th March, which was two weeks later than I thought it would be following the dry early spring. The team began drilling the BBRO’s largest trial site at Bracebridge Heath on the 15th March, and the trials here were watered-in nicely with rain that fell, on and off, for the following week. The BBRO team continued drilling once it was dry enough to commence again and wrapped up the first round of drilling by the middle of April. Only the late drilling sequences were left following the successful main spring drilling. Another point to note is that, once drilling has begun, it triggers more field operations that put pressure on the trials team and commercial growers alike. Once the nutrition trials were drilled, fertiliser needed to be spread. After the seed treatment trials were drilled, soil temperatures needed constant monitoring to action teams to complete emergence counts, with the first count being at 25% crop emergence. It is a challenge to achieve this protocol milestone, as within 24 hours the milestone can be hit or missed.

Moving on from drilling, the team will focus on continuing to manage their sites to the highest standards, ensuring all measurements and assessments are completed. Also we need to ensure the BBRO Open Day sites at Morley and Bracebridge Heath are maintained and ready to greet the many growers and advisers over the season to help facilitate good Knowledge Exchange for the levy payers and the industry as a whole.

If you have any questions please call me on 07850 369849 or any of the other BBRO team members on 01603 672169. I look forward to meeting you at the 2017 BBRO Open Days.
Spring 2017 has been a busy time, including time spent with new growers, guiding growers and drill operators on the sowing of this year's crop, setting up demonstration sites, and supplying LimeX.

Before drilling started it was a good time to spend with some of the new growers we have in the Bury area, discussing with them the basics of sugar beet seedbed preparation, nutrient requirements and herbicide choices.

Sowing of the 2017/18 beet crop started tentatively on the sand soils on 13th March, moving to heavier soils as conditions improved; drilling was all but complete by the first few days of April. Soils dried incredibly quickly in this period, and with parts of the Bury area seeing no more rain through the rest of the drilling window this year, it soon became obvious that getting seed to germinate in dry soils would be challenging. Fortunately, soil temperatures were favourable, and the decision to try and drill deeper into moisture was easy because soil temperatures were high.

The settled period of weather was matched with a period of warm nights meaning that the crop germinated and emerged extremely quickly, with crops reaching expanded cotyledon in 14-21 days. This led to decisions concerning early herbicide being relatively easy as weeds too were growing fast.

New for 2017, the BBRO are setting up a series of Demonstration sites. We are fortunate at Bury in that Rougham Estate Farms has been chosen as one of these sites. The site is near the factory, and central to the area with good access. Simon Eddell the farm manager at Rougham has been very supportive and allowed the use of one of the fields on the farm.

The field itself grew a cover crop over the winter; this was grazed by sheep, and then three separate cultivation methods were used over the top: the non-inversion method employed on the farm as a whole, ploughing and strip-tillage. Different varieties of sugar beet were also sown. This will form a platform for other treatments to be laid over as the season progresses. The site will be used for grower discussions and will be used throughout the growing season to discuss topical issues.

As well as the usual activities around the supply of LimeX, including soil sampling, the technical support team have also been assisting the LimeX manager, Richard Cogman, in finding sites for trials work to examine LimeX in a variety of different crops, in particular this year onions and a crop of vining peas.

The beet crop has got off to a good start this spring and I look forward to seeing it reach its full potential.

Andrew Creasy, Area Manager

As I approach my retirement in April, after nearly 40 years with British Sugar, it is good to see the fields in such good condition following a relatively dry autumn and winter combined with some frosty nights.

This has left the fields looking full of potential; however, the recent damp spell means patience is required and the soils should not be worked when they are too wet. Currently a dry spell is forecast but I hope these are not famous last words.

The successful campaign finished in late January at Cantley. However, yields were extremely variable due to the wet weather of late spring and early summer 2016; although higher than anticipated, at 70.27 adj. t/ha, they were still slightly disappointing compared to the 80 adj. t/ha of 2015 and the 90 adj. t/ha of 2014. The year I started (1977), the yield was 39 adj. t/ha and was considered a good year after the drought of 1976.

Last autumn all work was completed on time, with the lighter soils ploughed in February and March, again in good conditions. To take full advantage of this potential, growers got their drills tested and some visited the BBRO drill training day at Morley Research in early February. There they took advantage of the presentations by the BBRO and manufacturers on how to achieve the best sowing conditions and high establishment to produce a uniform plant stand of around 100,000 plants/ha. Tip of the day was to keep coulters ‘V’ shaped so that they provide good seed to soil contact. In 1977 we were aiming for 80,000 plants/ha but achieving 55,000 to 65,000. Laboratory seed germination was 80-85%, compared to 95% plus now. Another chance to catch up with the latest developments within the beet crop was at the BBRO Technical Meeting at Woodditton in mid-February; this was attended by Bury and Cantley growers, and was another successful day.

Seedbed preparation has changed totally from 1977; then it was roll, springtine, harrow, harrow, drill, roll. There was certainly no lack of consolidation, but the many wheelings caused compaction. Today we achieve the best seedbed from one or two passes with suitable wide wheels and low tyre pressures fitted. As I write this, a drier spell has just started; that should allow drilling to start mid-March; growers with wetter soils hopefully will hold back until field conditions are right. I am optimistic that this will allow the bulk of the drilling to be completed on time, and into ideal seedbeds.

Hopefully the first nitrogen will be applied at drilling, or within two days post-drilling to get early nitrogen take-up and quick leaf area growth. About 40% of the beet area will receive a pre-emergence herbicide, with the remainder receiving post-emergence only. Back in 1977, chemical rates were three times higher than those used now. We had a limited range of chemicals, harsh formulations and crop damage was often seen. This could be quite severe but knottgrass had a habit of surviving, due to the later timings. However some growers were still chopping out and using no, or very little, herbicide. Will robots make the full circle in the future?

Stephen Brown, Area Manager
Is sugar beet an excellent achievable. In addition hec tare should be excess of £600 per mileage limit now extends into the old York, Kidderminster yield, net margins in sugar market bonus, of existing growers in green and new growers for 2017 in red. The allowed growers to take advantage of late delivery allowance and just-in-time delivery, with some beet not being harvested until late 2017/18 campaign, mainly due to the increase in the transport seen in previous years, but this still came as a surprise to many of us, at the growing beet crops, as well as supporting on-farm agronomy by 90 plants per chain equates to 90,000 plants per hectare on 50 cm growers also took the showers. By the end of March, around 60% of the crop at Newark was account the potential growth and harvesting; this saved any need to sheet stored beet, and largely from North Yorkshire and the West Midlands but also from the existing growing area. Figure 1 shows the spread of existing growers in green and new growers for 2017 in red. The increased mileage limit now extends into the old York, Kidderminster and Alsott factory areas; the opportunity to grow sugar beet after a break of more than ten years is an attractive option for farms in these fertile areas. Taking into account the potential sugar market bonus, along with an average yield, net margins in excess of £600 per hectare should be achievable. In addition sugar beet is an excellent break-crop and that provides an opportunity to use different chemistry for black-grass control in the rotation. A number of these new growers also took the opportunity to backload LimeX70 at the end of last campaign, giving pH correction as well as being a valuable source of phosphate, magnesium and sulphur.

Drilling for the 2017 crop started around the 10th March but progress was slow to start with, owing to repeated interruptions by rain showers. By the end of March, around 60% of the crop at Newark was drilled, with the remainder following close behind. By the time this issue lands on door mats the Area Manager team will be busy looking at the growing beet crops, as well as supporting on-farm agronomy by compiling personalised grower yield plans. Behind the scenes, plans are currently being put in place for our Industry Harvest and Haulage Scheme for the approaching campaign.

Now is also the ideal time to do some quick plant counts across your beet area to check that you are achieving the optimal 100,000 plants per hectare;- the easiest way to do this is to measure one chain (22 yards/20.1 metres) and count the number of plants, for example 90 plants per chain equates to 90,000 plants per hectare on 50 cm rows, and unless there is an obvious reason for reduced establishment, this would suggest that in future years, a higher seed rate is needed for maximum yield.

Matt Booth, Area Manager

Fig. 1 – Existing growers in green and new growers in red.

One of the most common arguments from farmers against sugar beet is, “My following winter wheat crop will suffer from the late harvesting of sugar beet”. We could have a long debate as to the benefits of leaving sugar beet in the ground and maximising its potential, against the yield and income from early or late drilled winter wheat. However, beet is certainly gaining ground in the silts where leaving their beet in the ground to maximise its yield has clearly become ‘the norm’. These are the veg brassica growers who will not be sowing their ex-beet land until late spring or early summer. Yes, they still have to manage their land correctly, particularly soil structure, and yes they still have to choose soil types carefully in order to do this. However, the benefits of late lifted beet in terms of additional yield and income, via just-in-time harvesting are massive. Furthermore, the benefits to the hauliers in spreading their deliveries is also extremely useful, and it also gives the growers’ confidence that they have the opportunity to get land ploughed and put into good condition well before the following crop. This increases their sugar beet profitability, making it a valuable crop for them and fits well into their wider rotation.

Now: mention LimeX and most of you immediately think about raising soil pH and correcting acid patches. Then think again, because for many on the silts, LimeX also controls clubroot in vegetable brassicas and oil seed rape. Very often those who have vegetables and beet in the rotation, also have potatoes as another key crop. So where clubroot issues occur or soil pH is low, there is very often the need to apply lime. Understandably, there is a concern regarding the use of lime in the potato rotation, based on the longstanding attitude that this causes common scab, and it is something we are taught at college not to do! Therefore, in contrast to conventional wisdom, we set out to disprove this age old myth. In 2012 we conducted the first of our fully replicated potato trials in the South Lincs area, concluding in 2015 after a further 11 trials across a range of soil types, growing the susceptible variety, Maris Piper. Over this time there has been a huge change in the thinking around scab control, the role of calcium as a macro nutrient and how it can influence the crop’s ability to withstand diseases and help with calcium nutrient deficiency symptoms.

Following our consistent findings there has been much discussion with third parties such as CUF (Cambridge University Farms), AHDB, ADAS, processors and processing organisations, to influence this new approach founded on good science. As our trials work in many differing crops shows, we are making real differences to crop performance. So it has been pleasing over the last two years to be able to organise and be involved in numerous grower and adviser meetings to demonstrate our findings (not forgetting sugar beet of course!) and try and change age-old beliefs. This knowledge transfer is something we will actively continue to do going forward. A very long way to go, but watch this space...

Barry Goodale, Area Manager
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Unbeatable adjusted yield at 106.9% of controls*
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*BBRO Recommended List of sugar beet varieties (based on trials from 2014 – 2016)

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